Mongolia

Project for Strengthening Capacity of Macroeconomic Policy and Planning

Project Completion Report

April 2023

Japan International Cooperation Agency

Project Completion Report

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Abbreviations

ADB	Asian Development Bank
BOM	Bank of Mongolia
C/P	Counter Part
CGE	Computable General Equilibrium)
COVID-19	Coronavirus disease 2019
DSGE	Dynamic Stochastic General Equilibrium
ERI	Economic Research Institute
FP	Financial Programming
GAMS	General Algebraic Modeling System
GTAP	Global Trade Analysis Project
IFI	International Financial Institutions
IMF	International Monetary Fund
JDS	The Program for Human Resource development Scholarship by Japanese Grant Aid
JICA	Japan International Cooperation Agency
McDEP	Macroeconomic Policy Division, Economic Policy Department, Ministry of Finance-until Feb. 2021] Macroeconomic Policy Department, Ministry of Economy and Development - from Feb, 2021 to date
MED	Ministry of Economy and Development
MOF	Ministry of Finance
NSO	National Statistics Office
PEP	Partnership for Economic Policy
PEP1-1	One country Static CGE Model of PEP
PEP1-t	One country Dynamic CGE Model of PEP
PJ	Project for Strengthening Capacity of Macroeconomic Policy and Planning
SAM	Social Accounting Matrix
T21	Threshold 21 https://ledsgp.org/resource/threshold-21/
UNDP	United Nations Development Programme

Ⅰ. Basic Information of the Project

1. Country: Mongolia

2. Title of the Project: Project for Strengthening Capacity of Macroeconomic Policy and Planning

3. Duration of the Project (Planned and Actual)

Planned: December 2019 – December 2022

Actual: December 2019 – April 2023

4. Background

Description in "the Summary of the Project" dated July 26, 2019 by JICA

The Mongolian economy is heavily dependent on natural resources and volatile in the fluctuation of international commodity prices and the economic performance of China. For economic development, it is necessary to diversify its economic and industrial structure away from the resource-dependent, together with economic and fiscal stability in the medium and long term. Sustainable fiscal stability requires precise and verifiable macroeconomic projections

The Government of Mongolia is applying macroeconomic planning tools such as T21 model and CGE (Computable General Equilibrium) model. T21 model would not be sufficiently applicable nor CGE modeling is not in practical use. IMF made a suggestion for the economic authority to have multiple scenarios for the economic prospect. The economic and financial authorities are facing some difficulties in utilizing economic modeling tools such as CGE due to insufficient skills and knowledge. Furthermore, it would be required for economists of the Ministry of Finance to strengthen their organizational capacity of evidence-based and to make a prospective scenario. At the same time, it would be essential to quip and utilize analytical and predictive tools for economic projections, which form the basis of national policies in each development goal.

On these backgrounds, technical cooperation was requested to improve the CGE modeling work for practical use and upgrade the capacity of officials of the Ministry of Finance in evaluating and analyzing macroeconomic consequences.

It should be noted that IMF launched the extended fund facility to Mongolia in May 2020, and the international support framework was formed up to 5.5 billion USD by IMF, World Bank, ADB, Japan, China, and South Korea, where each party extended fiscal support programs.

Toward May 2020 when these programs would finish, the Government of Mongolia should take the initiative in maintaining its fiscal health. Therefore, it could be an urgent challenge to strengthen the capacity of macroeconomic analysis in the Ministry of Finance.

Under the COVID-19 Pandemic; quoted from IMF documents

The initial emergence of the pandemic was quickly contained. When the COVID-19 virus reached Mongolia in early 2020, the government immediately declared a state of high alert and closed the border with China. These prompt and strong measures quickly and effectively halted the spread of the virus. However, a gradual relaxation of containment measures for the 2020 Parliamentary and 2021 Presidential election campaigns led to the first cases of domestic transmissions of COVID-19 in November 2020, followed by Mongolia's first wave of the pandemic in 2021. Stringent domestic containment measures were reintroduced, including intermittent nationwide lockdowns.

The new government, which took office in 2020, adopted a long-term development strategy, Mongolia Vision 2050, which prioritizes macroeconomic stability and green and sustainable development, broadly in line with Mongolia's Sustainable Development Goals (SDG).

5. Overall Goal and Project Purpose (from Record of Discussions (R/D))

[Overall Goal]

The capacity to develop the pluralized macro-economic scenarios for the sustainable development is enhanced.

[Project Purpose]

The capacity to formulate macro-economic policy is enhanced.

6. Implementing Agency

Up to February 2022:

Macroeconomic Policy Division of the Economic Policy Department,

Ministry of Finance

From February 2022 to present

Macroeconomic Policy Department

Ministry of Economy and Development

Ⅱ. Results of the Project

1. Results of the Project

1-1 Input by the Japanese side

Experts	Planned	Actual
Long-term Expert (Chief Advisor)	March 2020 to December 2022	April 2021 to April 2023
Short-term Expert	1 MM for 3 years	None

- Soft and Hardware: Transferred in April, September and December 2022 (details see ANNEX-1)
- Project Assistant: Contracted from November 2021 to March 2023
- Remote lectures from Japan: 4 lectures in total of 10.5 hours
- GTAP Center (Purdue University)
  GTAP Short Course 80 hours
- Local consultants:
  SAM construction and Multiplier training 205 man-days
  CGE Modeling and training – 548 man-days
  "R" language and application to statistics 16 hours

1-2 Input by the Mongolian side

C/Ps

As of July 2020	As of March 2023
Macroeconomic Policy Division, Economic Policy Department, Ministry of Finance	Macroeconomic Policy Department, Ministry of Economy and Development
11 officers	17 officers

- In-person lectures: 2 lectures for a total of 4 hours
- Office space, Desk-top PC with intra- and internet connections

1-3 Activities

【July 2020 to June 2021】

Due to COVOD-19 Pandemic, the dispatch of the long-term expert (Chief Advisor), which had been scheduled in early March 2020, was postponed until the middle of April 2021.

In July 2020, online communication had begun between the Chief Advisor and the C/P organization (Ministry of Finance of the Government of Mongolia) to know the jurisdiction of the C/P organization and the duties of its staff. The Chief Advisor also made a survey on related institutions and took online contacts with them. He found T-21 model introduced by UNDP had limited relevance to the macroeconomic analysis for its model structure covered Economy, Social and Environment in the category of system dynamics modeling. It was clear that any ongoing attempts in CGE modeling were

existents, where a CGE (Computable General Equilibrium) model introduced in a UNDP project to National Development Agency in 2018 was inactive.

Under these circumstances, to make up delay in the commencement of the Project, the JICA Mongolia Office made competitive bidding in late January 2021 to construct SAM (Social Accounting Matrix) for the year 2018, which forms the basic data set of CGE modeling, based on the technical terms and conditions drafted by the Chief Advisor.

Under the supervision of the Chief Advisor, ERI (Economic Research Institute), which was the sole and winning bidder, collected and compiled necessary statistical data for SAM and constructed Macro and Micro SAM during March to June 2021. ERI conducted training sessions in April and June to transfer skills and knowledge of the construction to C/P staff and some outcomes were reflected in the Government's annual plan for 2022.

At the time of the Detailed Design Mission in June and the signing of the Record of Discussion in September 2019, the C/P organization was in the process of enhancing its capacity to formulate macroeconomic policy. It was forming an integrated system of sharing statistical information among the staff of different economic sectors. At the same time, they utilized online training courses by IMF to compile and redact economic reports, and the first quarterly economic report was edited in early 2020, thereafter the report was made up quarterly after exposure of the data by NSO (National Statistical Office) and the relevant analytical results have been discussed in the cabinet meeting.

【July 2021 to June 2022】

After easing of restrictive measures of the pandemic by the Mongolian Government and clearing quarantine requirements for working in the Governments' facilities, the Chief Advisor stationed in the Ministry of Finance in the middle of August 2021.

The Chief Advisor examined the functions of the Macroeconomic Policy Division and discussed the details of the Project Activities.

JICA Mongolia Office contracted the Project Assistant in November and started the procurement work of Soft and Hardware necessary for the Project.

Before starting the modeling work, the Project held an introductory lecture on the features of economic models remotely from Japan.

Among a variety of CGE models, the Project chose PEP1-1 model which were introduced in Mongolia by the PEP network in 2014 and prevailed in Mongolia for policy analyses since then. JICA Mongolia Office contracted ERI by competitive bidding to construct a standard static and dynamic CGE model based on PEP 1-1 with SAM 2018 for policy simulations. The modeling work began in March and was completed in June 2022, transferring skills and knowledge of the modeling through a series of training sessions in April and June according to hands-on and step-by-step manner suggested by the Chief Advisor. Two kinds of remote lectures were conducted in February and June to prepare a foothold for coming activities. One is "Public Policy Analysis" to understand the logic and application of "Strategic Thinking" for policy analysis, and the other is "Introduction to GTAP modeling" to have an alternative application of CGE modeling focused on trade.

The C/P side invited two academics to hold policy analyses discussion with specific policy issues in June.

【July 2022 to March 2023】

In early August, C/P participated in a remote event and presented Mongolian CGE models just developed, which JDS alumni in Saitama University organized among young Mongolian economists to share knowledge and information about economic policy analyses.

From September to December 2022, one policy issue was selected and analyzed each month by CGE model simulations as the trial application of the model. The C/Ps discussed the interpretation of the results in a narrative way with the consultant team and studied its relevance to the reality of Mongolia.

C/Ps have been realizing the usefulness of CGE modeling and the limit attributed to its characteristics of the simulation model, not for prediction purposes. Moreover, a simulation describes the comparative change to the base year/scenario and therefore it is not applicable to the latest dataset. To cover the deficiency and utilize big latest data such as VAT expenditure data, Statistics application training was designed and conducted in January 2023 for extended MED staff.

To wrap up the Project, two seminars were held. One is, on February 8th 2023, a remote lecture on “GTAP in GAMS” for the future application of GAMS-coded CGE modeling utilizing the GTAP database. On March 24th 2023, the final seminar was focused on information sharing and exchanging opinions among MED, MOF, NSO, academia, and research institute for the enhanced utilization of quantitative economic modeling for evidence-based policy formulation.

2. Achievements of the Project

2-1 Outputs and indicators

Output 1:
The capacity of the officers of Ministry of Economy and Development on macro-economic analysis and policy impact evaluation is improved.

[Objectively Verifiable Indicators]
Capacity building
**** Training plan, manual are developed.***
**** Relevant officers acquire necessary skills in the use of improved CGE modeling.***

A SAM shows a snapshot description of the economy in a concise way and its multiplier exercises give a first-round impact by policy variables. Under the COVID-19 lockdown, a series of online training was conducted in April and June 2021 and the officers had acquainted with the methodology of SAM 2018 construction, the circular flow of the Mongolian economy in 2018, and the impacts of policy variables through multiplier exercises without price adjustments through markets. The manual for SAM construction process was prepared through the training.

Two remote lectures from Japan paved the fundamentals for economic policy analyses. Prof. Taguchi of Saitama Univ. gave the introduction of economic models, the features of each type of model, and the limits of each including CGE model. Prof. Yanagihara conducted a series of lectures and practices in Feb. 2022 on the strategic thinking manner to analyze and evaluate public policies.

Working with the Prototype Models (Output-2 below), relevant officers have familiarized themselves with the structure of PEP-type CGE model and standard simulations method to trace policy impacts, where impacts by fiscal expenditures increased, tax/tariff rates changed, and subsidies shifted. The PEP-type CGE modeling instruction manuals were distributed to concerned officers to review the model.

Three lectures by Mongolian academics and researchers provoked discussion in policy evaluation among C/P officers. “Supply chain coordination” by Prof. D.Tuvshinjargal of the University of Finance and Economics shed light to the inefficiency of transaction cost in Mongolia, Prof. G. Ganbayar of the National University of Mongolia presented a usage of DSGE model for the External Debt Sustainability of Mongolia, and Dr. Sh. Enkhbayar of ERINA showed a simulation of the free trade agreement by GTAP model. Those discussions have served much for C/P to broaden economic perspectives.

Output 2:
Computable General Equilibrium (CGE) modeling to analyze narrative prediction, evaluation of policy impacts for each economic sector is refined and utilized.

[Objectively Verifiable Indicators]
Improvement and establishment of CGE modeling
**** Improved CGE modeling is developed.***

Both the PEP1-1 model and PEP1-t model have been constructed in June 2022, as prototype models to evaluate policy impacts on the Mongolian economy. The hands-on training in June 2022 has been conducted for the microeconomic foundation involved and GAMS code manipulations for modeling and standard simulations. To apply to specific policy issues, it would be a necessary modification of equations and/or change of equation structure. It would require trial and error practices under the supervision of CGE modeling experts. Further upgrading in skills is expected for modelers to adjust and modify properly in substitutable equations and/or datasets including SAM.

Output 3:
Ability of the Macroeconomic Policy Department for policy analysis and recommendation is enhanced.

[Objectively Verifiable Indicators]
The Macroeconomic Policy Department has several times examined if CGE modeling results shall be reflected in the Quarterly Economic Report.

Discussion among officers on a narrative interpretation of simulation results, including cause-and-effect relationship, leads to enhancement of the analytical ability of the McDEP. From September to December 2022, the relevant officers picked up policy issues and made trial simulations each month. The ability would reflect in compiling economic reports and policy recommendations therein. For example, the Economic Report of the third quarter of 2022 drew up the Public productivity simulation results in the box and the child money program case in the fourth quarter Report. The UNDP report on the SDGs progress quoted the CGE model simulations of public sector productivity and corruption issues as a response to the 6th objective of the Revival Plan 2021.

2-2 Project Purpose and indicators

The capacity to formulate macro-economic policy is enhanced.

[Objectively Verifiable Indicators]
In the Macroeconomic Policy Department, a working flow is established to examine whether or not the regular reporting of macroeconomic perspectives should reflect the results of CGE model simulations.

The PJ has facilitated discussions among the McDEP officers. The PJ made an opportunity to connect young Mongolian economists of JDS alumni, some academics of Mongolia in in-person lectures and discussions, and researchers of the private institution through policy simulation training sessions.

The report-making and editing process was set as a group discussion in front of the Large Smart Monitor and working on the same PC platform. The report-making discussions make officers develop their skills in analyzing and formulating policy. The CGE model simulations would give them good materials for discussion to deepen insights.

The number of staff in the Department has increased from 11 as of July 2020 to 14 as of January 2023 and almost all staff changed from the contract base to permanent status as Government officers. Although it occurred some turnover of staff, the scope of the analysis in the Department has been enhanced and the policy simulation exercises have catalyzed deeper insights into economic issues and challenges.

The final seminar is organized for officers of MED, MOF, NSO, academia, and research institute in quantitative analyses for policy issues and evaluation in order to share information and to have a common platform for policy recommendations.

Close communication among working-level officers would enhance the capacity for better policy formulation with time.

3. History of PDM Modification

The Record of Discussion signed on September 4, 2019, and the PJ was deemed to start in December 2019. However, the COVID-19 pandemic and its consequent restrictions forced to start the actual activities of the Project with close and direct communication with C/Ps until August 2021. Taking into account some progress online, PDM has been reorganized and agreed upon as the following.

1. Objectively Verifiable Indicators for Overall Goal

Before	Amended Version
1. Dialogue by the Macroeconomic Policy Division with the other government institutions, research institutions to formulate macro-economic forecast through the application of CGE modeling is occasionally held. 2. More precise macro-economic forecast with the feed backs from the relevant stakeholders is made by the Macroeconomic Policy Division.	Important background documents for policy making, such as the quarterly economic reports, include constant feedback from the simulation results with the CGE model.

2. Objectively Verifiable Indicators for Project Purpose

Before	Amended Version
1. Forum/conference for strengthening cooperation and information exchange among the government institutions and research institutions is held. 2. Improved CGE modeling is applied/utilized. 3. Periodically/institutionalized report based on the application/utilization of improved CGE modeling is shared. 4. Information sharing/Policy recommendation based on the application/utilization of improved CGE modeling is made.	In the Macroeconomic Policy Department, a working flow is established to examine whether or not the regular reporting of macroeconomic perspectives should reflect the results of CGE model simulations.

3. **Output-1**

Narrative Summary

Before	Amended Version
Output1: The capacity of the officers of Ministry of Finance on macro-economic analysis and forecast is improved.	Output1: The capacity of the officers of Ministry of Economy and Development on macro-economic analysis and policy impact evaluation is improved.

Objectively Verifiable Indicators for Output-1

Before	Amended Version
1. Capacity building * Training plan, manual are developed. * Relevant officers acquire necessary skills in the use of improved CGE modeling. * Career path/roadmap for government economist is developed.	1. Capacity building * Training plan, manual are developed. * Relevant officers acquire necessary skills in the use of improved CGE modeling.

4. **Output 2**

Narrative Summary

Before	Amended Version
Output 2: Macro-economic applied Computerized General Equilibrium (CGE) modeling to analyze estimated prediction, evaluation of macro-economic indicator for each economic sector is refined and utilized.	Output 2: Computable General Equilibrium (CGE) modeling to analyze narrative prediction, evaluation of policy impacts for each economic sector is refined and utilized.

5. **Output 3**

Narrative Summary

Before	Amended Version
Output 3: Formats for periodical report and to utilize the data from "Tentative Title: "Macro-economic Database" are developed. Output 4: The capacity to develop policy recommendation to the policy makers is enhanced.	Output 3: Ability of the Macroeconomic Policy Department for policy analysis and recommendation is enhanced.

Objectively Verifiable Indicators for Output-3 and Output-4

Before	Amended Version
3. Development of format for reporting * Periodical reporting format and	3. The Macroeconomic Policy Department has several times examined if CGE modeling results

format to extract the data from the Database are developed. 4. Information sharing/policy recommendation * Relevant officers share information with the relevant stakeholders and give policy recommendation to the policy makers.	shall be reflected in the Quarterly Economic Report.

Ⅲ. Results of Joint Review

1. Results of Review based on DAC Evaluation Criteria

DAC Evaluation Criteria	As of March 2023
Relevance	*High*
Coherence	*High*
Effectiveness	*Relatively high*
Efficiency	*high*
Impact	*Expected to be achieved*
Sustainability	*Relatively high*

(1) Relevance: High

Facing a balance of payment crisis in 2016 and negotiating with IMF for EFF, IMF recommended McDEP of MOF to equip with several analytical and monitoring tools for macroeconomic stabilization in the medium and long term after the adjustment program supported by IFIs and other donors. In this connection, MOF and JICA agreed on the technical cooperation project to enhance the capacity of macroeconomic analysis and planning.

The PJ was requested to JICA upon execution of the “Development Policy Planning Law" in 2015 and in accord with “Mongolia Sustainable Development Vision-2030” of 2016.

On May 13, 2020, the Mongolian Parliament promulgated Decision No.52 "VISION-2050". Chapter four of the Decision stipulates the Objectives of the Economy as follows.

> **Objective 4.** Become a nation with sustainable economic growth beneficial to all, predominantly middle class and substantially reduced poverty, a solid economic development policy base and self-sufficiency in meeting domestic needs, increased export, enhanced capacity in investment and savings, and a multi-pillared economy.
>
> **Objective 4.1.** Promote macroeconomic stability and transform the middle class into a predominant group.

These objectives coincide with the Project’s Purpose.

(2) Coherence: High

The PJ had been designed to enhance human capital for one of the priority areas of the Country Development Cooperation Policy for Mongolia, “Strengthening governance for creating healthy macro economy,” by the Ministry of Foreign Affairs in Japan, in transferring the knowledge and skills of Economic modeling which is focused on CGE models and data preparation in the form of Social Accounting Matrix

(SAM). This apparatus will be the launch pad for the other two priority areas “Creating eco-friendly and balanced economic growth” and “Inclusive social development” as an application tool to analyze and evaluate policies.

The World Bank compiled the Mongolia Poverty Update report in 2020 based on the Household Socio-Economic Survey 2018 by the National Statistics Office and analyzed various aspects of poverty in Mongolia. In MOF later in MED, there was a strong need to reveal policy impacts by income levels of households. In this context, CGE modeling would be the pertinent tool among economic modeling tools as a pivotal element of the Project.

CGE modeling can be applied to the extension of JICA’s cooperation activities. For example, it evaluates the socioeconomic welfare impacts of public investment projects and the impacts on rural areas by regional balanced growth policies.

Ministry of Economy and Finance of Korea and the Korea Development Institute (KDI) implemented a policy consultation project with MOF in 2019 and 2020 and made a survey of relevant economic analysis tools and a comparative study on reference countries to Mongolia. The Project brought its guidelines into simulation exercises of CGE models.

(3) Effectiveness: Relatively high

Each staff of McDEP. collects data and analyzes it in the assigned area/sector and tends to conduct the partial equilibrium analysis without considering the interdependence of other market segments. CGE modeling exercises introduced them to consider trade-off issues among areas/sectors. Standard simulation exercises of exogenous variables such as an increase in government spending or capital stock increase in the mining sector affect real GDP, relative prices, exports, unemployment level, and so on.

Policy simulation results are referred to in the boxed article in the economic reports citing the case of public sector productivity in the Q3 report and the Child Money Program simulation in the Q4 report. These policy simulations were conducted under supervision of CGE modeling experts through training. For some policy simulations, one should modify SAM and/or equation structure/forms. It would need more practices to perform these modifications by themselves.

(4) Efficiency: high

Due to the COVID-19 pandemic, the Chief Advisor was dispatched more than one year later and the lockdown and quarantine measures in Mongolia made the face-to-face and close communication with C/P commence 20 months later than planned in R/D. Through remote communication with C/P and other related institutions, the Project

actively utilized local resources in collaboration with JICA Mongolia Office. Remote lectures and seminars from Japan were substituted for short-term experts from Japan and training in Japan. Remote devices and local resources have made up for the delay in Project activities to a certain part.

(5) Impact: Expected to be achieved

The Government shall play a central role in Mongolia's economic development. It needs to amplify human resources and to consolidate institutional arrangements. MED assumes an important part of the development planning process and the Government shall enhance the functional platform for multifaceted approach for development.

CGE modeling was tried to introduce in 2018 to NDA by UNDP project and ended incomplete. The Project took an initial hold for evidence-based policy-making in the government sector with CGE modeling. It is expected that CGE modeling is one of the fundamental planning and evaluation tool for development policy.

The focus of economic policy In Mongolia has been directed to the efficiency of scarce resource allocation. While the regulatory reforms are designed to improve the efficiency of resource allocation, support for the reform among stakeholders is required. This can be done only by showing the effects of these reforms not only qualitatively but also quantitatively; that is the economy-wide impact of the reforms and their effect on individual industrial sectors income groups and so on. CGE modeling would be the core of this kind of simulation.

(6) Sustainability: Relatively high

Since early 2020, the Macroeconomic Policy Dep. (at that time was the Macroeconomic Policy Division of MOF) has published quarterly Economic Reports and has improved its contents over time. The Project added a framework of analysis in the Report. While the number of staff has increased, the turnover has occurred for studying abroad and job changing. As teaching and coaching newcomers among the staff are the routine practice of the Department, it is expected to maintain knowledge and skills in economic analysis. It is also necessary to intercommunicate with relevant institutions and academics for advanced modeling and data compilation.

In this regard, it should be noted that the COVID-19 pandemic may have changed peoples' economic attitudes, behavior and expectation. Careful data analysis, especially in the construction of post-COVID SAM, and the applicability of some parameters in behavioral equations are required.

2. Key Factors Affecting Implementation and Outcomes

The COVID-19 pandemic caused unexpected circumstances in the implementation of the Project during the three-year period of the Project from December 2019. We can point out the following three factors to attain initial outcomes and objectives with three months extension in the Project period.

(1) Competent local resources

We found competent local resources in the preliminary survey on research institutes.

As they have ample experience in CGE modeling, it was an easy task to discuss on the customization of CGE modeling suitable to MOF/MED.

(2) Receptive attitude for modeling work

Some staff had experiences in economic modeling work and empirical studies with statistical data. The fact that all staff has knowledge of fundamental microeconomics helps them understand CGE modeling logic. Economic reporting is becoming a routine quarterly procedure since early 2020 and CGE simulation results are adequately incorporated in the reports.

(3) Arrangement by JICA

The concerned department of JICA HQ and JICA Mongolia Office adequately conducted a modified course of the Project activities such as remote lectures from Japan, procurement of soft and hardware, and competitive bidding for local resources.

3. Evaluation on the results of the Project Risk Management

CGE modeling is a time-consuming and somehow tedious challenge. To minimize the giving-up risk of modelers, the Project minded the following points.

(1) Learning from the program codes

In 2017 and 2018, the UNDP project implemented CGE modeling to NDA. It conducted intensive training courses and transferred a CGE model with manipulating interface. It can operate price change simulation through EXCEL interface without knowing the GAMS code. It can instantly obtain the results from this toolbox, but without even minor modifications of the model.

The Project designed training to familiarize the GAMS code to understand the structure of model equations and solving procedure so that modelers can modify to their alternative attempts.

(2) Simulation of the relevant policy issues

After learning basic simulation exercises with prices, participants of the training selected trial simulation topics each month to review code managing skills and to find simulation beneficial to actual policy issues.

4. Lessons Learnt

Through the Project implementation, we noted the following lessons.

(1) Utilization of local resources for sustainable knowledge and skills.

CGE modeling has various schools or types in the form of SAM, notation of variables, and structure and functional forms of equations. The Project adopted the PEP models which prevail in local research institutions other than popular types in Japan. Local institutions are used to maintain analytical tools for their research works, but personal changes in Government organizations affect the maintenance and development of the analytical tools.

(2) Facilitation by the Project among local resources

Other than modeling, the Project facilitated the acquaintance of local personnel and institutions to provoke narrative discussion on policy issues. This kind of expert survey on issues is important to interpret simulation results expressed in numbers into economic transmission structure. In general, technical cooperation projects, as outsiders of the policy-making authorities, could act to facilitate among stakeholders.

(3) Ownership of modeling and outsourcing

In recent times there increase in the amount and kinds of data, analytical methods and technology advancing, and policy issues are multiplicated and complicated. While it requires the authority to enhance its research and analysis arms, the authorities extend outsourcing of data analysis and modeling simulations. Under these circumstances, the policy-making authority should observe the evaluation capacity of outsourced results and the ability to conduct terms and conditions for outsourcing.

Ⅳ. For the Achievement of Overall Goals after the Project Completion

1. Prospects to achieve Overall Goal

Overall Goal

The capacity to develop the pluralized macro-economic scenarios for the sustainable development is enhanced.

We understand “the pluralized macroeconomic scenario” as alternative economic development scenarios, while the objective of macroeconomic policy focuses on sustainable economic growth in the medium and long run and eliminates the boom-and-bust cycle/business cycle in the short run.

Macroeconomic policy instruments are composed of fiscal measures and monetary ones. The fiscal policy will be enforced by fiscal authority, namely MOF based on the annual budget law. The monetary policy will be conducted by BOM based on the decision of the Monetary Council.

Then, what is the role of MED?

Since the fiscal and monetary policy mix affects production sectors and household income, MED is concerned about the overall impacts on economic welfare. In this regard, MED should evaluate the sectoral and social impacts of policies implemented by line ministries.

MED has been set up to compile development issues and consolidate policy responses. The Macroeconomic Policy Department analyzes economic evolution quarterly and makes ad hoc research for hot issues. The CGE modeling can be applied to some policy issues and contributes to formulating optimum policy responses. The Department should be a core department in MED to integrate the policy efforts of other departments in MED. The Macroeconomic Policy Department together with the Integrated Development Policy Department will lead MED to enhance its capacity to formulate development policies, consolidating policy issues of line ministries. The “pluralized economic scenario for sustainable development” can be achieved under a suitable arrangement of information sharing and coordination mechanisms among relevant departments and ministries.

2. Reminder for CGE Modeling

Typology of Economic Models

	Macro-econometrics Model	*CGE*	*DSGE*	*VAR*
Economic Theory	*Yes*	*Yes*	*Yes*	
Micro Foundation		*Yes*	*Yes*	
Price Regidity	*Yes*		*Yes*	
Long-term Dynamics	*Yes*			
Sectoral Analysis	*Yes*	*Yes*		Yes

adapted from Prof.Taguchi's lecture material

2.1 Characteristics of CGE models

Among the category of economic models, CGE models are apt for evaluating the efficiency of scarce resource allocation.

Resource allocation can be viewed as a trade-off issue. Output can be either exported or set aside for domestic supply. Exports earn hard currency to support imports. Imports and domestic supply can be either consumed by households or used as intermediate inputs. Household consumption determines society's economic welfare while intermediate inputs contribute to a further increase in output. As an economy has a number of agents such as households firms and a government as well as various industrial sectors, it is difficult to solve these trade-off problems or to find an efficient allocation of resources among those agents and sectors under given resources and technology constraints.

The efficiency of resource allocation is not a purely theoretical issue. For example, the effects of reforms should show not only theoretically/qualitatively but also quantitatively; that is the economy-wide impact of the reforms and their effect on individual industrial sectors, income group and so on.

The CGE models are useful for quantitative analysis and evaluation of economic policies.

2.2 Advantages of CGE models

A major advantage of CGE models is the relatively small data requirements considering the model size. This has enabled the wider use of CGE analysis. Most CGE models are developed with macroeconomic data such as Supply and Use table or IO tables, national accounts and trade statistics for one year. This advantage makes CGE models preferable to standard econometric models which require observations for several years to estimate parameters with sufficient degrees of freedom.

This is particularly advantageous for a country for which sufficient statistical data are not available or where the social and economic systems are susceptible to international commodity prices.

In addition, CGE models can easily incorporate dozens of industrial sectors which would require a large dataset in econometric models.

2.3 Shortcomings of CGE models

First, the parameters of CGE models are estimated on the basis of data from a single reference year. This means that the parameter estimates may be extremely sensitive to the choice of the reference year.

Second, estimating the CGE models with a one-year dataset can be compared to taking a snap shot picture of a dynamically evolving reality.

That is, inclusion of dynamic components of an economy such as investment and savings, in a static model based on a static estimation procedure is theoretically inconsistent.

Third, financial/monetary aspects are rarely incorporated into CGE models. Usually following the Walrasian general equilibrium model, most CGE models focus on the real side of the economy; thus, they can deal with economies in terms of only relative prices, not absolute prices. As a result, CGE models cannot deal with monetary phenomena such as inflation or (nominal) foreign exchange rate policy. To overcome this difficulty, so-called financial CGE models have been developed; however, these models tend to be so large that they cannot be solved easily and their simulation results are difficult to interpret.

2.4 The meanings of “static” and “dynamic” CGE modeling

A CGE model is based on the base year – in case of the PJ is the year 2018. It forms the base scenario. Then, changing policy variables one gets

the new equilibrium solution, which is the simulation result. There does not exist time, that is, sometime when the new equilibrium is reached. In microeconomic terminology, this exercise is indicated as comparative statics.

The recursive dynamic CGE modeling is designed through investment changing the next capital stock and some growing path in labor, etc. Each time the model shows the next equilibrium. In this case “dynamic”

3. Applications of CGE models

The PEP1-1 standard CGE model for Mongolia can simulate impacts by changing exogenous variables or policy variables.

- General macroeconomic issues:
  - public expenditure increase or cuts,
  - impact of trade by international price change or import tariff
  - domestic tax reforms such as value-added tax and commodity tax
- Regional and transport policy:
  - impact of transport margins cut, and removal of non-tariff barriers.
- Industrial and labour policies:
  - impacts of deregulation or brokerage markets.

3.1 Extension of CGE modeling

McDEP has equipped with a standard static CGE model based on PEP1-1 and a dynamic model based on PEP1-t. These models are designed for simple simulation mentioned in 2.4 above, setting the basic scenario for 2018 which is the compiled year of SAM.

When one designs policy simulations described below, he has to design the suitable SAM for each policy issue and formulate adequate model structure/equations.

(1) Regional CGE modeling

If SAM for Ulaanbaatar metropolitan area can be compiled, then we can construct 2 region CGE model, Ulaanbaatar- the other region, to measure urban-rural welfare discrepancy. If a regional IO table were constructed with shipping-in and out, a multiregional simulation can be conducted. These results may be an important reference for the comprehensive development planning of the country.

(2) Food and energy security

Preparing disaggregate data for livestock and food processing, it can be analyzed in these prospective sectors. CGE modeling would be applied to not only coal mining but also economic impact by the refinery construction project and related investment.

(3) Climate change simulation

One of the application areas of CGE modeling is climate change impacts. As “Vision 2050” promotes the green transformation of the country, relevant data should be compiled for this purpose. It would be revived for the data collection for the “Threshold 21 (T-21) ” project and be updated for the CGE modeling.

(4) GTAP with PEP models

GTAP model can be used to evaluate trade agreement policy with surrounding countries. It would be a good challenge to combine GTAP simulation results with PEP models to analyze the detailed impacts on domestic sectors, households, and other economic agents.

3.2 Data analysis

(1) Complemental modeling to CGE

In case the disaggregation of data cannot reflect in SAM, a usual alternative is to analyze with the subordinate model such as a microsimulation model. In this way, a detailed analysis could be done, for example, of specific subsidy impacts on different income levels of households.

(2) Administrative data and Big data

In Mongolia digital transformation is currently underway in sales and purchases, payment for taxes and social security., various transactions, and SNS big data. It would be useful to observe the ongoing picture of economic activities and analyze the situation by data analysis techniques.

3.3 Projection for future development

In addition to the simulation models indicated in 2.1 above, economic models with time series data should be installed to make future projections of the economy such as DSGE-type models and VAR models. The EXCEL-based FP simulations are currently used for medium-term projections. It would be revisited small macro-econometric models with the forward-looking mechanism.

ANNEX 1: Results of the Project

(List of Dispatched Experts, List of Counterparts, List of Trainings, etc.)

ANNEX 2: List of Products (Report, Manuals, Handbooks, etc.)

Produced by the Project

ANNEX 3: PDM (All versions of PDM)

ANNEX 4: R/D, M/M, Minutes of JCC (copy) (*)

ANNEX 5: Monitoring Sheet (copy)(*)

(Remarks: ANNEX 4 and 5 are internal reference only.)

Separate Digital Device : Copy of Data files and GAMS code programs

ANNEX-1 Results of the Project

Inputs by Japanese side

Chief Advisor	Masahiro Yamashita
Jul.2020 to Mar.2021 online communications	
Despatched to UB on Apr. 13, 2021	
Stationed in MOF/MED in Mid Aug.2021 to Apr.2023	
Project Assistant	Bayarsaikhan Zulbadrak
Contracted Nov.2021 to Mar. 2023	

Online lectures

Prof. Hiroyuki Taguchi, Saitama University	
Sep. 10 2021	“Overview of Economic Models”
Prof. Emeritus Toru Yanagihara	
Feb. 18 and 25, 2022	"Public Policy Analysis"
Dr. Enkhbayar Shagdar, Senior Research Fellow, ERINA,	
May 13 2022	"Introduction of GTAP modeling"
Mr. Yoji Kunimitsu, Visiting Researcher in Reitaku University	
Feb. 8, 2023	"GTAP in GAMS"

GTAP Short Course online by Purdue University, USA

End May, 2022 to Mid August, 2022

Local consultants

Economic Research Institute (ERI)

SAM construction	Feb.2021 to June 2021
RAGCHAASUREN Galindev	Lead Economist
MANLAIBAATAR Zagdbazar	DATA PROCESSING SPECIALIST
OYUNZUL Tserendorj	SUPPORTING RESEARCHER
UNURJARGAL Davaa	SUPPORTING RESEARCHER
CGE modeling & simulations	Mar.2022 to Dec.2022
RAGCHAASUREN Galindev	Team Leader
MANLAIBAATAR Zagdbazar	SENIOR RESEARCHER
OYUNZUL Tserendorj	SUPPORTING RESEARCHER
UNURJARGAL Davaa	SUPPORTING RESEARCHER

National Research & Consulting Center (NRCC)

"R" language and its application	Jan. 2023
Soyolmaa.B	Senior Researcher
Altantsetseg.B	Senior Researcher

Input by Mongolian Side		
List of Counterparts as of July 2021		
Project Director		
	BATKHUREL Galsandorj	Director General, Economic Policy Department, MOF
Project Manager		
	Ganbayar Javkhlan	Head, Macroeconopmic Policy Division, MOF
Macroeconomic Policy Division, MOF		
	Kh. Munkhjavkhlan	Officer
	L. Enkh-Amgalan	Consultant
	L.Davaajargal	Consultant
	Ch.Enkhlut	Consultant
	O.Myagmardorj	Consultant
	G.Nyamtsetseg	Consultant
	T.Zolzaya	Consultant
	B.Delgermaa	Consultant
	U.Enkhbat	Consultant
List of Counterparts as of May 2022		
Project Director		
	Ganbayar Javkhlan	Director General, Development Policy Department, MED
Project Manager		
	L. Enkh-Amgalan	Director General, Macroeconomic Policy Department, MED
List of Counterparts as of Mar 2023		
Project Director		
	L. Balchinluvsan	Director General, Intergrated Development Policy Department, MED
Project Manager		
	L. Enkh-Amgalan	Director General, Macroeconomic Policy Department, MED
Macroeconomic Policy Department, MED		
	B.Munkh-Erdene	Head of department
	Kh. Munkhjavkhlan	specialist
	O.Myagmardorj	specialist
	L.Davaajargal	advisor
	T.Zolzaya	advisor
	B.Delgermaa	advisor
	B.Tuguldur	Specialist
	E.Uurtsaikh	advisor
	Ts.Munkhdelger	Advisor
	N.Narantsatsralt	Advisor
	T. Myagmarjav	specialist
	Ts.Badamtsetseg	Specialist
	J.Ulziisaikhan	Specialist
	T.Munkhtsetseg	Specialist
	G.Nyamtsetseg（Integrated Development Policy Department）	specialist

Training Agenda of the Construction of SAM2018 & its Multiplier Excercises

(April 1 - 2, 2021) , (June 24 - 29, 2021)

April 1

	Topic	Leader	Duration
1	Opening remarks	JICA: Masahiro Yamashita	10:00-10:10
2	Project introduction	Team leader G.Ragchaasuren	10:10-10:30
2	Introduction to SAM	Team leader G.Ragchaasuren	10:30-11:30
3	SAM practical exercise	Team member: D.Oyuntugs	11:40-12:30
4	Data collection and processing of the Macro SAM	Team member: D.Unurjargal	12:30-13:00
5	Data collection and processing of the Macro SAM, continued	Team member: D.Unurjargal	14:00-15:30
6	Construction of the Macro SAM 2018	Team member: D.Unurjargal	15:40-17:00

April 2

	Topic	Leader	Duration
1	SAM-based multiplier analysis	Team member: Ts.Oyunzul	10:00-11:30
2	Macro SAM-based multiplier practical exercise	Team member: Ts.Oyunzul	11:40-13:00
3	Exercise: Construction of the Macro SAM 2017	Team member: D.Unurjargal	14:00-15:10
4	Exercise: Macro SAM 2017-based multiplier analysis	Team member: Ts.Oyunzul	15:20-16:20
5	Exam	Team	16:20-17:00

June 24

	Topic	Leader	Duration
1	Project introduction	G.Ragchaasuren /PhD/	10:00-13:00
2	Reinforcement lesson: Macro SAM		
3	Introduction to Micro SAM and Construction of Micro SAM		
4	Adjustments in the Micro SAM-1: Adding direct purchases of residents and non-residents in the SAM		
5	Adjustments in the Micro SAM-2: Adjustments in re-exports	Team member: D.Unurjargal	14:00-17:00
6	Adjustments in the Micro SAM-3: Separating “mixed income” from gross operating surplus		
7	Adjustments in the Micro SAM-4: Distributing production and margins into domestic production and exports		

June 25

	Topic	Leader	Duration
1	Basic skills of GAMS software	G.Ragchaasuren /PhD/	10:00-13:00
2	Adjustments in the Micro SAM-4: Continuation		
3	Balancing the Micro SAM	Team member: D.Unurjargal	
4	Aggregation of commodities and sectors of 2018 Micro SAM /5X5/	Team member: D.Oyuntugs	14:00-17:00
5	Describing economic circular flow of Mongolian economy using constructed 2018 SAM /5X5/	Team member: D.Oyuntugs	

June 28

	Topic	Leader	Duration
1	Further disaggregation of SAM: Separation the firm from household account	Team member: D.Unurjargal	10:00-13:00
2	Basic skills of STATA software	Team member Z.Manlaibaatar	
3	Further disaggregation of SAM: Disaggregation of household by income level		
4	Further disaggregation of SAM: Disaggregation of household by income level (continued)	Team member: D.Unurjargal	14:00-17:00
5	Further disaggregation of SAM: Disaggregation of labor by skill level	Team member: D.Oyunzul	

June 29

	Topic	Leader	Duration
1	Applications of the SAM: Micro SAM-based multiplier	Team member: Ts.Oyunzul	10:00-13:00
2	Exercise: 2017 Micro SAM	Team member: D.Unurjargal	14:00-17:00
3	Exercise: Multiplier exercises based on 2018 SAM	Team member: Ts.Oyunzul	

Participants	
MoF	
	J. Ganbayar
	Kh. Munkhjavkhlan
	L.Davaajargal
	U.Enkhbat
	Ch.Enkhlut
N	
	B. Tumendelger
	S. Suzzana
	B. Ariubileg
	Ts. Nomin-Erdene
	G. Tuguldur
	O. Enkhmunkh
	S. Khurel-Erdene
	J. Ulziisaikhan

Table. Detailed curriculum of Training Session-1

(Aoril 19 to April 22, 2022)

April 19 th

	Topic	Leader	Duration
1	Project introduction	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Review of methodology of constructing: Macro SAM	Team member: D.Unurjargal	
3	Review of methodology of constructing: Micro SAM		

April 20 th

	Topic	Leader	Duration
1	Review of methodology of constructing: Micro SAM	Team member: D.Unurjargal	14:00-17.30
2	Exercise	Team member: U.Enkhsaikhan	

April 21 st

	Topic	Leader	Duration
1	Introduction to CGE model	Project team leader G.Ragchaasuren /PhD/	14:00-17:30
2	Theoretical foundations	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: U.Enkhsaikhan	

April 22 nd

	Topic	Leader	Duration
1	Theoretical foundations	Project team leader G.Ragchaasuren /PhD/	14:00-17:30
2	Introduction to GAMS programming	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: U.Enkhsaikhan	

Participants	
Ministry of Economic and Development	
	Kh.Munkhjavkhlan
	G.Nyamtsetseg
	O.Myagmardorj
	U.Enkhbat
	L.Davaajargal
	Ch.Enkhlut
	O.Oigonbayar
	G.Tuguldur
	T.Munkhtsetseg
	O.Enkhmunkh
The Research Institute of Labor and Social Protection	
	J.Ulziisaikhan
	S.Khurel-Erdene

Table. Detailed curriculum of second part of training

(May 30 ti June 8, 2022)

May 30th

	Topic	Leader	Duration
1	Opening remarks	JICA: Masahiro Yamashita	
2	Simplified CGE model: Structure and equations of the model	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
3	Simplified CGE model: Programming using GAMS		
4	Simplified CGE model: Output files in GAMS		
5	Exercise	Team member: U. Enkhsaikhan	

May 31st

	Topic	Leader	Duration
1	Simplified CGE model: Error solving in GAMS	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Simplified CGE model: Simulations and result analysis	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: U. Enkhsaikhan	

June 2nd

	Topic	Leader	Duration
1	Static CGE model with 5x5 SAM: Structure and equations of the model	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Static CGE model with 5x5 SAM: Code of the model in the GAMS	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: U. Enkhsaikhan	

June 3rd

	Topic	Leader	Duration
1	Static CGE model with 5x5 SAM: Error solving in GAMS	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Exercises	Team member: D. Unurjargal	

June 6th

	Topic	Leader	Duration
1	Static CGE model with 5x5 SAM: Policy simulation in the model	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Static CGE model with 5x5 SAM: Summarize and explain the result of the policy simulations	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: D. Unurjargal	

June 7th

	Topic	Leader	Duration
1	Static CGE model with micro-SAM: Code of the model in the GAMS	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Static CGE model with micro-SAM: Error solving in GAMS	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: D. Unurjargal	

June 8th

	Topic	Leader	Duration
1	Static CGE model with micro-SAM: Policy simulation in the model	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Static CGE model with micro-SAM: Summarize and explain the result of the policy simulations	Project team leader G.Ragchaasuren /PhD/	
3	Exercise	Team member: D. Unurjargal	

Participants

Ministry of Economic and Development	
	G.Nyamtsetseg
	U.Enkhbat
	L.Davaajargal
	Ch.Enkhlut
	G.Tuguldur
	L.Enkh-Amgalan
The Research Institute of Labor and Social Protection	
	J.Ulziisaikhan
	S.Khurel-Erdene

Table. Detailed curriculum of training session 3

(June 16 & 17, 2022)

June 16 th

	Topic	Leader	Duration
1	Dynamic CGE model: Structure and equations of the model	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Exercise: work on the model code	Team member: D. Unurjargal	

June 17 th

	Topic	Leader	Duration
1	Dynamic CGE model: Simulations and result analysis	Project team leader G.Ragchaasuren /PhD/	9:00-12:30
2	Exercise: Simulations and result analysis	Project team leader G.Ragchaasuren /PhD/	
3	Discussion: Discuss the policy analysis of the third phase of the project	Project team leader G.Ragchaasuren /PhD/	

Participants	
Ministry of Economic and Development	
	G.Nyamtsetseg
	U.Enkhbat
	Ch.Enkhlut
	E.Uurtsaikh
	L.Enkh-Amgalan
The Research Institute of Labor and Social	
	J.Ulziisaikhan

Table. Curriculum of the additional training in September

September 12 th

	Topic	Duration
1	Review of specification and sources of parameters and calibration used in the PEP-1-1 model	9:30 – 12:30
2	Exercise on introducing new variables and equations to the static model	

September 14 th

	Topic	Duration
1	Discussion on simulation exercises: • Increase in Government spending • Increase in Capital • Narrative interpretation of the simulation results • Robustness test	9:30 – 12:30
2	Discussion on policy simulation from October to December.	

Participants	
Ministry of Economy and Development	
	G.Nyamtsetseg
	L.Davaajargal
The Research Institute of Labor and Social Protection	
	J.Ulziisaikhan
	S.Khurel-Erdene

October 10 th

	Topic	Duration
1	Review of the extensions to the 2014 SAM	9:30 – 12:30
2	Review of the extensions to the PEP-1-t model	
3	Review of the scenarios in Galindev (2018)	

October 11 th

	Topic	Duration
1	Hands-on exercises on making extensions to PEP-1-t and scenario development (coding)	9:30 – 12:30
2	Discussing the results of Galindev (2018)	

Participants	
Ministry of Economy and Development	
	G.Nyamtsetseg
The Research Institute of Labor and Social Protection	
	J.Ulziisaikhan
	S.Khurel-Erdene
Ministry of Finance	
	B.Bodi-Ragchaa
	B.Namuunaa

November 10 th

	Topic	Duration
1	Introduction to modifications made to the SAM 2018	9:30 – 12:30
2	Model extensions related to a simulation for productivity increase in the public sector (Labor-augmenting technology increases in the public administration sector)	
3	Model extensions related to a simulation on "corruption decrease"	

November 11 th

	Topic	Duration
1	Interpretation of simulation results: Participants will try to interpret the results of the previous day themselves	9:30 – 12:30
2	Combine the simulations and analyze the results	

Participants		
Ministry of Economy and Development		
	G.Nyamtsetseg	Joined zoom meeting
	J.Ulziisaikhan	
	L.Enkh-amgalan	Joined zoom meeting
The Research Institute		
	S.Khurel-Erdene	
Ministry of Finance		
	B.Bodi-Ragchaa	Joined zoom meeting
	B.Namuunaa	

December 19 th

	Topic	Duration
1	Introduction to modifications made to the SAM 2018: Disaggregation of households' account	9:30 – 12:30
2	Modifications to the PEP-1-1 model: Step-by-step coding on GAMS	

December 20 th

	Topic	Duration
1	Analysis and interpretation of results of the simulation	9:30 – 12:30
2	Introduction to the new 2019 SAM	

Participants		
Ministry of Economy and Development		
	G.Nyamtsetseg	
	J.Ulziisaikhan	
The Research Institute of Labor and Social Protection		
	S.Khurel-Erdene	Via zoom on Day 2
Ministry of Finance		
	B.Bodi-Ragchaa	
	B.Namuunaa	

遠隔講義報告―「Introduction to Economic Model」

日時：2021 年 9 月 10 日、14:00～15:40（モンゴル時間）
講師：田口博之・埼玉大学教授・・・Zoom による遠隔講義（ホスト：田口教授）
講義の目的

CGE モデル開発に当たって、
① 一般論としての経済モデルの役割と限界
②各モデルの特性
③課内で行っている推計作業等の位置づけ、等を明確にすること。

講義の概要

➢Ganbayar 課長による Opening Remark
➢田口教授作成の PPT（添付）に従って、学説上の論争、歴史的経緯の上に、Macro Econometric Model, CGE, DSGE, VAR, SVAR の特徴と長所・短所、DSGE による資源価格変動に対するモンゴル経済への影響の例示。
➢質疑応答：　▸日本におけるモデル活用と研究機関、政策決定
▸関税率変更等によるシミュレーション
▸DSGE による動学的分析
▸内政変数とモデル規模の関係

出席者：
MOF・マクロ経済政策課
J. Ganbayar・・・Project Manager
Kh. Munkhjavkhlan
L. Enkh-Amgalan
L.Davaajargal
B.Delgermaa
U.Enkhbat
Ch.Enkhlut
T.Zolzaya
Tsogbayar
Nyamtsetseg
M.Yamashita・・・Chief Advisor

JICA モンゴル事務所
ガバナンス班 3 名

Introduction to Economic Models

by Taguchi, Hiroyuki, Professor at Saitama University[1]

The lecture will deal with the various types of economic models used practically in policy makers, and will explain the brief history of the model development and the pros and cons of each model (suite of models). The outline of the contents are as follows.

1. The purpose of economic models
   - Economic forecast, policy evaluation, etc.

2. The brief history of models
   - From macro-econometric model to DSGE model and VAR model

3. The main features of each model

   - Macro-econometric model

   - The Lucas Critique

   - Computable General Equilibrium (CGE) Model

   - Dynamic Stochastic General Equilibrium (DSGE) Model

   - The Sims Critique

   - Vector Auto Regressive (VAR) model

4. Comparison in models and Summary

[1] Taguchi, Hiroyuki is a professor at Graduate School of Humanities and Social Science, at Saitama University. He obtained a PhD in Social Sciences from Waseda University. His research focuses on economic policies, Asian economies, international finance, etc.

Introduction to Economic Model

Taguchi, Hiroyuki
Saitama University

Sep. 10. 2021

Purposes of Economic Model in Practices

- *To verify theories of economics and clarify economic mechanisms in quantitative way*
- *To forecast economies based on scenarios and assumptions*
- *To analyze and evaluate economic policies*

Different models for different purposes
→ Suite of Models

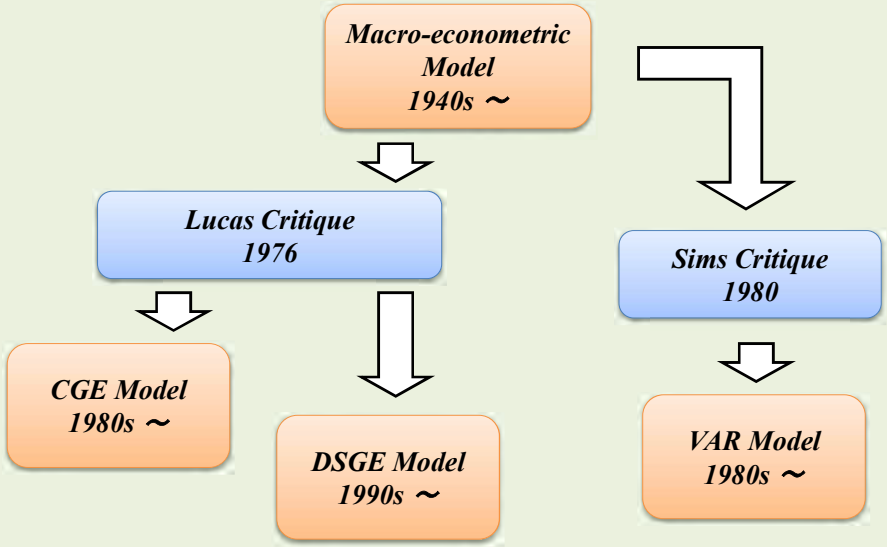
Relationship between SU and Mongolia

- *Academic Agreements with National University of Mongolia in 2013, and Mongolian University of Science and Technology in 2011*
- *Accepting JDS students from 2017 to 2024 (scheduled)*

	2017	2018	2019	2020	2021
Ministry of Finance	2	2	1		1
Financial Regulatory Commission	2		1	2	
National Statistics Office		1			
National University of Mongolia			1		
Bank of Mongolia				1	1

- *Accepting MEXT students*

Bird's eye view



Macro-econometric Model

- *Origin: Tinbergen (1939), Klein (1950), Klein & Goldberger (1995)*
- *Structure: 1) Keynesian demand-side (IS-LM & AS) model → Divided into sectors, and/or extended to open economy and dynamic growth model → Developed into large-scale system of equations, 2) assuming price rigidities and GDP gap → evaluating fiscal & monetary policies*
- *Methodology: Econometric methods (e.g., OLS) with time-series data for parameters' estimate of each equation (e.g., consumption and investment functions)*

Macro-econometric Model

- *Applications: Policy evaluations and projections by Interlink model of OECD, Multimod model of IMF, and Japanese Gov. (Short-term & Middle- term macro-econometric model), etc. → Practical use rather than academic use*

- *Simple example:*

$$Y = C + I + G;\ C = \alpha + \beta Y$$

α and β are estimated by econometric method
Then, Keynesian multiplier is computed as

$$\Delta Y / \Delta G = 1 / (1- \beta)$$

Estimates for Fiscal Multiplier

Impact on GDP (%) of a 1%-of-GDP Increase in Public Consumption

	Short run (≤ 1 year)				Long run (> 1 year)			
	Germany	France	U.K.	U.S.	Germany	France	U.K.	U.S.
QUEST (European Commission)	0.9	0.9	1.0	na	0.0	0.0	0.0	na
NIGEM (NIESR)	1.0	0.8	0.6	na	0.0	0.0	-0.1	na
MULTIMOD (IMF)	1.3	1.3	na	1.1	-0.2	-0.2	na	-0.6
INTERLINK (OECD)	1.5	0.8	na	1.1	-0.3	0.2	na	0.1

Hemming, R.. Kell, M. and Mahfouz, S. 2002. The Effectiveness of Fiscal Policy in Stimulating Economic Activity – A Review of the Literature, IMF Working Paper WP/02/208.

Lucas Critique: Lucas (1976)

- *The argument that traditional policy analysis using Macro-econometric Model does not adequately take into account the impact of policy changes on people's expectations and behaviors*
- *Simple example:*

$$Y = C + I + G;\ C = \alpha + \beta Y$$

β estimated econometrically by past data, can be affected by policy changes → fiscal expansion may make people expect future tax increase, then consumption does not necessarily increase → needs to estimate "deep parameter" (substitution, discount, etc.)
- *Inflation Targeting: working on expectations*

CGE Model

(CGE: Computable General Equilibrium)

- *Initial studies: e.g., Shoven and Whalley (1984, 1992)*
- *Structure: 1) Micro Foundation (optimal behaviors of firms and households), 2) Supply-side model for comparative statics of equilibrium (Walras' law)*
- *Methodology: Calibration for parameters by point estimate*
- *Application: Policy analyses (tax, trade as in FTA, etc.) examining impacts on welfare, resource allocations, spillovers among sectors → e.g., Hertel (1997): GTAP model, https://www.gtap.agecon.purdue.edu/ (ver. 10)*
- *Limitations: 1) Lack in demand-side analyses due to no GDP gap, 2) Ignoring adjustment process due to comparative statics*

DSGE Model

(DSGE: Dynamic Stochastic General Equilibrium)

- *Application: Analyses of monetary policies and macroeconomic shocks by IMF, central banks, etc.: Botman et al. (2007), Smets & Wouters (2003, 2007)*
- *Limitations: 1) Not reflecting realities (DSGE shows rapid price adjustment ---> jump variable), → outcomes should be checked by impulse responses by VAR model, 2) Discordance between parameters based on micro foundation and those in macroeconomics, 3) Difficulties of disaggregation into sectors and institutions due to micro foundation*

DSGE Model

(DSGE: Dynamic Stochastic General Equilibrium)

- *Origin: Kydland & Prescott (1982) for Real Business Cycle → Christiano et al. (2005), Smets & Wouters (2003) for New Keynesian model*
- *Structure: 1) Micro Foundation (optimal behaviors of firms and households), 2) Assuming price rigidities and GDP gap → Perfect combination of Keynesian model & Neo-classical model*
- *Methodology: Calibration → Bayesian estimation: observable data + prior distribution ---> posterior distribution (lessened misspecification)*

DSGE Model

Basic Structure based on Gali (2008)

$$\tilde{y}_t = -(i_t - \pi_{t+1}) + Et[\tilde{y}_{t+1}] - (1-\rho_a) * a_t$$

→ *Expectational IS curve*

$$\pi_t = \beta * Et[\pi_{t+1}] + \kappa * \tilde{y}_t + e_t$$

→ *New Keynesian Phillips curve*

$$i_t = \phi_i * i_{t-1} + (1-\phi_i) * (\phi_\pi * Et[\pi_{t+n}] + \phi_y * \tilde{y}_t) + \varepsilon_{it}$$

→ *Monetary policy rule*

Differences from Macro-econometric model: 1) Inclusion of "expectation", 2) Based on micro foundation

DSGE Model

Example: Taguchi & Ganbayar (2020)

- *Evaluating monetary policy rule under inflation targeting since 2007 in Mongolia*
- *Criteria: Taylor Principle (TP) = for inflation to be stable, the central bank must respond to an increase in inflation with an even greater increase in a nominal interest rate = $\phi_\pi > 1$ in monetary policy rule*

Parameters		Priors			Posterior	
		Dist.	Mean	Stdev.	Mean	90% HPD Interval
Monetary policy rule		–	–	–	–	–
Inflation	ϕ_π	norm	1.172	0.050	1.152	1.071–1.232
GDP gap	ϕ_x	norm	0.000	0.050	0.011	−0.003–0.027
Smoothing	ϕ_r	norm	0.905	0.050	0.891	0.854–0.928

- *TP is identified by DSGE, but the smaller reaction than Thailand (1.3) and Indonesia (1.8)*

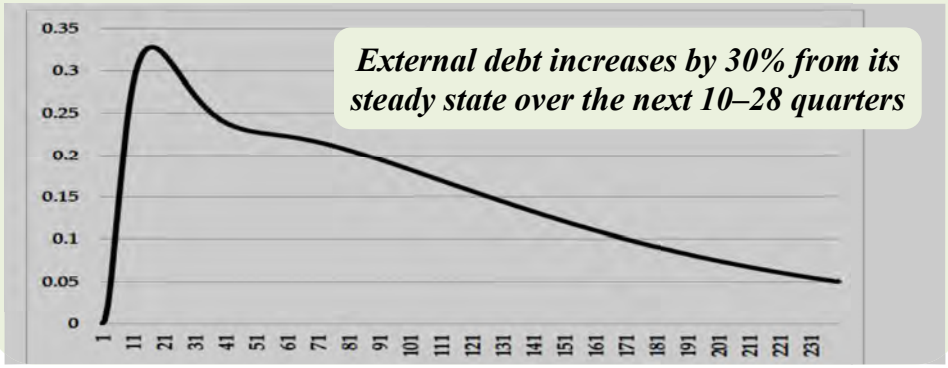
Sims Critique: Sims (1980)

- *Sims (1980): Large-scale models (= Macro-econometric model) do perform useful forecasting and policy-analysis functions despite their incredible identification; the restrictions imposed in the usual style of identification are neither essential to constructing a model which can perform these functions nor innocuous; an alternative style of identification is available and practical (= a six-variable dynamic system).*
- *In Macro-econometric model, variables are interacted endogenously → estimation bias → suggesting a vector autoregressive model*

DSGE Model

Example: Ganbayar (2021)

- *Assessing COVID-19 pandemic structural shock on external debt in Mongolia*
- *Model (small Open Economy DSGE) extension by including the mining sector & preference shock*



VAR (Vector-Autoregressive) Model

- *Modality: Reduced form with past lagged variables for avoiding endogeneity:*

$$y_t = \mu + V_1 y_{t-1} + \cdots + V_p\, y_{t-p} + e_t$$

y: vector of variables, V: vector of parameters

- *Analysis followed by 1) Granger causality, 2) impulse responses, and 3) variance decomposition*
- *Limitations: 1) Criticized by "statistical estimation without economic theory", 2) Ignoring "contemporaneous interaction" of variables*

SVAR (Structural VAR) Model

- *Modality: Allowing "contemporaneous" interaction of variables:*

$$y_t = \mu + V_0 y_t + V_1 y_{t-1} + \cdots + V_p\, y_{t-p} + e_t$$

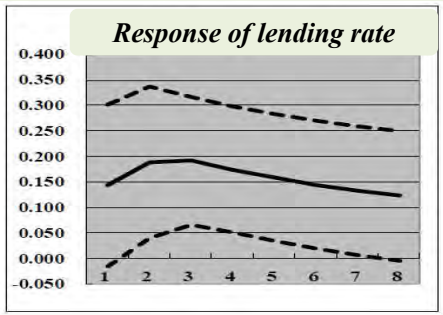
y: vector of variables, V: vector of parameters

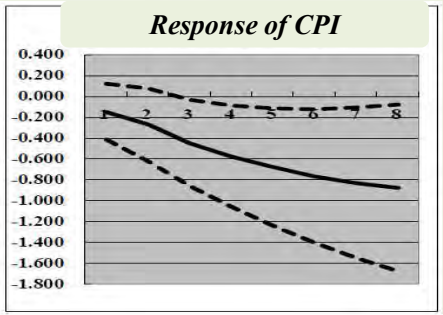
- *Estimation requires imposing restrictions (short-term or long-term) based on "theoretical" grounds; Cholesky decomposition with recursive order is one of short-term restrictions → identifying structural shocks*

SVAR Model

Example: Khishigjargal (2018)

- *Examining monetary policy transmission mechanism under the inflation targeting (under the adoption of interest rate corridor since Feb.2013) in Mongolia*
- *Recursive order: interbank rate → lending rate → CPI*
- *Impulse responses to the shock of interbank rate (itr)*





Summary of Economic Model

	Macro-econometrics Model	*CGE*	*DSGE*	*VAR*
Economic Theory	*Yes*	*Yes*	*Yes*	
Micro Foundation		*Yes*	*Yes*	
Price Regidity	*Yes*		*Yes*	
Long-term Dynamics	*Yes*			
Sectoral Analysis	*Yes*	*Yes*		*Yes*

References

Botman, D., Karam, Ph., Laxton, D., and Rose, D. (2007). DSGE Modeling at the Fund: Applications and Further Developments, IMF Working Paper, No. 07/200.

Christiano, L.J., M. Eichenbaum and C.L. Evans (2005) "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy" Journal of Political Economy 113, 1-45.

Gali, J (2008) Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework, Princeton University Press: Princeton and Oxford.

Ganbayar, G. (2021) Analysis of External Debt Sustainability in Mongolia: An Estimated DSGE Approach. Sustainability, 13, 8545.

Hertel, T. W. (1997). Global Trade Analysis: Modeling and Applications, Cambridge University Press.

Khishigjargal, E. (2018) Monetary Policy Transmission under Inflation Targeting in Mongolia. Research in Applied Economics, 10(2): 1-17.

Klein, L. R. (1950). Economic Fluctuations in the United States, 1921-1941, Cowles Commission Monograph No. 11 (New York: J. Wiley and Sons).

Klein, L. R. and Goldberger, A. S. (1955). An Econometric Model of the United States, 1929-1952, (Amsterdam: North-Holland).

Kydland, F. K. and Prescott, E. C. (1982). Time to Build and Aggregate Fluctuations, Econometrica, 50, pp.1345-1370.

Lucas, R. J. (1976). Econometric Policy Evaluation: A Critique, Carnegie-Rochester Conference Series on Public Policy, Vil. 1(1), Elsevier, Pages 19-46.

Shoven, J. B. and Whalley, J. (1984). Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey, Journal of Economic Literature, 22.

Shoven, J. B. and Whalley, J. (1992). Applying General Equilibrium, Cambridge University Press.

Sims, C. A. (1980). Macroeconomics and Reality, Econometrica, 48(1), pp. 1-48.

Smets, F. and R. Wouters (2003) "An estimated dynamic stochastic general equilibrium model of the euro area," Journal of the European Economic Association, 20, pp. 1123- 1175.

Smets, F. and R. Wouters (2007) "Shocks and Frictions in US Business Cycles: A Bayesian Approach" The American Economic Review 97(3), 586-606.

Taguchi, H. and Ganbayar, G. (2020) Monetary Policy Rule and Taylor Principle in Mongolia: GMM and DSGE Approaches, International Journal of Financial Studies, 8(4): 1-16.

Tinbergen, J. (1939). Statistical Testing of Business-Cycle Theories II: Business Cycles in the United States of America, 1919-1932 (Geneva: League of Nations).

Online Workshop by Young Economists in Mongolia
Aug. 6, 2022 (Mongolian time)

10:00	Opening (by Prof. Taguchi, Saitama University)
10:00 – 10:10	Guest Speech by Mr. Tanaka, Chief Representative of JICA Mongolia Office
	Guest Speech by Ms. Nagasawa, Representative of JICE Mongolia Office
10:10– 11:00	**Session I: Computable General Equilibrium (CGE) Model in Mongolia**
	Moderator: Mr. Yamashita, JICA Experts
	Presenters: G. Nyamtsetseg & U. Enkhbat, Advisor, Ministry of Econ. and Dev.
11:00 – 14:15	**Session II-A: Presentations by Ex JDS Students [Updates in Job and Research]**
	Moderator: Prof. Taguchi, Saitama University
11:00 – 11:15	Mr. Bulgankhuu Ganzorig (Ministry of Finance)
11:15 – 11:30	Ms. Natsagdorj Narantuya (Financial Regulatory Commission)
11:30 – 11:45	Mr. Namjil Enkhbaatar (Financial Regulatory Commission)
11:45 – 12:00	Ms. Tsaschikher Naranzul (Ministry of Finance)
12:00 – 13:00	Break
13:00 – 13:15	Ms. Luvsansharav Naranchimeg (Ministry of Finance) *
13:15 – 13:30	Ms. Jambaldorj Bolortuya (National Statistics Office)
13:30 – 13:45	Ms. Ganbold Bolormaa (Ministry of Finance)
	(Mr. Zandariya Bayanmunkh (Ministry of Finance), *absence*)
	(Ms. Amgalan Urantugs (Financial Regulatory Commission, *absence*)
13:45 – 14:00	Mr. Ganbayar Gunbileg (National University of Mongolia)
14:00 – 14:30	Break
14:30 – 15:45	**Session II-B: Presentations by Current JDS Students [Research Activities]**
14:30 – 14:45	Ms. Munkhbat Bolortuya (Bank of Mongolia)
14:45 – 15:00	Ms. Tserennadmid Dorjkhand (Financial Regulatory Commission)
15:00 – 15:15	Mr. Tseren Dashnyam (Financial Regulatory Commission)
15:15 – 15:30	Mr. Luvsandorj Gantogtokh (Ministry of Finance)
15:30 – 15:45	Mr. Natsagdorj Batjin (Bank of Mongolia)
15:45 – 16:00	Discussions and Messages from Graduates to Students
16:00	Closing

MINISTRY OF ECONOMY AND DEVELOPMENT

CGE MODEL IN MONGOLIA

Nyamtsetseg.G, Specialist, Ministry of Economy and Development, Mongolia
Enkhbat.U, Consultant, Ministry of Economy and Development, Mongolia

2022

MACROECONOMIC POLICY DEPARTMENT

MINISTRY OF FINANCE

COUNCIL OF MINISTERS — MINISTER OF FINANCE — VICE MINISTER

- CUSTOMS CENTRAL ADMINISTRATION
- STATE SECRETARY
- CENTRAL DEPARTMENT OF TAXATION

- BUDGET POLICY AND PLANNING DEPARTMENT
- ECONOMIC POLICY DEPARTMENT
- ACCOUNTING POLICY DEPARTMENT
- DEVELOPMENT FINANCING POLICY DEPARTMENT
- FINANCIAL POLICY DEPARTMENT
- PUBLIC INVESTMENT POLICY DEPARTMENT
- PUBLIC ADMINISTRATION DEPARTMENT
- TREASURY DEPARTMENT
- LAW END LEGAL DEPARTMENT
- FINANCIAL MONITORING AND RISK MANAGEMENT DEPARTMENT

Amendment of law on the Government of Mongolia

- Macroeconomic policy research and planning
- To determine the priority sectors of economy, create a favorable economic environment
- To plan and develop main strategy on balance of payment

MINISTRY OF ECONOMY AND DEVELOPMENT

COUNCIL OF MINISTERS — MINISTER OF MED — VICE MINISTER

STATE SECRETARY

- INTEGRATED DEVELOPMENT POLICY DEPARTMENT
- MACRO ECONOMIC POLICY DEPARTMENT
- REGIONAL AND INDUSTRIAL POLICY DEPARTMENT
- PORT DEVELOPMENT AND FREEZONE POLICY DEPARTMENT
- INVESTMENT POLICY DEPARTMENT
- TRADE AND ECONOMIC COOPERATION POLICY DEPARTMENT
- PUBLIC ADMINISTRATION DEPARTMENT
- DEVELOPMENT FINANCING DEPARTMENT
- DEVELOPMENT RESEARCH DEPARTMENT
- MONITORING AND AUDITING DEPARTMENT

CONTENTS

01 **Macroeconomic Policy Department** /main duties, analyses, current activities/

02 **Construction of CGE model and conduct policy simulation for Mongolian Economy** /The project implementation /

03 **Mongolian SAM 2018** /Macro and Micro SAM, adjustments, extendings/

04 **Simulation and Results of CGE in Mongolia** /static CGE, Dynamic CGE/

MACROECONOMIC POLICY DEPARTMENT

CURRENT ACTIVITIES OF MACROECONOMIC POLICY DEPARTMENT

1 MACROECONOMIC DIAGNOSTIC

- Real sector
- Fiscal sector
- Monetary sector
- Foreign sector

2 Macroeconomic forecasts

- GDP, *by sectors*
- Inflation
- Exchange rate
- Export and Import, *by products*

ADPS 2023 MTFF 2023-2025

3 Macroeconomic analyses and studies

-Russia's Invasion of Ukraine: Overview, current economic situations, Impact on macroeconomic, policy implications
-Coved 19 Pandemic: Overview, current economic situations, Pandemic Impact on macroeconomic, impact of China's zero-COVID strategy, policy implications
-Inflation: Latest statistical analyses and trends, impact on poverty, some policy implementations
-Labor market: Overview, Impact analysis of Covid 19, some policy suggestions to improve workforce and productivity.
-Foreign sector: Overview, statistical analysis of BOP, BOP problems, impact of mega projects on BOP
-Risk assessment: Macroeconomic short-term risks, problems and issues.

4 Macroeconomic models

- FPP
- OIT analysis
- FARI
- CGE
- GAP
- DSGE
- SAM
- GTAP
- CLEWS
- DATA ANALYSIS /e-barimt, household survey, social welfare data, fiscal data/

MINISTRY OF ECONOMY AND DEVELOPMENT

CONSTRUCTION OF CGE MODEL AND CONDUCT POLICY SIMULATION FOR MONGOLIAN ECONOMY

/THE PROJECT IMPLEMENTATION /

MINISTRY OF ECONOMY AND DEVELOPMENT

Macro and Micro SAM

CGE MODEL IN MONGOLIA

THE PROJECT IMPLEMENTATION

CONSTRUCT SAM IN MONGOLIA /Phase I/

- Review of methodology to construct Macro-SAM and Micro-SAM
- Team working on building SAM-2018 in Mongolia used Supply-Use table and other data.
- Adjustments on MICRO-SAM 2018
- Some extending on MICRO-SAM 2018
- Simple microeconomic foundations for CGE modeling and introduction section of GAMS

Simplified CGE model /Phase I/

- Macroeconomic theoretical and functional forms
- Autarky without government (AUTA) model is the model of a closed economy without government.
  - Three industries/commodities:
  - Two factors of production:
  - Two categories of households:
  - 58 equations, 58 endogenous and 6 exogenous variables.
- GAMS:
- Output files
- Error solving in GAMS /Syntax error, Execution errors, INFES errors, LEON errors/
- Simulation and analysis

Static CGE model /Phase II/

- Static model with 5x5 SAM
- Static CGE model with MICRO-SAM 2018.
- A modified version of the PEP 1-1 model
- Mongolian SAM 2018 /19 sectors and 20 commodities/
- **Policy simulation in the static CGE model**
  - Raising the price of export coal
  - Implementing government policies to reduce excise tax of fuel when fuel prices rise.
  - Divide labor into two parts: skilled labor and unskilled labor.

Dynamic CGE model /Phase II/

- A modified version of the PEP 1-1 model
- Mongolian SAM 2018
- Structure and equations of the model
- **Simulations and results analysis**
  - Adding two variables in the model and solve errors associated with adding variables.
  - Estimating the economic impact of large transport investment project

MACRO SAM 2018 IN MONGOLIA

		L	K	AG	AG	AG	AG	AG	AG	J	I	OTH	OTH	OTH
		LAB	CAP	H	GVT	TD	TM	TI	ROW	Sec	Com	INV	VSTK	TOT
L	LAB								447,921	8,394,072				8,841,993
K	CAP								81,558	20,358,292				20,439,850
AG	H	8,567,547	17,332,051		3,134,187				767,239					29,801,024
AG	GVT			1,711,812		4,568,916	682,477	2,835,996	233,172	140,387				10,172,760
AG	TD			4,568,916										4,568,916
AG	TM										682,477			682,477
AG	TI										2,835,996			2,835,996
AG	ROW	274,446	3,107,799	269,373	720,491						20,751,914			25,124,022
J	Sec										60,944,538			60,944,538
I	Com			17,598,908	3,782,113				18,951,604	32,051,787	6,566,168	9,533,060	3,297,452	91,781,093
OTH	INV			5,652,015	2,535,970				4,642,527					12,830,512
OTH	VSTK											3,297,452		3,297,452
OTH	TOT	8,841,993	20,439,850	29,801,024	10,172,760	4,568,916	682,477	2,835,996	25,124,021	60,944,538	91,781,093	12,830,512	3,297,452	-

Use table
Supply table
Balance of Payment
Budget
SAM is Balanced

+TI-Supply table- from NSO

+BOP data from IMF

MACRO SAM ⟹ MICRO SAM

		L	K	AG	AG	AG	AG	AG	J	J	J	J	J	I	I	I	I	I	X	X	X	X	X	OTH	OTH	OTH
		LAB	CAP	H	GVT	TD	TM	TI	AGR	Mining	Man	Pubad	Ser	AGR	Mining	Man	Pubad	Ser	AGR	Mining	Man	Pubad	Ser	INV	VSTK	TOT
L	LAB								448	2,515	1,532	1,993	2,310	4,196													12,995
K	CAP								82	980	6,129	2,898	659	5,540													16,287
AG	H	12,720	13,180		3,134				767																		29,801
AG	GVT			1,712		4,569	682	2,836	233	1	60	45	4	31					0.00	0.00	0.00	0.00	0.00				10,173
AG	TD			4,569																							4,569
AG	TM													12	1	670	-	-									682
AG	TI													30	1	2,520	10	275									2,836
AG	ROW	274	3,107	269	721									238	9	15,517	606	4,119									24,861
J	AGR													4,557	-	72	-	16	629	-	1	-	0				5,275
	Mining													0	1,121	3,434	0	749	0	11,603	438	0	3				15,349
	Man													2	7	12,303	1	2,303	0	40	2,053	0	12				16,721
	Pubad													-	-	2	4,620	22	-	1	0	60	1				4,705
	Ser													-	0	194	5	16,277	-	4	6	0	2,410				18,896
I	AGR			1,277	-				480	5	2,103	6	51											1,060	513	5,495
	Mining			14	-				-	21	842	0	3											-	345	1,225
	Man			9,746	16				745	4,483	6,986	655	4,473											8,063	2,449	37,119
	Pubad			1,445	3,435				0	57	95	100	109											-	(0)	5,242
	Ser			5,618	328				554	3,061	1,758	972	4,492	655	85	4,408	-	-	91	947	379	-	-	411	(0)	23,760
X	AGR																									721
	Mining								12,595																	12,595
	Man								2,878																	2,878
	Pubad								60																	60
	Ser								2,425																	2,425
OTH	INV			5,652	2,536				4,653																	12,841
OTH	VSTK																							3,308		3,308
OTH	TOT	12,995	16,287	29,801	10,173	4,569	682	2,836	24,861	5,275	15,349	16,721	4,705	18,896	5,495	1,225	37,119	5,242	23,760	721	12,595	2,878	60	2,425	12,841	3,308	-

ADJUSTMENTS

- ✓ Direct purchase of economic residents and non-residents
- ✓ Separating Mixed income
- ✓ Adjusting re-export
- ✓ Transport and trade surcharges

SAM EXTENDINGS MICRO-SAM 2018

01 SEPARATING THE FIRM FROM THE HOUSEHOLD)

02 DIVIDING THE HOUSEHOLD INCOME TO 5 GROUP

03 DIVIDE LABOR INTO TWO PARTS: SKILLED LABOR AND UNSKILLED LABOR

MACRO SAM ⟹ MICRO SAM

Direct purchase of economic residents and non-residents

Household consumption:
+Direct purchase of residents to foreign
-Direct purchase of non-residents from domestic market

Export:
+ Direct purchase of non-residents from domestic market

Import:
-Direct purchase of residents to foreign

Adjusting re-export

EX-(EX-PROD)

Transport and trade surcharges

GAMS

Separating Mixed income

	Value added	Value added/Total
Worker's compensation	L	K/(K+L+MIXINC)
Consumption of fixed capital	K	L/(K+L+MIXINC)
Operating surplus, net		
Mixed income	MIXING	MIXING/(K+L+MIXINC)
TOTAL	K+L+MIXINC	100%

	Value added
Worker's compensation	L
1212.MN	Lnso=W*N
Worker's compensation +Mixed income	L+MIXING
ADJUSTED WORKER'S COMPENSATION	Lnso, (L+MIXING)>L -min(L, (L+MIXING)-Ladj Lnso, (L+MIXING)<L -L-Ladj
ADJUSTED INCOME OF CAPITAL	Kadj=TOTAL-Ladj

SEPARATING THE FIRM FROM THE HOUSEHOLD

		L	K	AG	AG	AG	AG	AG	AG	AG	J	I	OTH	OTH	OTH
		LAB	CAP	H	F	GVT	TD	TM	TI	ROW	Sec	Com	INV	VSTK	TOT
L	LAB									447,921	8,394,072				8,841,993
K	CAP									81,558	20,358,292				20,439,850
AG	H	8,567,547	9,393,972			2,847,735				641,424					21,450,678
AG	F		7,938,079			286,452				125,815					
AG	GVT				1,711,812		4,568,916	682,477	2,835,996	233,172	140,387				10,172,760
AG	TD			2,466,315	2,102,601										4,568,916
AG	TM											682,477			682,477
AG	TI											2,835,996			2,835,996
AG	ROW	274,446	3,107,799	261,600	7,772	720,491						20,751,914			25,124,021
J	Sec											60,944,538			60,944,538
I	Com			17,598,908		3,782,113				18,951,604	32,051,787	6,566,168	9,533,060	3,297,452	91,781,093
OTH	INV			3,464,471	2,187,544	2,535,970				4,642,527					12,830,512
OTH	VSTK												3,297,452		3,297,452
OTH	TOT	8,841,993	20,439,850	23,791,294		10,172,760	4,568,916	682,477	2,835,996	25,124,021	60,944,538	91,781,093	12,830,512	3,297,452	-

National account
MOF
Balance of Payment
SAM is balanced

DIVIDING THE HOUSEHOLD INCOME TO 5 GROUP

Household income:
- Wage
- Capital income
- Transfers from government
- Transfers from ROW

Household consumption: 48 product

Ratio of this household consumption to used SAM

Household Socia-Economic survey

Household	N	MEAN	MIN	MAX	Income ratio/total
1	3285	3860112	20000	5651033	0.063
2	3285	7131172	5653051	8630000	0.116
3	3284	10300000	8632300	12000000	0.167
4	3290	14300000	12000000	17100000	0.232
5	3278	26100000	17100000	196000000	0.422
TOTAL	**16450**	**13500000**	**20000**	**196000000**	

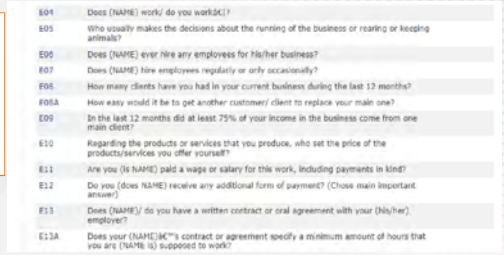
MINISTRY OF ECONOMY AND DEVELOPMENT

Static CGE model in Mongolia

/PEP 1-1 model, Mongolian SAM 2018 -19 sectors and 20 commodities/

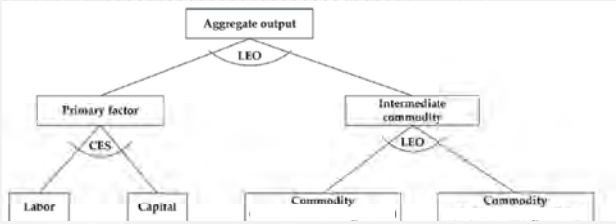
DIVIDE LABOR INTO TWO PARTS: SKILLED LABOR AND UNSKILLED LABOR

DATA:
- Labor force survey
- Balance of payment
  - Lab-row
  - Lab-skilled
  - Lab-unskilled



	Value added of Labor	Ratio
Lab-ROW	447921	0.034
Lab-skilled	4383058	0.337
Lab-unskilled	8163596	0.628
TOTAL	**12994575**	**1**

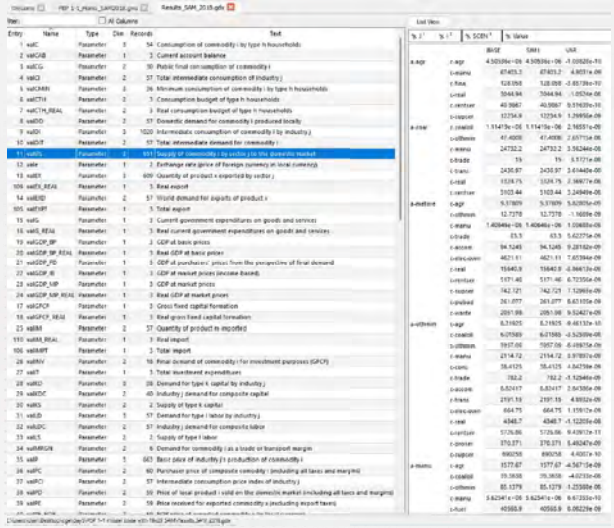
THE MATHEMATICAL STRUCTURE:
- Single-country
- 19 sectors and 20 commodities
- Two factors of production: L,K
- Agents: H, G, ROW
- A broader set of tax instruments
- All possible transfers between agents
- GAMS code
- Parameters
- Mongolia SAM 2018

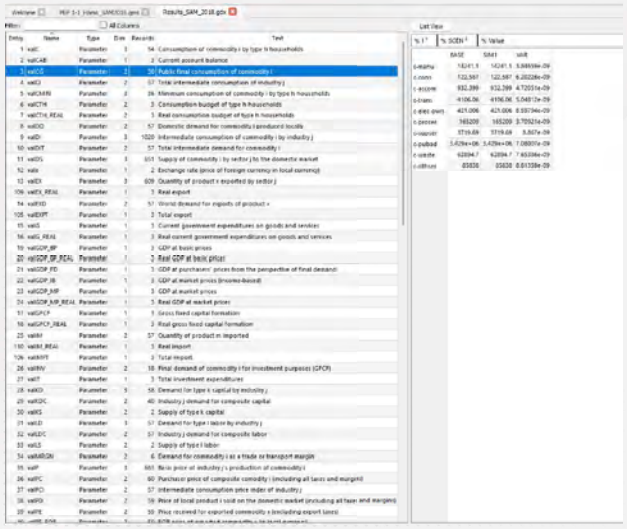



```
** 6.3 Closures
*  The numeraire is the nominal exchange rate

e.fx            = 1;
CAB.fx          = CAB0;
CMIN.fx(i,h)    = CMIN0(i,h);
G.fx            = G0;
LS.fx(l)        = LS0(l);
* W.fx(l)         = W0(l);
PWM.fx(i)       = PWM0(i);
PWX.fx(i)       = PWX0(i);
VSTK.fx(i)      = VSTK0(i);
sh0.fx(h)       = sh00(h);
sh1.fx(h)       = sh10(h);
tr0.fx(h)       = tr00(h);
tr1.fx(h)       = tr10(h);
ttdh0.fx(h)     = ttdh00(h);
ttdh1.fx(h)     = ttdh10(h);
ttic.fx(i)      = ttic0(i);
ttik.fx(k,j)    = ttik0(k,j);
ttim.fx(i)      = ttim0(i);
ttip.fx(j)      = ttip0(j);
ttiw.fx(l,j)    = ttiw0(l,j);
ttix.fx(i)      = ttix0(i);
WD.fx(i)        = WD0(i);
* EXD.fx(i)       = EXD0(i);

LAB_ROW.fx      = LAB_ROW0;
CAP_ROW.fx      = CAP_ROW0;
```

Source: ERI

```
** 6.4 Simulations

* Homogeneity (nominal) test - the following 6 variable must increase by the same amount

*$ontext
 PWX.fx(i)    = PWXO(i)*1.2;
 PWM.fx(i)    = PWMO(i)*1.2;
 cab.fx       = cabo*1.2;
 G.fx         = GO*1.2;
 LAB_ROW.fx   = LAB_ROWO*1.2;
 CAP_ROW.fx   = CAP_ROWO*1.2;
*$offtext

$ontext
 PWX.fx('c-metore')       = PWXO('c-metore')*0.9;
 PWX.fx('c-coaloil')      = PWXO('c-coaloil')*0.9;

 WD.fx('c-metore')        =  WDO('c-metore')*0.8;
 WD.fx('c-coaloil')       =  WDO('c-coaloil')*0.8;
$offtext

** 6.5 Resolution
option limrow = 10000;
OPTION NLP = conopt3
MODEL PEP11 Standard PEP static model version 2_1 /ALL/;
PEP11.HOLDFIXED=1;
SOLVE PEP11 USING CNS;
$include Results_PEP_1-1_Homo_SAM19x20.GMS
```



MINISTRY OF ECONOMY AND DEVELOPMENT

Dynamic CGE model in Mongolia

/PEP 1-1 model, Mongolian SAM 2018 -19 sectors and 20 commodities/

Variables that grow at a constant rate

- Recursive Dynamic CGE
- Forward-looking Dynamic CGE

1. $VA_{j,t} = v_j XST_{j,t}$

2. $CI_{j,t} = io_j XST_{j,t}$

3. $VA_{j,t} = B_j^{VA}\left[\beta_j^{VA} LDC_{j,t}^{-\rho_j^{VA}} + (1-\beta_j^{VA}) KDC_{j,t}^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}$

$$LS_{l,t+1} = LS_{l,t}(1+n_t)$$
$$CAB_{t+1} = CAB_t(1+n_t)$$
$$C_{i,h,t+1}^{MIN} = C_{i,h,t}^{MIN}(1+n_t)$$
$$G_{t+1} = G_t(1+n_t)$$
$$IND_{k,pub,t+1} = IND_{k,pub,t}(1+n_t)$$
$$VSTK_{i,t+1} = VSTK_{i,t}(1+n_t)$$

MINISTRY OF ECONOMY AND DEVELOPMENT

THANK YOU

2022

Remote Lecture Course on **Public Policy Analysis**

Lecturer Toru YANAGIHARA (Mr.), Professor Emeritus of Takushoku University, Honorary Fellow of Institute of Developing Economies, Adjunct Professor of Vietnam-Japan University, M. Phil. in economics (Yale University).

Course objective: This intensive course is designed to provide practice-oriented professional training in policy analysis and policy development for officials of the Ministry of Finance of Mongolia as part of JICA's cooperation project "Project for Strengthening Capacity of Macroeconomic Policy and Planning". Training will be conducted on the practical approaches to policy papers/reports and theories/hypotheses behind them and directed case-based study for in-depth examination of policy issues.

Expected learning outcomes Knowledge competence: Firm grasp of contemporary ideas, methods and tools in policy analysis. Skills: Mastery of the logic and application of "strategic thinking" and associated analytical skills.

February 18, Friday, at 14:00～15:30

Class 1 Introduction

The purposes, goals, processes, procedures and requirements of this course. The virtual world of discourse and the real world of action. Strategic thinking, rationality, and pragmatism. Policy Analysis and Policy Process Analysis.

February 18, Friday, at 15:45～17:45

Class 2 Critical review of the macroeconomic issues, scrutinizing some points raised in the latest IMF's staff report of the Article IV consultation.

February 25, Friday, at 14:00～15:30

Class 3 Review of the important questions, key concepts, and conceptual/analytical frameworks on poverty analysis. Reference is made to the World Bank's Poverty Update report.

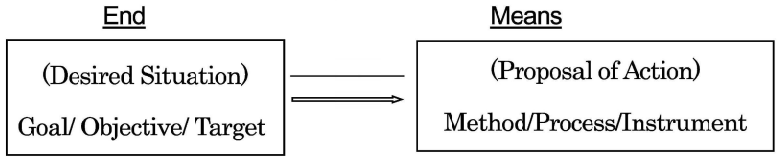
February 25, Friday, at 15:45～17:45

Class 4 Introduction to the rationales, principles, and methodology of Randomized Controlled Trials (RCTs) for policy formulation, implementation, and evaluation, paying particular attention to the strengths and limitations of RCTs.

Materials and Zoom-URL will be distributed later.

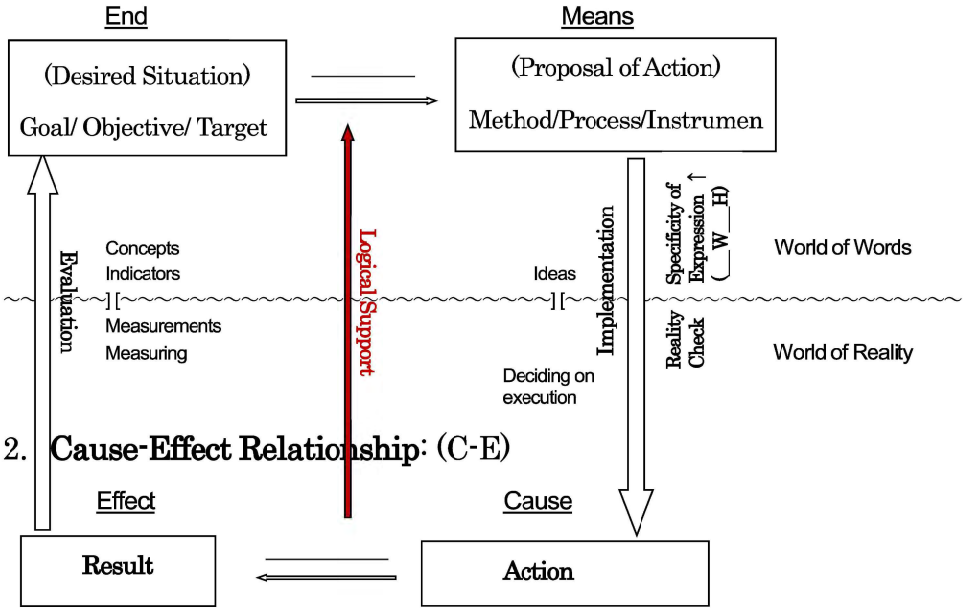
Strategy: A package of two set of **phrases**
expressing
Goal/Objective/Target
and
Method/Process/Instrument

End-Means Relationship: (E-M)



Strategy and Two Types of Logical Relationship

1. End-Means Relationship: (E-M)



2. Cause-Effect Relationship: (C-E)

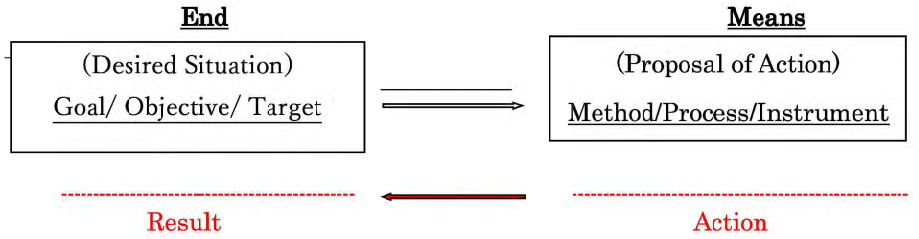
Logical Thinking (outline)

Any policy can be viewed from two perspectives: (1) formal/logical aspect and (2) substantive aspect.
There are three types of tasks in the examination of policies:
(1) appropriateness of formal/logical construction of the argument;
(2) appropriateness of empirical evidence; and
(3) appropriateness of the correspondence between the argument and evidence.
Logical Thinking relates mostly to (1) above but oftentimes also to (3) and therefore indirectly to (2) as well.

Formal/Logical structure of policy: Strategic Thinking

Strategy: A **package** of two sets of **phrases** (belongs to World of Words)
stating
stating
Desired Situation: Goal/Objective/Target (to be realized in the future World of Reality)
and
Proposal of Action: Method/Process/Instrument (to be realized in the future World of Reality)

End-Means Relationship: (E-M)



IMF Executive Board Concludes 2021 Article IV Consultation with Mongolia – November 19, 2021

The Executive Board of the International Monetary Fund (IMF) concluded the Article IV consultation with Mongolia. The Mongolian economy is rebounding from its deepest recession in a decade, despite a lingering pandemic. The recovery is largely export-led, supported by the global recovery and base effects. Notwithstanding continued economic support and a successful vaccination program, domestic activity remains weak due to the pandemic. Many workers, especially female workers, are leaving the workforce, perhaps permanently. Inflation has risen recently but mainly due to transitory factors affecting import prices. Policies were appropriately supportive during the pandemic. However, large, untargeted and continuing fiscal, quasi-fiscal and financial forbearance measures due to Parliamentary measures have heightened macrofinancial vulnerabilities: public debt has sharply increased, bank balance sheets have further weakened, and the Bank of Mongolia's (BOM) operational independence has been compromised. The government and BOM have appropriately managed Mongolia's external vulnerabilities. Taking advantage of supportive global financial conditions, Eurobonds coming due in 2022−23 were successfully rolled over on better terms. The BOM has opportunistically built its gross international reserves, aided by import compression and disruptions, a favorable terms of trade and the 2021 IMF SDR allocation of US$98.3 million (95.8 percent of quota). Even so, international reserves are assessed to be inadequate given large external liabilities. The economic outlook remains strong, though uncertain. Real GDP is projected to grow by 4.5 percent in 2021, after contracting by 4.6 percent in 2020. In 2022-23, Mongolia remains poised for an export-led boom, with growth expected to accelerate to 6½–7 percent if export portals fully reopen and the Oyu Tolgoi copper mine is completed on schedule. As the pandemic is largely controlled, domestic activity is expected to gradually normalize. Medium term growth is expected to moderate to 5 percent, but output levels are likely to remain below pre-pandemic trends due to permanent losses in activity. Inflation is expected to return to the BOM's targeted range. Despite an export price boom, the 2020 current account improvements are likely to be temporary once recovery takes hold and imports pick up. This reflects Mongolia's lack of export diversification, heavy import dependence and high external debt. Risks to the outlook are on the downside risks. A worsening of the pandemic, extended border closures, and tighter global financing conditions pose significant risks, given Mongolia's thin net international reserves and high external debt. Financial sector weaknesses, exacerbated by the pandemic, increase Mongolia's exposure to external shocks by forcing the public and private sectors to borrow externally. A major deterioration in asset quality could impact bank capital, and delay the recovery. Finally, procyclical policies could undermine macrofinancial stability and debt sustainability, reducing the policy space to address other major risks, undermining Mongolia's recovery.

Executive Board Assessment

Executive Directors commended the authorities on a successful vaccination campaign and welcomed the export-led recovery underway. Notwithstanding the strong economic outlook, Directors noted that significant downside risks remain given uncertainties associated with the pandemic, Mongolia's limited buffers and high external public debt. In that context, they stressed the importance of managing the export boom prudently to secure the recovery while achieving the country's long-term development goals. Directors agreed that in the near term, policies may need to remain supportive, given the lingering pandemic and weak recovery in domestic activity. Calling for an ambitious fiscal consolidation strategy, Directors emphasized the importance of bold structural fiscal reforms to address untenable debt dynamics. To this end, they underscored the importance of better targeted and more effective social assistance programs, ambitious pension reforms, improved public investment management, and tax administration. Commendable plans for e-governance and state enterprise reform should be fleshed out and implemented. Directors also emphasized that the integrity of the Future Heritage Fund should be preserved to maintain investor confidence. Directors stressed the need to enhance the Bank of Mongolia's (BOM) operational independence to ensure monetary and external stability. Continued vigilance is needed to ensure that inflation does not become persistent. Directors emphasized that quasi-fiscal operations should be moved to the budget and phased out, and the Parliament should resist making decisions on

monetary and financial operations. Greater exchange rate flexibility could serve as a shock absorber. The BOM should continue building its external buffers and drawdown non concessional external liabilities. Noting with concern the possibility of potential vulnerabilities in the banking sector, Directors called for greater supervisory focus on strengthening banks and contingency planning. In that context, they stressed the importance of a well-sequenced approach to bank reforms to minimize the risk of systemic instability. Phasing out regulatory forbearance by end-2021 and promptly undertaking a fresh and independent asset quality review for potentially capital deficient banks would be imperative for transparency and a proper assessment of bank balance sheets. Emphasizing the need for putting in place the necessary pre conditions for successful IPOs and contingency plans, they called for delaying the deadline for the IPOs. Directors welcomed the authorities' long-term development strategy focused on sustainable, inclusive, and green growth. To improve the business climate, they urged the authorities to decisively address the long standing concerns about corruption, governance, and AML/CFT to strengthen the investment climate and promote diversification. Revamping the insolvency framework and judiciary reforms should be prioritized to address impaired balance sheets. Directors stressed the importance of the publication of the full audit report on COVID related expenditures, including the missing information on beneficial owners.

Statement by Chang Huh, Executive Director for Mongolia, Gantsogt Khurelbaatar, Senior Advisor to Executive Director, and Jinhyuk Yoo, Advisor to Executive Director

The Mongolian authorities wish to convey their appreciation to Ms. Banerji and her team for the candid and constructive discussions during the Article IV mission. The authorities responded proactively to containing the spread of the virus including closing borders and providing unprecedented support measures to save the lives and livelihoods of the Mongolian people. The pandemic crisis inevitably caused a deep economic contraction in 2020 and substantial scarring effects are expected over the medium term. Without policy support, however, there would have been more adverse impacts on the economy and the poverty situation. Despite high uncertainty surrounding the course of the pandemic, the Mongolian government adopted a national long-term vision, Mongolia Vision 2050, that aims to transform the country by fighting poverty, creating a greener economy, improving the education system and gender equality for enhanced job access, and redefining the social strategy in a more citizen-centered way. Continuing reform efforts, together with the swift pandemic response, have contributed to favorable external financing conditions. After a spike in sovereign spreads early in the pandemic, Mongolia's spreads have narrowed faster than those other emerging market peers and Eurobonds were successfully rolled over. External borrowing costs are now at their lowest level since 2015. Going forward, the Mongolian authorities aim to ensure an inclusive recovery and to continue to pursue necessary structural reforms, while preserving macroeconomic stability as well as debt sustainability.

Economic outlook

The economy is recovering strongly after the recession in 2020 with growth projected to be around 4.5 percent in 2021 and around 5 percent over the medium term. The completion of the construction of railway lines to mining sites, and the successful renegotiation and start of the underground exploration of Oyu Tolgoi mine are expected to improve growth prospects further from 2022 onwards. Covid-19 cases remained high throughout 2021 despite the strong vaccination campaign. However, cases have started to drop recently. As nearly 95 percent of the population is fully vaccinated, and the country has started administering the third dose of vaccines, domestic economic activity is expected to begin to slowly recover. Mainly due to higher global commodity prices, the economic outlook is positive, but the authorities are treating the positive outlook with caution. Since Mongolia's economy is closely tied to China, possible economic volatilities in China may significantly impact the economy, especially in the mining sector. For example, the recent closure of the main border points due to a covid-19 outbreak in the bordering areas of China highlights the risks related to Mongolian commodity exports and imports of goods. Moreover, prolonged disruption in trade with major trading partners could seriously hurt the export sector and deteriorate the supply of food and goods.

Fiscal policy

The budget for 2022 envisages policies to support the recovery by increasing capital investment to strengthen export sector

productivity and maintaining adequate welfare support to the vulnerable while rationalizing expenditure. The primary budget deficit is expected to be 3.1 percent of GDP for 2021, and to further decrease to 1.1 percent for 2022. The continued fiscal adjustment is planned through 2026 so as to firmly put debt on a downward path from 81.5 percent of GDP in 2021 to 68.1 percent in 2026, which amounts to a reduction of about 13 percentage points. Given pandemic instigated risks are still high, and the subdued and slow revival of domestic economic activity, the authorities believe that deeper fiscal consolidation at this moment could hurt the recovery and the livelihoods of vulnerable people. Once the recovery is on a firm footing, the authorities plan to undertake fiscal consolidation and explore options to set the appropriate and much lower target level of the public debt. The current crisis clearly showed a need for reforms in many areas of government finances. Thus, fundamental fiscal reforms to rationalize expenditure are being planned. For example, the pension law is currently being discussed in the Parliament to reform the pension insurance scheme, improve the pension fund's economic viability, and reduce the dependence on budget transfers. The authorities also plan to pursue a number of other significant reforms, such as introducing result-based financing of public entities, civil service reforms, freezing of new hires except in priority sectors, improving SOEs governance, and exploring liquidation and privatization of non-strategic SOEs through the stock market, to name a few. The child money program proved to be very efficient and effective in providing financial support to households during the covid-19 pandemic. A number of surveys showed that the program helped the vulnerable and assisted most of the population avoid poverty and maintain adequate living standards. Considering that pandemic risks remain and that a reliable and up-to-date database on the household income does not exist, the authorities have chosen to provide an assistance to children without discrimination. For this, the authorities are planning to introduce savings accounts for cash transfers rather than cash handouts, which could help build savings for children's futures. Going forward, when the ongoing crisis is over and dependable data is available, the authorities will seek to better target the social assistance programs.

Monetary and external policies

Inflation was subdued during the covid-19 pandemic, but there has been a sign of inflationary pressures since June of this year. In addition, recent border closures and the global disruptions in the shipment of goods increased supply-side inflationary pressures and may result in double-digit inflation later this year. If inflationary pressures persist, the Bank of Mongolia stands ready to undertake policy measures to curb inflation. External financial support, including the Fund's RFI and an SDR allocation as well as subdued import activity, helped to increase the gross foreign reserves to 4.2 billion USD, equivalent to 5 months of supply at the end of October this year. Going forward, the authorities are committed to a floating exchange rate regime to accommodate adverse external shocks and maintaining an adequate level of foreign reserves. The Bank of Mongolia is keenly aware that the current level of reserves is not adequate and will take necessary measures to attain additional buffers.

Financial sector policy

An inefficient banking sector has been the root cause of financial instability and the low level of financial inclusion for many years. The lack of competition, weak supervision, and the concentration of banking sector ownership gave rise to an unhealthy banking sector. Deep banking sector reforms have been the Fund's main recommendation for the past decade, and the previous Fund program stalled in 2019 because of inaction reforming the banking sector. After years of setbacks, the Parliament finally approved the banking sector reform package in 2021 to make banks public, improve transparency, and restrict the ownership of individuals and their related parties to no more than 20 percent of shares. The banking sector reform will proceed gradually through 2024. In the first phase, the initial public offerings of 10 percent of shares of banks through the stock market are planned for June 2022. The authorities are keenly aware of the risks related to this significant reform that staff point out. Hence, they will carefully assess the result of the first phase of the reforms and based on this analysis will make necessary changes to the banking sector reform strategy, if needed. The authorities are fully committed to delivering this historic reform and are of the view that any delay to reforms could jeopardize the reform momentum and leave unresolved the root cause of financial instability and underdevelopment of the financial market

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Capacity Development

Mongolia is an intensive recipient of IMF technical assistance (TA). Since the 2019 Article IV consultation, assistance in the fiscal area focused on tax and customs administration via short-term expert visits and a resident advisor, supported by the Revenue Mobilization Thematic Fund. In the wake of the COVID-19 pandemic, the IMF provided TA to assist the Mongolian tax authorities in preparing a business continuity plan (July 2020). Given the country's elevated external public debt levels, MCM provided TA to support the authorities' external debt rollover (June 2020) and to assist the authorities in developing a framework for issuing local currency bonds and developing the domestic capital market (January 2021). Besides this, IMF TA has focused on assisting the authorities in improving and developing new macroeconomic statistical indicators: high frequency indicators (September 2019 and March 2021) and residential property price index (April 2021). IMF TA is also contributing to building capacity for debt sustainability analysis (June 2021). Since the CCAMTAC was established in February 2021, the authorities have been discussing potential TA areas with the CCAMTAC as a complement to IMF HQ-based TA.

IMF TA Missions (September 2019–2021):

• Customs administration, (FAD) August–September 2019
• High frequency economic indicators, (STA) September 2019
• Banking regulation, (MCM) September 2019
• Revenue performance analysis, (FAD) October 2019
• AML/CFT, (LEG) November 2019
• Banking regulation, (MCM) November 2019
• Macro-Fiscal modeling, (FAD) January 2020
• Banking regulation, (MCM) January–February 2020
• Medium term debt strategy and liability management operations, (MCM) June 2020 (remote mission)
• Business continuity plan for MTA, (FAD) June–September 2020 (remote mission)
• Customs diagnostic mission, (FAD) July 2020 (remote mission)
• Mongolia Customs General Authority (MCGA) strategic plan for 2021–2024, (FAD) September 2020 (remote mission)
• Domestic government bond market development mission (MCM), January–February, 2021
• High Wealth Strategy (FAD), February–April 2021 (remote STX mission)
• Tax Gap Analysis (FAD), February–April 2021 (remote STX mission)
• High frequency economic indicators, (STA) March 2021 (remote mission)
• Residential property price index, (STA) April 2021 (remote mission)
• Issuing tax guidelines (FAD), April–June 2021 (remote STX mission)
• Data and analytics (FAD), June 2021 (remote STX mission)
• Debt Dynamics Training (ICD), June–July 2021 (remote mission)
• Hidden economy strategy (FAD), August–September 2021 (remote STX mission)

*** Material for the first class at 14:00 on Feb.25 ***

Between 2016 and 2018, poverty reduction was uneven, declining in rural but not in urban areas. Growth in rural areas was faster and favorable to the poor, contributing to reducing rural poverty by 4 percentage points from 34.9 percent in 2016 to 30.8 percent in 2018. By contrast, less-inclusive consumption growth in urban areas was accompanied by stagnation in poverty, leaving the poverty rate unchanged at 27 percent from 2016 to 2018. The lack of progress in poverty reduction in urban areas was mainly driven by stagnant wage growth in the poorest population group, while strong growth in farm income supported by rising livestock prices, together with the expansion of poverty-targeted social protection programs, contributed to robust poverty reduction in rural areas.

World Bank Document (Mongolia Poverty Update 2018)
pp.62-64

*** Material for the second class at 15:45 on Feb.25 ***

Randomized Controlled Trials (RCTs)

Introduction to the rationales, principles, and methodology of Randomized Controlled Trials (RCTs) for policy formulation, implementation, and evaluation, paying particular attention to the strengths and limitations of RCTs.

WHAT: The most rigorous statistical protocol for formulating, implementing and evaluating policies based on evidence, or Evidence-Based Policy-Making (EBPM)

WHY: Before-and-after comparisons may reflect the influences of factors other than the policy action in question.

HOW: Step1: Trail design of the Treatment Group and the Control Group through random assignments
Step2: Execution of the "Treatment" to the Treatment Group (and not to the Control Group)
Step3: Statistical test of the outcomes across the two groups

CAUTION:
(1) "Internal validity" Easier said than done!
(2) "External validity" No guarantee of replicability / scalability
(3) "Issue type" Suited for micro policies (and often impossible/difficult for macro policies)

Reference:
（1）Evaluating Longer-term Impact of Indonesia's CCT Program: Evidence From A Randomised Control Trial (povertyactionlab.org)
（2）Report-on-Findings-of-Impact-Evaluation-of-Program-Keluarga-Harapan-PKH.pdf (microsave.net)
A rusting gold standard: Failures in an Indonesian RCT, and the implications for poverty reduction - Vikram Tyagi,
（3）Sophie Webber, 2021 (sagepub.com)
（4）http://www.nber.org/papers/w27554

Introduction to GTAP

Dr. Enkhbayar Shagdar,
Senior Research Fellow of ERINA (Economic Research Institute for Northeast Asia), Niigata, Japan

Date & Time: May 13th Friday at 14:00 (Mongol time)
Duration: 90 minutes
Language: Mongolia

Agenda:

1. A brief introduction of GTAP model and GEMPACK (15 min).
2. Data aggregation and RUNGTAP (15 min)
3. Introduction of my recent discussion paper (30 min): Macro-economic Impacts of the COVID-19 Pandemic on Mongolia's Economy: CGE Analysis with the GTAP 10a Data Base:
   (Available: https://www.erina.or.jp/en/wp-content/uploads/2022/03/DP2201.pdf)
4. Q&A (30 min)

The Zoom link will be announced on May 11th with the lecture's presentation.

Participants list	
Delgermaa B	Macroeconomic Policy Dept.
Munkhdelger	Macroeconomic Policy Dept.
Ulziisaikhan	Macroeconomic Policy Dept.
myagmardorj.o	Macroeconomic Policy Dept.
Enkhbat Ulambayar	Macroeconomic Policy Dept.
enhamgalan	Macroeconomic Policy Dept.
Munkhjavkhlan.Kh MED	Macroeconomic Policy Dept.
Г. Нямцэцэг СЯ ЭЗБГ	Macroeconomic Policy Dept.
Enkhlut Ch	Macroeconomic Policy Dept.
Г. Төгөлдөр ХНБГ	Development Policy Dept.
Khurel Erdene	Institute of Labour and Social Protection
Enkhsaikhan eri (Enkhsaikhan)	ERI
Manlaibaatar	ERI
Oyunzul Tserendorj	ERI
Unurjargal ERI	ERI
Oyuntugs ERI	ERI

JICA's Technical Cooperation Project "Project for Strengthening Capacity of Macroeconomic Policy and Planning", Ministry of Economy and Development, Government of Mongolia
14:00-15:30 (UB time) May 13, 2022 (ZOOM lecture)

INTRODUCTION TO GTAP

ENKHBAYAR SHAGDAR (PH.D.)
SENIOR RESEARCH FELLOW, RESEARCH DIVISION AND BUSINESS SUPPORT DIVISION
ECONOMIC RESEARCH INSTITUTE FOR NORTHEAST ASIA (ERINA)

CONTENT

- A brief introduction (15 min)
  - GTAP model
  - GEMPACK
  - Database
- Software intro and demo (15 min)
  - GTAPAgg2
  - RUNGTAP
- Example: Discussion paper (30 min)
  - Macro-economic Impacts of the COVID-19 Pandemic on Mongolia's Economy: CGE Analysis with the GTAP 10a Data Base
- Q&A (30 min)

A BRIEF INTRODUCTION: GTAP MODEL AND GEMPACK

The Model, GEMPACK & Data Base

GLOBAL TRADE ANALYSIS PROJECT

- GTAP is a global network of researchers and policy makers conducting quantitative analysis of international policy issues.
- GTAP's goal is to improve the quality of quantitative analysis of global economic issues within an economy-wide framework.
- GTAP is coordinated by the Center for Global Trade Analysis, which is housed in the Department of Agricultural Economics at Purdue University in West Lafayette, Indiana, USA.

Source: https://www.gtap.agecon.purdue.edu/

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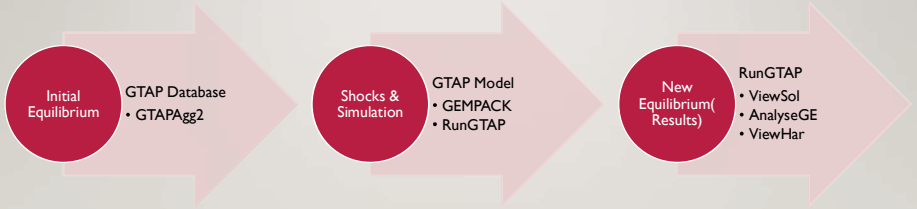
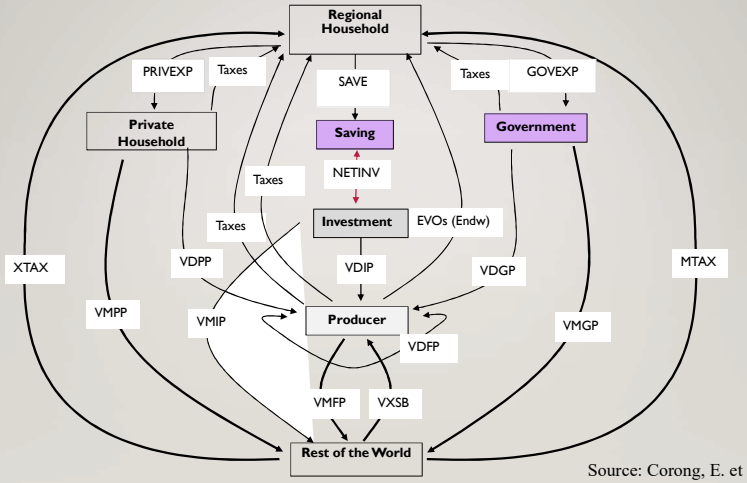
GTAP FRAMEWORK



7

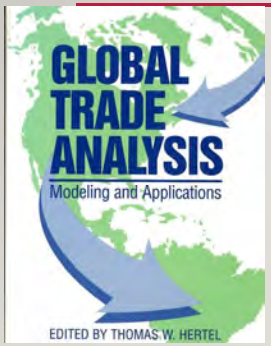
Circular Flows in a Regional Economy



Source: Corong, E. et al. (2017), p.10.

6

STANDARD GTAP MODEL



- The standard GTAP Model is a multiregion, multisector, computable general equilibrium, comparative static model, with perfect competition and constant returns to scale. Bilateral trade is handled via the Armington assumption.
- The GTAP Model was initially documented in the GTAP Book by Hertel, Thomas.W., Ed., 1997 (https://www.gtap.agecon.purdue.edu/products/gtap_book.asp)
- The Standard GTAP Model, Version 7 by Corong et al., Journal of Global Economic Analysis, 2017 (https://jgea.org/ojs/index.php/jgea/article/view/47)

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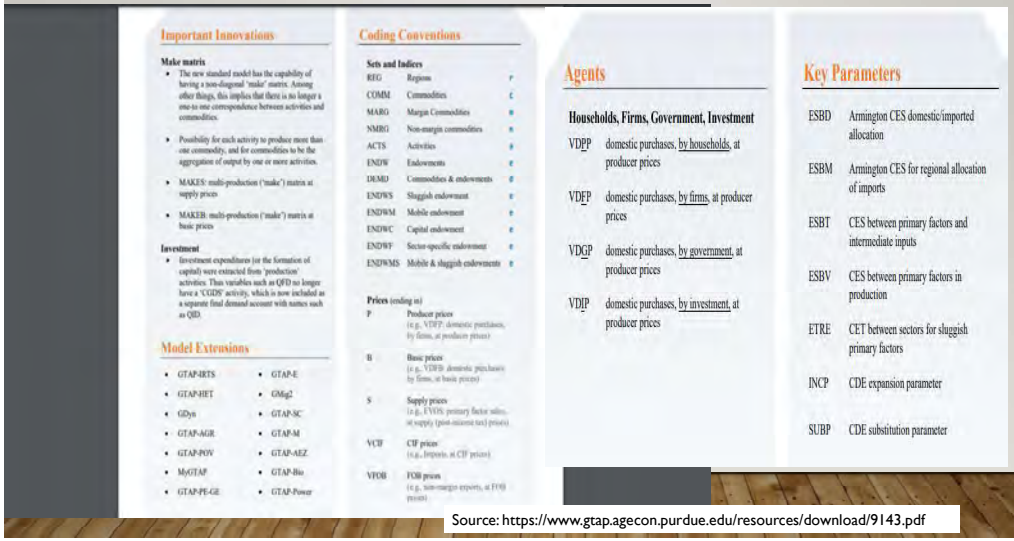
STANDARD GTAP MODEL V7 QUICK REFERENCE CARD



Source: https://www.gtap.agecon.purdue.edu/resources/download/9143.pdf

Extract from the GTAP model:

9 OUTPUT TAX VARIABLE & EQUATIONS IN THE MODEL

- **Variable** (**all**,c,COMM)(**all**,a,ACTS)(**all**,r,REG) to(c,a,r) *# power of tax on com. c supplied by act. a in region r #*;
- **Equation** E_ps *# links basic and supply price of commodity c produced by activity a in r #*
  (**all**,c,COMM)(**all**,a,ACTS)(**all**,r,REG)
  pca(c,a,r) = ps(c,a,r) + **to**(c,a,r);
  E_ps links supplier/producer (pre-) and basic (post-tax) prices for firms. This captures the effect of output taxes or subsidies.
  Note: The power of activity tax, to, is commodity-and activity-specific.
  to(c,a,r) > 1 in the case of a tax
  to(c,a,r) < 1 in the case of a subsidy.
- **Equation** E_del_taxrout *# change in ratio of output tax payments to regional income #* (**all**,r,REG)
  100.0 * INCOME(r) * del_taxrout(r) + TAXROUT(r) * y(r)
  = **sum**{c,COMM, **sum**{a,ACTS,
  MAKEB(c,a,r) * **to**(c,a,r) + PTAX(c,a,r) * **[**ps(c,a,r) + qca(c,a,r)**]**}};

Source: Standard GTAP Model

10 SOME SPECIFICS OF THE GTAP STANDARD MODEL

- Rests on an input-output accounting framework;
- The framework is complete:
  - All sources and uses of each economic good and all inputs into production are accounted for;
- The database does not reflect any concept of a government budget deficit
  - Trade-oriented as opposed to tax-oriented stream of general equilibrium modeling;
- The external accounts cover only trade in products and net capital inflow:
  - No foreign income receipts and or payments;
  - No remittances and no international aid flows.
- The limitations can be addressed in the model extensions and other GTAP models and databases.

11 SOME OTHER GTAP MODELS AND DATA BASE

- **GTAP-AEZ** modifies the standard GTAP model by spatially disaggregating land use and land cover in agriculture, pasture and forestry by agro-ecological zone (AEZ).
- **GTAP-E** is an extension of the GTAP framework (data base and model) used to evaluate costs of abatement and to assess the spill-over effects of greenhouse gases (GHG) abatement policies via international trade and sectoral interaction.
- **GTAP-GMig2** extends the GTAP framework to include bilateral labor migration data and is explicitly modeled to track the movement of workers and estimate the level of remittances.
- **GTAP-POV** is another extension of the GTAP framework to analyze poverty impacts of global economic policies across a wide range of developing countries, in a way which enables systematic cross-country comparisons.
- **GTAP-Power** Jeffrey Peters explains how the electricity sector plays a crucial role in the global economy. Referencing the extension, GTAP-Power Data Base.
- **Land Use and Land Cover Data Base** builds global land cover and land use databases for base years: 2004, 2007 and 2011.

12 GEMPACK (GENERAL EQUILIBRIUM MODELLING PACKAGE)

- The standard GTAP Model is implemer
  using **GEMPACK;**
- GEMPACK is a software for general an
  equilibrium modelling;
- GEMPACK license is required to modi
  standard GTAP Model;
- The Centre of Policy Studies (CoPS), A
  develops and supports GEMPACK.

Available: https://www.copsmodels.com/gempack.htm

13

DATA BASE, AGGREGATION AND RUNGTAP

GTAP Data Base 10a, GTAPAgg2, RunGTAP3.75

14 GTAP DATA BASE

Version	Release Date
•GTAP 10 Data Base	July 2019
GTAP 9 Data Base	May 2015
GTAP 8 Data Base	March 2012
GTAP 7 Data Base	December 2008
GTAP 6 Data Base	May 2005
GTAP 6 Beta Release Data Base	November 2004
GTAP 5.4 Data Base	November 2003
GTAP 5 Data Base	June 2001
GTAP 4 Data Base	1998
GTAP 3 Data Base	1996
GTAP 2 Data Base	1994
GTAP 1 Data Base	1993

- The GTAP Data Base is the global data base representing the world economy for a given reference year.
- It describes bilateral trade patterns, production, consumption and intermediate use of commodities and services.
- National input-output tables, trade, macroeconomic, and protection data from several sources are underlying the data base.
- The GTAP Data Base is denominated in millions of base year US dollars.
- Mongolia included as a separate region from GTAP 8 Data Base.
  - Based on the Mongolian Inter-Sector balance table for 2005 constructed by the National Statistical Office of Mongolia (NSO).
  - Contributed by: Begg, Michael Burmaa Chadraaval Ragchaasuren Galindev, Esmedekh Lkhanaajav and Erdenesan Eldev-Ochir
  - Available: https://www.gtap.agecon.purdue.edu/resources/download/6068.pdf
- Versions that are at least 2 releases old are freely available for download.

15 GTAP DATA BASE (CONTINUED)

Available on YouTube:

GTAP 10 Data Base - Intro and Key Components

https://www.youtube.com/watch?v=Jkzx4C3e2g8

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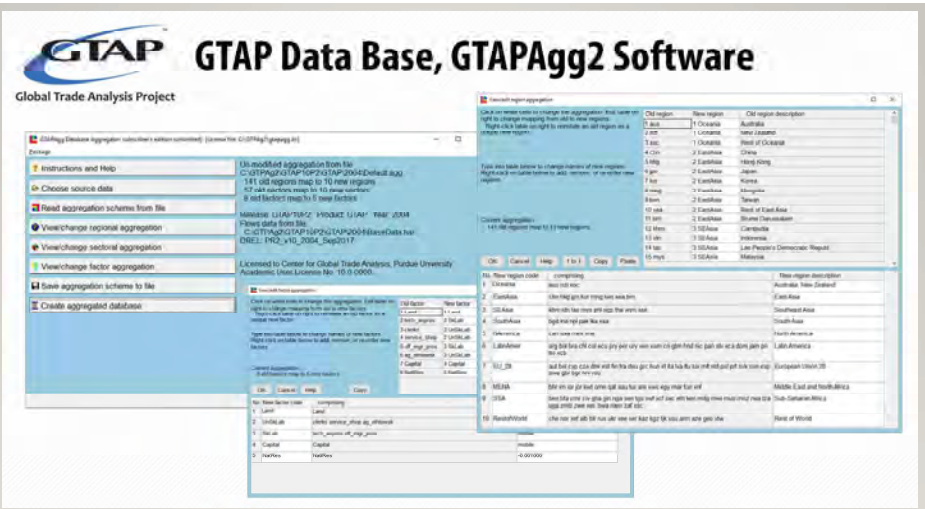

Source: https://www.gtap.agecon.purdue.edu/images/about/presskit/GTAPDB.jpg (May 11, 2022)

17 GTAPAGG2 DEMO

- Choose source data
- View/change regional aggregation
- View/change sectoral aggregation
- View/change factor aggregation
- Save aggregation
- Create aggregated database
- Instructions and Help

18 RUNGTAP

Source: https://www.gtap.agecon.purdue.edu/images/about/presskit/rungtap.jpg (May 11, 2022)

- The program for interactively solving the GTAP model;
- Allows the user to run simulations interactively in a Windows environment using the GTAP general equilibrium model;
- No previous knowledge of the GEMPACK language or programming skills is necessary to use the program.

More: https://www.gtap.agecon.purdue.edu/products/rungtap/default.asp

19 RUNGTAP DEMO:

- Title, RunGTAP, Version info
- Closure
- Shocks
- Solve (& saving experiments)
- View:
  - Results (Row, Col, Total, Digits etc.)
  - Base & Updated data, Sets, Parameters etc
  - ViewSol, AnalyzeGE: search, evaluate, gloss etc.

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DISCUSSION PAPER

Macro-economic Impacts of the COVID-19 Pandemic on Mongolia's Economy: CGE Analysis with the GTAP 10a Data Base

Available: https://www.erina.or.jp/en/wp-content/uploads/2022/03/DP2201.pdf

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GTAP MODEL & DATA

Regions (16/141)	Sectors (35/65)			Factors (4/8)
Mongolia	Rice	Apparel	Education	Unskilled labor
Tajikistan	Wheat	Light Manufacturing	Health	Skilled labor
China	Other Grain	Petrochemical Industry	Housing	Capital
ROK	Vegetables, Fruits	Other Manufacturing		Land and natural resources
Japan	Other Crop	Metal Manufacturing		
Russia	Sugar	Electronics		
Other East Asia	Livestock Meat	Machinery, Equipment		
Central Asia	Other Animal Products	Auto Vehicles		
Southeast Asia	Milk, Dairy Products	Utilities		
South Asia	Wool, Silk	Construction		
Advanced Economies	Forestry	Trade		
EU-27	Fishing	Transport		
LARNA	Other Food	Hotel, Restaurant, Recreation		
MENA	Beverages, Tobacco	Communication		
SSA	Extractive Industry	Financial Service		
Rest of the World	Textile	Other Service		

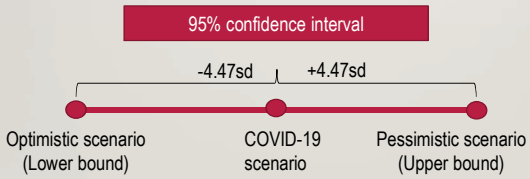
- Global CGE: GTAP version 7.0
  - Multi-region, multi-sector, static CGE model.
  - Perfect competition and constant returns to scale.
- GTAP Data Base 10A.
  - Reference year 2014

Source: Authors' aggregations

23

METHODOLOGY: ALTERNATIVE SCENARIOS

- The systemic sensitivity analysis (SSA) tools of the GTAP Model used to determine the alternative scenarios:
  - Labor productivity (the technical change variable) varied by 50% for both the unskilled and skilled labor;
- 95% confidence interval to build lower and upper bounds of the shocks, which correspond to the optimistic and pessimistic scenarios.



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COVID-19 SCENARIO AND SHOCKS

- Stimulus packages introduced by the governments (% of GDP as income tax changes);
- Increased trade costs due to various restrictions on border crossing and international shipment (Export & import tariff rates rise as % changes in trade);
- Loss of working hours due to adoption of shorter business hours and shifts to remote work (Labor productivity drops in Mongolia);
- Worldwide travel ban and restrictions on tourists and business travelers (productivity drop in this sector worldwide);
- International capital mobility became difficult due COVID-19 restrictions (RORDELTA=0);
- Unskilled labor became less mobile due to reduced economic activities on the one hand and scarce due to border-crossing restrictions on the other (unskilled labor fixed).

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SUMMARY OF COVID-19 SHOCKS IN THE MODEL (BASE SCENARIO)

Regions	Government stimulus	Increase of trade cost		Loss of working hours		Restrictions on travel, worldwide
	Corresponding GTAP Variables and Shocks					
	Output/Income tax changes (% change) (to)	Import Tax (% change) (tm)	Export Tax (% change) (tx)	Labor Productivity (% change) (afeall)		Factor input technical change, worldwide (% change) (afesec)
				Unskilled labor	Skilled labor	HotelResRec
Mongolia	-27.2	9.5	2.5	-10	-10	
China	-20.6	0.5	0.6			
ROK	-13.8	2.2	2.0			
Japan	-35.1	1.3	2.5			
Russia	-7.1	2.3	9.9			
Other East Asia	-31.5	0.1	0.8			
Tajikistan	-19.5	1.3	3.3			
Other Central Asia	-13.5	4.2	5.2			
Southeast Asia	-27.7	3.5	2.7			- 40
South Asia	-12.7	12.4	8.3			
Advanced Economies	-36.9	3.8	3.1			
EU_27	-12.1	5.3	6.3			
LARNA	-6.4	5.9	4.6			
MENA	-13.8	6.1	9.4			
SSA	-11.0	5.3	11.0			
Rest of the World	-9.1	2.8	2.3			

25 GDP COMPOSITION (SHARE OF TOTAL) (BASE DATA)

EXPENDITURE SIDE

Regions	Household Consumption	Investment	Government Consumption	Export	Import	Total
Mongolia	0.566	0.285	0.130	0.579	-0.560	1.000
China	0.380	0.441	0.135	0.244	-0.201	1.000
ROK	0.509	0.295	0.153	0.480	-0.437	1.000
Japan	0.589	0.214	0.200	0.200	-0.203	1.000
Russia	0.532	0.212	0.185	0.272	-0.201	1.000
Other East Asia	0.473	0.289	0.124	0.675	-0.561	1.000
Tajikistan	1.102	0.265	0.148	0.119	-0.633	1.000
Other Central Asia	0.541	0.291	0.131	0.329	-0.291	1.000
Southeast Asia	0.584	0.291	0.119	0.561	-0.555	1.000
South Asia	0.645	0.302	0.111	0.201	-0.258	1.000
Advanced Economies	0.662	0.204	0.162	0.164	-0.192	1.000
EU_27	0.567	0.204	0.217	0.412	-0.400	1.000
LARNA	0.644	0.211	0.166	0.190	-0.212	1.000
MENA	0.538	0.248	0.182	0.367	-0.335	1.000
SSA	0.677	0.208	0.134	0.266	-0.285	1.000
Rest of the World	0.708	0.240	0.203	0.433	-0.584	1.000
World	0.582	0.249	0.169	0.272	-0.272	1.000

SOURCES SIDE

Regions	Factor Income	Tax	Depreciation	Total
Mongolia	0.577	0.279	0.144	1.000
China	0.619	0.224	0.158	1.000
ROK	0.595	0.251	0.154	1.000
Japan	0.525	0.321	0.154	1.000
Russia	0.578	0.337	0.085	1.000
Other East Asia	0.667	0.194	0.140	1.000
Tajikistan	0.751	0.176	0.073	1.000
Central Asia	0.727	0.194	0.079	1.000
Southeast Asia	0.723	0.160	0.117	1.000
South Asia	0.768	0.116	0.116	1.000
Advanced Economies	0.580	0.291	0.129	1.000
EU_27	0.450	0.414	0.136	1.000
LARNA	0.644	0.241	0.115	1.000
MENA	0.706	0.188	0.106	1.000
SSA	0.695	0.202	0.103	1.000
Rest of the World	0.559	0.318	0.123	1.000
World	0.583	0.285	0.131	1.000

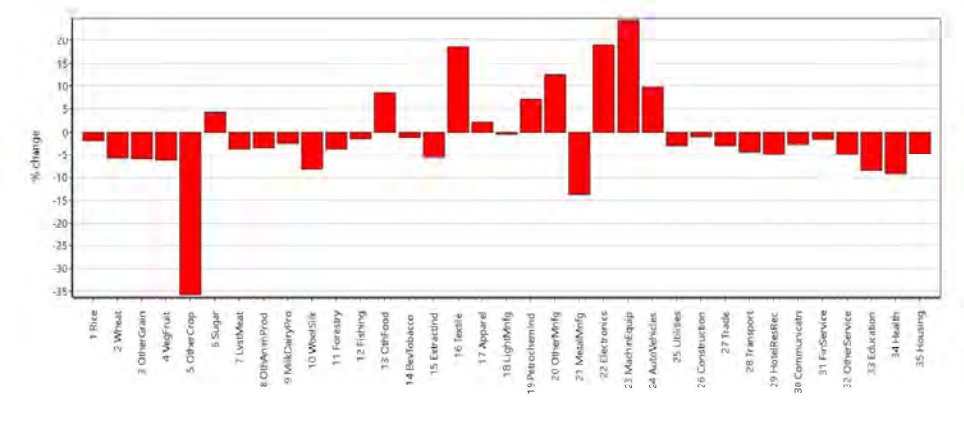
26 SOURCES OF FACTOR INCOME (SHARE OF TOTAL) (BASE DATA)

Regions	Land and Natural Resources	Unskilled Labor	Skilled Labor	Capital	Total
Mongolia	0.125	0.217	0.095	0.563	1.000
China	0.032	0.369	0.111	0.488	1.000
ROK	0.008	0.284	0.220	0.488	1.000
Japan	0.002	0.221	0.248	0.529	1.000
Russia	0.067	0.180	0.214	0.538	1.000
Other East Asia	0.012	0.288	0.211	0.490	1.000
Tajikistan	0.093	0.254	0.075	0.578	1.000
Central Asia	0.095	0.231	0.102	0.572	1.000
Southeast Asia	0.060	0.247	0.168	0.526	1.000
South Asia	0.066	0.270	0.211	0.453	1.000
Advanced Economies	0.012	0.277	0.390	0.321	1.000
EU_27	0.004	0.208	0.294	0.493	1.000
LARNA	0.027	0.246	0.229	0.498	1.000
MENA	0.079	0.188	0.147	0.586	1.000
SSA	0.068	0.304	0.212	0.416	1.000
Rest of the World	0.034	0.241	0.279	0.445	1.000
World	0.024	0.261	0.272	0.443	1.000

27 RESULTS: SELECTED MACRO-ECONOMIC INDICATORS FOR MONGOLIA

Indicators		Variables	Model result	95% confidence interval	
				Upper limit	Lower limit
Welfare change, US$ Million		EV	- 772.2	-203.9	-1,368.0
Real GDP, % change		qgdp	- 4.9	-2.9	-7.1
Merchandise exports, % change		qxwreg	- 9.1	-8.6	-9.7
Merchandise imports, % change		qmwreg	- 10.0	-5.9	-14.3
Price index of merchandise exports, % change		pxwreg	3.5	7.6	-0.6
Price index of merchandise imports, % change		pmwreg	6.1	7.6	4.8
Terms of trade, % change		tot	- 2.5	2.6	-7.7
Private consumption expenditure, % change		yp	1.9	8.5	-4.9
Per capita utility, % change		u	- 7.4	-1.9	-13.1
Per capita utility from private expenditure, % change		up	- 6.8	-1.3	-12.6
Price index for private household consumption expenditure		ppriv	9.3	9.9	8.7
Price of mobile endowments, % change	Skilled labor	pfe(e,a,r)	-0.4	3.7	-4.6
	Capital		-4.0	-0.3	-7.8

28 MONGOLIA: OUTPUT CHANGES BY SECTORS



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REFERENCES

Aguiar, A., Chepeliev, M., Corong, E., McDougall, R., & van der Mensbrugghe, D. (2019). The GTAP Data Base: Version 10. Journal of Global Economic Analysis, 4(1), 1-27. Retrieved from https://www.jgea.org/ojs/index.php/jgea/article/view/77

Corong, E., Hertel, T., McDougall, R., Tsigas, M., & van der Mensbrugghe, D. (2017). The Standard GTAP Model, Version 7. Journal of Global Economic Analysis, 2(1), 1-119. doi: dx.doi.org/10.21642/JGEA.020101AF

Hertel, Thomas. W., Ed., 1997. Global Trade Analysis: Modeling and Applications. Cambridge University Press, Massachusetts, USA

Horridge J.M., Jerie M., Mustakinov D. & Schiffmann F. (2018), GEMPACK manual, GEMPACK Software, ISBN 978-1-921654-34-3

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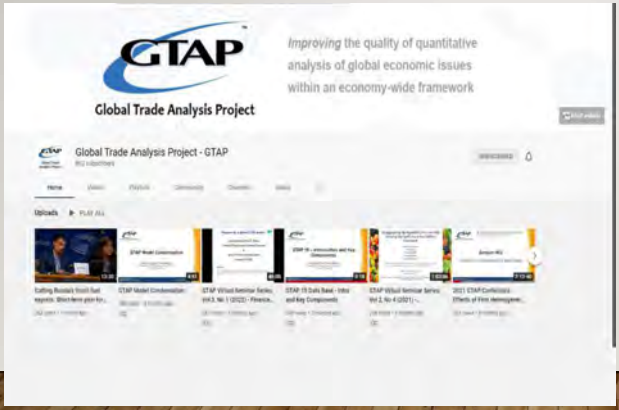
FURTHER:



- Visit CTAP's YouTube channel for freely available videos on the GTAP Data Base, model, and more:

https://www.youtube.com/c/GTAPPurdue

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Q&A

Any questions are welcome!

Thank you for your kind attention!

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Supply chain coordination issues and institutional research **D.Tuvshinjargal** (PhD) , a senior lecturer and researcher at the University of Finance and Economics **(on June 23, 2022)**

The report presents the following three contents based on real-world and domestic examples. These include:

1. To compare the historical stages of the development of supply chain coordination, the economic and social issues they face, the characteristics, advantages and disadvantages of the forms of coordination and the options available in Mongolia ;
2. How the harmonization of supply chain contracts is determined by the stages of development of the agro industry, the basic factors influencing the initiation and implementation of the contract instrument and the contract farm method, its pros and cons;
3. new institutional economy, how transaction costs and contractual instruments are reflected in the underlying economic mechanism, and how to determine the involvement of economic stakeholders and address gaps in interaction ;

Нийлүүлэлт сүлжээ болон тээвэр логистикийг менежментийг сайжруулах агуулгын хүрээнд **Нийлүүлэлтийн сүлжээний уялдуулалтын асуудал ба институцийн судалгаа** сэдвээр Санхүү эдийн засгийн их сургуулийн ахлах багш, судлаач Д.Түвшинжаргал (PhD) илтгэл тавилаа.

Тус илтгэлээр доорх 3 агуулгыг олон улсын болон дотоодод тулгарч буй бодит жишээнд тулгуурлан танилцуулав. Үүнд:

1. Нийлүүлэлтийн сүлжээний уялдуулалтын хөгжлийн түүхэн үе шат, тэдгээрт тулгарсан эдийн засаг, нийгмийн асуудлууд, уялдуулалтын хэлбэрүүдийн онцлог шинж, давуу, сул тал болон Монгол улсад боломжтой хувилбаруудыг харьцуулан танилцуулах;
2. Agro industry хөгжлийн үе шатуудаар Нийлүүлэлтийн сүлжээний гэрээний уялдуулалт нь хэрхэн тодорхойлогддог, Гэрээний арга хэрэгсэлийг санаачлан, хэрэгжүүлэхэд нөлөөлсөн суурь хүчин зүйлс болон Гэрээт фермийн арга, түүний эерэг болон сул тал;
3. Шинэ институцийн экономиксын хүрээнд Хэлцлийн зардал болон Гэрээний арга хэрэгсэл нь эдийн засгийн суурь механизмд хэрхэн илэрдэг болох, түүнтэй уялдан эдийн засгийн оролцогч талуудын оролцоог тодорхойлж харилцан нөлөөллийн дутагдлыг хэрхэн арилгах талаар;

Participants List

Full name		Position	
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G.Nyamtsetseg	Macroeconomic Policy Department	specialist	
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U.Enkhbat	Macroeconomic Policy Department	advisor	√
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D.Munkhjargal	Regional and Indusrial Policy Department	specialist	√
B.Oyuntulkhuur	Regional and Indusrial Policy Department	specialist	√
Ts.Badamtsetseg			√

Нийлүүлэлтийн сүлжээний уялдуулалтын асуудал ба институцийн судалгаа

Д.Түвшинжаргал
доктор (Ph.D), дэд профессор, СЭЗИС

23.06.2022

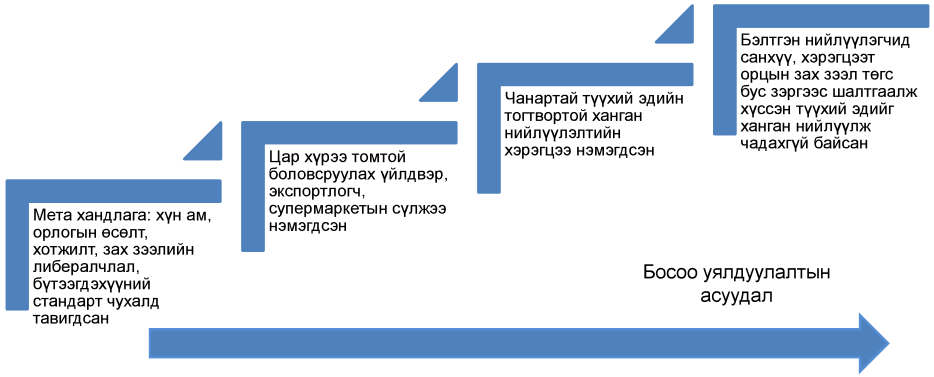
Агуулга

1. **Нийлүүлэлтийн сүлжээний уялдуулалтын хэлбэр**
   - ❖ Нийлүүлэлтийн сүлжээний уялдуулалтын асуудал
   - ❖ Босоо уялдуулалтыг зохион байгуулах арга
2. **Нийлүүлэлтийн сүлжээний гэрээний уялдуулалт**
   - ❖ Гэрээний арга хэрэгсэл (contract arrangement) буюу Гэрээт фермийн аргын нөлөө
   - ❖ Гэрээний арга хэрэгсэл санаачилж, хэрэгжүүлэхэд нөлөөлсөн хүчин зүйлс
3. **Шинэ институцийн экономикс**
   - ❖ Хэлцлийн зардал
   - ❖ Онолын гол таамаглал
   - ❖ Гэрээний арга хэрэгслийг тайлбарлах

Нийлүүлэлтийн сүлжээний уялдуулалтын хэлбэр

Нийлүүлэлтийн сүлжээний уялдуулалтын асуудал

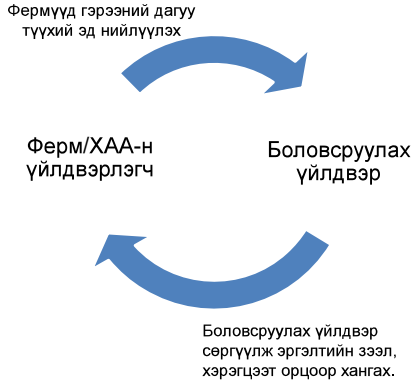
- Агро-аж үйлдвэр (agro-industry)-ийн салбар нь 1990-ээд сүүл, 2000-аад он зэрэг ялгаатай цаг хугацаанаас хурдтай өссөн хөгжиж буй орнуудад нийлүүлэлтийн сүлжээний дагуу босоо уялдуулалтын асуудал нийтлэг ажиглагдсан.



Нийлүүлэлтийн сүлжээний уялдуулалтын хэлбэр

Босоо уялдуулалтыг зохион байгуулах аргууд (vertical coordination)

Гэрээт фермийн арга (Contract farming)



Нийлүүлэлтийн сүлжээний уялдуулалтын хэлбэр

- Гэрээт фермийн аргын хүрээнд ферм түүхий эд нийлүүлэх гэрээтэй хосолж, боловсруулах үйлдвэр сөргүүлэн дангаар болон түүхий эд нийлүүлэгч, эсвэл банктай хамтран орцоор хангах, урьдчилгаа төлбөр олгох, зээл олгох, хөрөнгө оруулалтын зээл олгох, зээлийн баталгаа гаргах, техникийн туслалцаа үзүүлэх, зах зээлийн баталгаа гаргах зэрэг үйлчилгээ үзүүлдэг.

Хүснэгт 1. ГФА хэрэгжүүлдэг сүүний компаний эзлэх хувь (%)

		Эргэлтийн зээл	Түүхий эд	Техникийн туслалцаа	Мал эмнэлэг	Банкны баталгаа	Нийт
1994	Польш	50	67	50	0	50	43
	Словак	0	0	83	17	17	23
	Болгар	9	18	9	0	0	7
1998	Польш	83	100	83	17	83	73
	Словак	17	17	83	17	33	33
	Болгар	45	64	18	18	18	33
2002	Польш	83	100	83	17	83	73
	Словак	100	33	83	17	50	57
	Болгар	82	91	73	18	36	60

Эх сурвалж: Dries, (2004)

Нийлүүлэлтийн сүлжээний гэрээний уялдуулалт

- ГФА-ын шууд бус нөлөө нь фермерүүдэд үзүүлэх нөлөө юм. Түүнийг дэмжигч талыхан жижиг фермүүдийг нийлүүлэлтийн гинжин хэлхээнд холбогч, улмаар орлогоо нэмэгдүүлэх, ядуурлыг бууруулах боломжийг олгодог гэж үздэг.

Эерэг хандлага	Шүүмжлэлт хандлага
• Зах зээл нээх, саадыг гэтлэх • Орлого, үр ашиг нэмэгдэх • Орчин үеийн технологи нутагшуулах • Бусад боловсруулах үйлдвэр ба фермд дам нөлөө үзүүлэх	• Боловсруулах үйлдвэрээс хэт хамааралтай болох • Жижиг фермүүд гэрээт фермийн аргаас хасагдах • Хөдөөгийн зарим бүс нутаг ядуу хэвээр үлдэх

Нийлүүлэлтийн сүлжээний гэрээний уялдуулалт

Гэрээт фермийн аргын нөлөө

- ГФА-ын шууд нөлөө нь санаачлагч боловсруулах үйлдвэрийн гарц, түүхий эдийн хангамж, чанар нэмэгдсэн. Жишээ нь, Польшийн сүүний салбарын кейсээс 1996 оны байдлаар зах зээлийн 30% бүрдүүлж байсан сайн чанарын сүүний нийлүүлэлт 2001 оны байдлаар 80% болж өссөн.

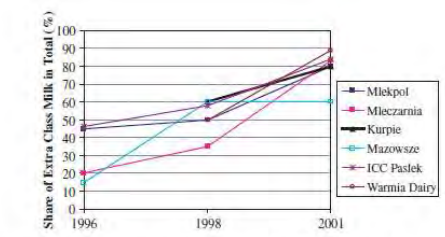


Figure 1. *Change in share of highest quality milk (EU standard) by dairy company.*

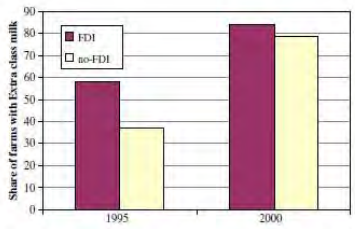


Figure 2. *Change in share of highest quality milk (EU standard) in the farm survey.*

Эх сурвалж: Dries & Swinnen (2004) Foreign Direct Investment Vertical Integration and Local supplier Evidence from Polish Dairy sector

Нийлүүлэлтийн сүлжээний гэрээний уялдуулалт

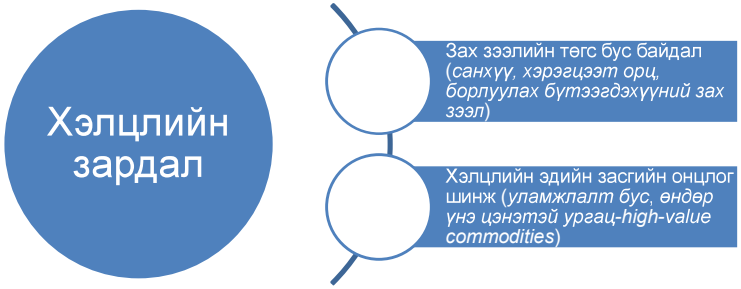
ГФА-ыг санаачилж, хэрэгжүүлэхэд нөлөөлсөн хүчин зүйлс

- ГФА-ын хэрэгжүүлэхэд гадаад хүчин зүйлс болон худалдан авагч, солилцох бүтээгдэхүүний онцлог нөлөөлдөг байна. Үүнд:
  - ❖ **Хөгжиж буй орнууд дахь агро үйлдвэржилт эрчимжсэн:** 1990-ээд оноос "либералчлал/даяарчлал"-ын нөлөөгөөр хөгжиж буй орнуудад агро үйлдвэржилт (agro-industrialization) өмнө байгаагүй хурдтай явагдсан.
  - ❖ **Нийгэм, эдийн засгийн тогтолцооны шилжилт:** Пост коммунист орнуудад шилжилтийн үйл явцаар өмнөх нийлүүлэлтийн сүлжээ задарч фермерүүдийн түүхий эд болон бүтээгдэхүүний зах зээлтэй холбогдсон харилцаа тасалдсан.
  - ❖ **Хөгжлийн тусламжийн байгууллага болон засгийн газрын санаачилга:** Хөгжлийн тусламжийн байгууллага болон зарим хөгжиж буй орны засгийн газрын жижиг фермүүдийг зах зээлд хүргэх бодлогын нөлөөгөөр гэрээт фермийн аргыг ашигласан.
  - ❖ **Худалдан авагчийн онцлог:** Цар хүрээ томтой боловсруулагч, экспортлогч, супермаркетын сүлжээ ГФА-ын гол хэрэгжүүлэгч байдаг.
  - ❖ **Солилцох бүтээгдэхүүний онцлог:** Бүтээгдэхүүний ахиу чанарт эцсийн хэрэглэгч нэмэлт төлбөр төлөх, бүтээгдэхүүн түргэн муудах шинжтэй зэрэг онцлог шинж ГФА-ыг санаачлахад нөлөөлдөг.

Шинэ институцийн экономикс

ГФА-ыг сонгох эдийн засгийн хөшүүрэг

Боловсруулах үйлдвэр ГФА-ыг санаачилж, түүнийг бэлтгэн нийлүүлэгч фермер сонгох хөшүүргийг шинэ институцийн экономиксийн хүрээнд спот зах зээл дээрх хэлцлийн зардал (transaction cost)-ыг бууруулах зорилготой гэж тайлбарладаг.



Шинэ институцийн экономикс

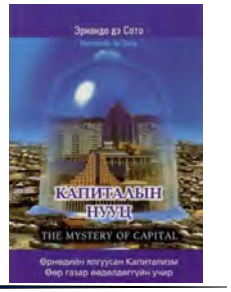
- Хэлцлийн зардлыг зорилгынх нь хувьд уялдуулах зардал (coordination cost) болон сэдэлжүүлэх зардал (motivation cost), үүсч буй хугацаагаар нь хэлцлийн өмнөх ба дараах хэлцлийн зардал, мөн үүсэж буй объектоос нь хамааруулан зах зээлийн, удирдлагын хэлцлийн зардал, улс төрийн хэлцлийн зардал гэж ангилдаг.
  - **Д.Гансүлд нарын (2016) "*Монгол улсын ЖДҮ-ийн салбар дахь хэлцлийн зардлын судалгаа*"** судалгаагаар ЖДҮ эрхлэгч тусгай зөвшөөрөл, лиценз авах үйл ажиллагаанд дундажаар 1,6 сая төгрөг (борлуулалтын орлогынх нь 0,84 хувь) зардал гаргадаг байна.
  - **Masten (1991) *"The Costs of Organization"*** судалгаа хөлөг онгоц үйлдвэрлэхэд шаардлагатай эд ангийн (74 эд анги) хэлцлийн зардлыг тодорхой аргачлал ашиглан тооцсон. Үр дүнгээр пүүс дотроо үйлдвэрлэж байгаа (make) эд ангийг бусдаас гэрээ байгуулан худалдан авбал (buy) хэлцлийн зардал 1,86 сая доллароос 5,43 сая доллар болж огцом өссөн.
  - **Stringer et al (2009) "Producers processors and procurement decisions: The Case of Vegetable Supply Chains in China"** судалгаа нь нийлүүлэлтийн сүлжээний тодорхой онцлог шинж хүнсний ногоо боловсруулагчдын уялдуулалтын зардалд хэрхэн нөлөөлж байгааг тодорхойлсон.

Шинэ институцийн экономикс

Хэлцлийн зардал

- Шинэ институцийн экономиксийн нэг гол төлөөлөгч Р.Коуз **хэлцлийн зардлыг** эдийн засгийн солилцооны өртөг буюу үл үзэгдэх гарын алдагдсан боломжийн зардал гэж анх тодорхойлсон.
- Фуруботн, Ричер нар *бодит хөрөнгийн ба гэрээний эрхийн харилцааны хувьд хэлцлийн зардал нь тэрхүү эрхийг тодорхойлох, ашиглах, хангуулахтай холбоотой гарах зардал* гэж тодорхойлсон байна.

"… Египетэд газар тариалангийн ашиглахаа больсон газарт хуулийн дагуу орон сууц барихад **6-аас 11 жилийн** хүнд суртлын маргаан мэтгэлцээн шаардана, илүү ч байж мэднэ. Үүгээр ялгаад 4,7 сая египет хүн өөрийн орон сууцаа хууль бусаар барихаар шийдсэнийг ойлгож болно." (Эрнандо дэ Сото, *Капиталын нууц*).



Шинэ институцийн экономикс

- Уг судалгаагаар Хятадын хүнсний ногоо боловсруулагч, экспортлогчдын хувьд хэлцлийн зардлыг хамгийн ихээр нэмэгдүүлж байгаа нийлүүлэлтийн сүлжээний онцлог шинж нь олон тооны жижиг фермтэй гэрээ байгуулах, хэрэгжилтийг хангах байжээ.

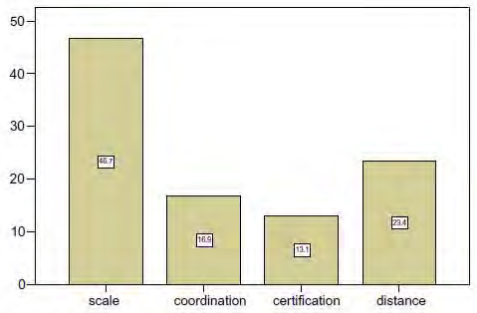


Figure 1. *Relative importance of four vegetable supply channels characteristics (percentage).*

Эх сурвалж: Stringer et al (2009) "Producers processors and procurement decisions: The Case of Vegetable Supply Chains in China"

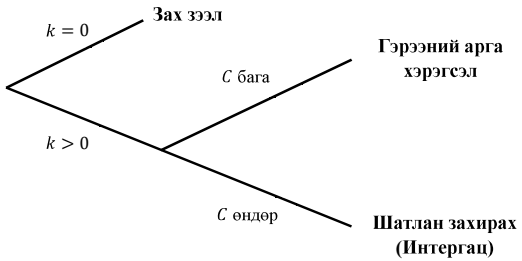
Шинэ институцийн экономикс

Шинэ институцийн экономикс-New Institutional Economics

- Институцийн судалгаа нийгэм, улс төр, эдийн засгийн харилцааг хэлбэржүүлэн хэлцлийн зардлыг бууруулж (эсвэл нэмэгдүүлж) байгаа институцийг судлах, танин мэдэхэд чиглэдэг.
  - ❖ Институц гэдэг нь улс төр, эдийн засаг, нийгмийн харилцааг хэлбэржүүлэхийн тулд хүний зохиосон хязгаарлалт, албан болон албан бус дүрэм юм. Товчхондоо институцийг тоглоомын дүрэм гэж тодорхойлсон (North, 1991).
- Институцийн экономиксийн судалгааг өргөн хүрээгээр нь дараах хоёр түвшинд хуваадаг. Үүнд:
  - ❖ ***Институцийн орчин-Institutional environment:*** Улс үндэстний хэмжээнд улс төр, хуулийн институц бүрдэлдэх, ялангуяа тоглоомын албан ёсны дүрэм, өмчлөх эрхийг тогтоох үйл явцыг хамардаг.
  - ❖ ***Засаглалын механизм-Governance arrangement:*** Өгөгдсөн институцийн орчинд эдийн засгийн оролцогчид гэрээний хэрэгжилтийг хангуулах, хэлцлийн зардлыг бууруулахын төлөө сонгож буй институцийн арга хэрэгсэл гол судлагдахуун болдог.

Шинэ институцийн экономикс

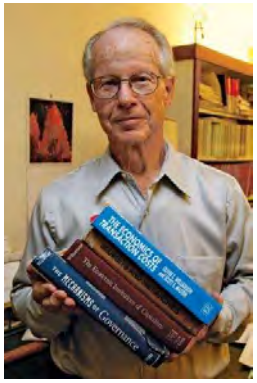
Зураг. Хэлцлийн зардлын экономиксийн гол таамаглал



k –хэлцлээр хийгдэх хөрөнгийн зориулалтын нарийвчлалын түвшин,
C-гэрээний арга хэрэгслийн (харьцангуй) зардал

Хөрөнгийн зориулалтын нарийвчлал өндөр байх тусам уг хөрөнгийг эзэмшигч талын барьцаалагдах аюул (Hold-up problem) их байна.

Шинэ институцийн экономикс

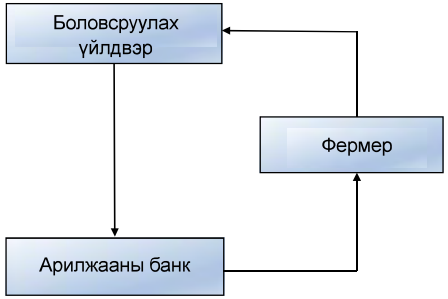


2009 онд "*эдийн засгийн засаглалын шинжилгээ, тэр дундаа пүүсийн хэмжээний*" талаарх судалгаагаар Эдийн засгийн Нобелийн шагнал хүртсэн.

Судлагдахуун: Хэлцэл, засаглалын механизм, зах зээл ба пүүсийн зааг (Make or buy), стандарт бус гэрээний арга хэрэгслийн сонголт

Шинэ институцийн экономикс

- Словакын элсэн чихэр боловсруулагч Juhocukor компани ГФА-ыг Polnobanka банктай хамтран хэрэгжүүлж, барьцаа хөрөнгөгүй фермерүүдэд ажлын капитал, машин техникт хөрөнгө оруулалт хийхэд нь зээлийн баталгаа гаргаж өгсөн байна.
  - ❖ Juhocukor фермерт төлбөрийг цаг хугацаанд нь шилжүүлэхгүй бол фермерүүд авсан зээлээр барьцаалах,
  - ❖ Нөгөө талаар худалдан авалтын гэрээ болон барьцаа хөрөнгийн гачигдалтай фермерт хөрөнгө оруулалт хийх бололцоо олгох (банкны зээлийн баталгаа гаргах) замаар Juhocukor фермерийг харилцан барьцаална.



Тайлбар: ГФА-д хамрагдсан фермер зээлийн эргэн төлөлтийг боловсруулах үйлдвэрт нийлүүлсэн бүтээгдэхүүнээр барагдуулах ба өөр худалдан авагчид нийлүүлэлт хийхийг хязгаарлах далд гэрээ байгуулдаг.

Шинэ институцийн экономикс

- 2018 онд “Нүүдэлчин Агро Ферм-НАФ” ХХК-ий санаачилж 400 үнээтэй 10 ферм бүхий Монголын анхны сүүний кластер Төв баймгийн Баяндэлгэр суманд байгуулагдсан.
- Энэхүү орчин үеийн загвар сүүний ферм тус бүрт автомат саалтуур, тэжээл холигч, сүү хадгалах танк зэрэг тоног төхөөрөмж бүхий Европ стандартын үнээний байр, фермер өрхөд зориулсан Канад технологийн амины ороц сууц, гүний худаг, тэжээл тариалах талбай зэргийг цогцоор нь шийдсэн.
- АПУ Дэйри компани болон ХААН Банк НАФ-тэй түншлэл болж хамтран ажилласан. АПУ Дэйригийн хувьд жилийн дөрвөн улиралд фермүүдээс сүүг нэг үнээр худалдан авах баталгаа гаргасан.

Анхаарал хандуулсанд баярлалаа

Date & Time: June 24, Tuesday at 10am to 12

Venue: BiG Center, Seminar Room on 2nd floor

Title: **Analysis of External Debt Sustainability in Mongolia: An Estimated DSGE Approach**

Presenter: Mr. Gunbileg Ganbayar, Lecturer, U. of Mongolia

Paper is downloadable from below;
https://www.mdpi.com/2071-1050/13/15/8545/pdf?version=1628126534#:~:text=Furthermore%2C%20we%20assess%20Mongolia's%20external,the%20next%2010%E2%80%9328%20quarters

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E.Uurtsaikh
Ts.Munkhdelger
N.Narantsatsralt

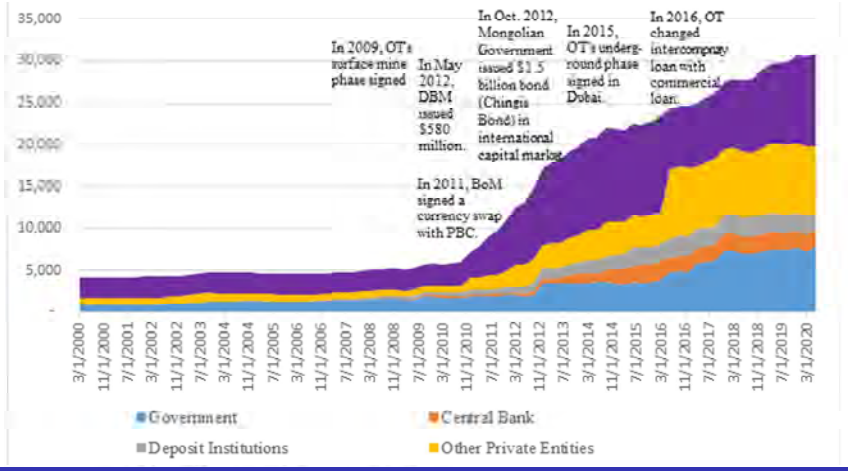
ДСЕТ Загвар Ашиглан Гадаад Өрийн Тогтвортой Байдлын Шинжилгээ Хийх

Эдийн Засаг, Хөгжлийн Яам

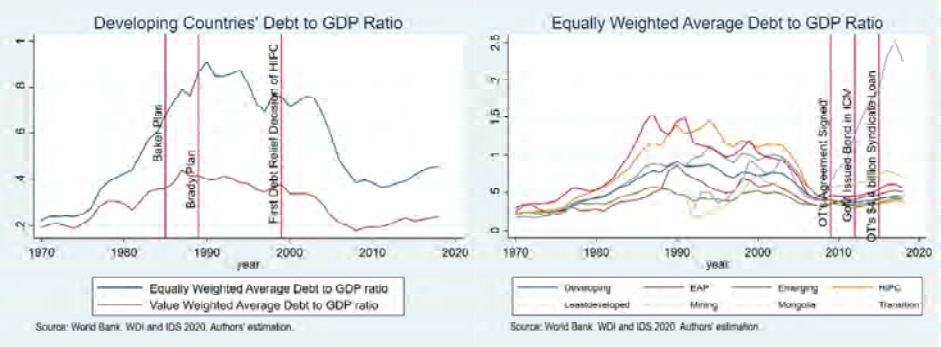
2022/06/24

Агуулга

Гадаад өрийн задаргаа



Өрийн харьцааны өөрчлөлт

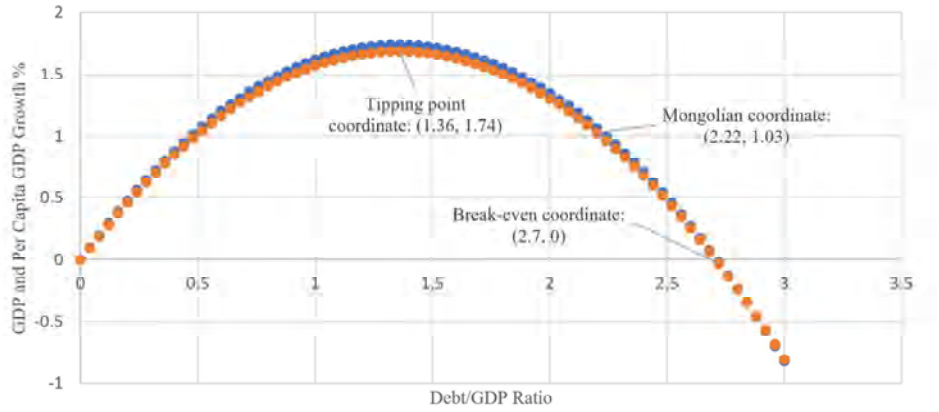


Гадаад өр үүсэх шалтгаан

Source: The NSO, The BoM and WDI, WB

Онолын ба Эмпирик Загвар

Уул уурхайгаас хамааралтай орнуудын гадаад өр, эдийн засгийн хамаарал



Бүтцийн ба Хялбаршуулсан загвар

- Бүтцийн (structural) загварын хувьд эдийн засгийн онолд суурилан гарч ирдэг.
  - Тухайлбал пүүсийн онолд суурилан барааны нийлүүлэлтийн загвар/дүрэм гарч ирэх бол хэрэглэгчийн онолд суурилан барааны эрэлтийн загвар/дүрэм гарч ирнэ.
  - Нийлүүлэлт, эрэлтийн дүрмийг тодорхойлохдоо пүүс, хэрэглэгч хоёрыг тусад нь салангид бүтэц мэт авч үзнэ.
  - Эрэлт, нийлүүлэлт тэнцвэртэй байна гэсэн нөхцлөөр эдгээр салангид бүтэц нэгтгэгдэнэ.
- Хялбаршуулсан (reduced form) загвар нь бүтцийн загвар дах эндоген хувьсагчдыг экзоген хувьсагчдаас хамааруулан илэрхийлсэнг хэлнэ.

Монголын Эдийн Засагт Тохирох ДСЕТ Загвар

- ДСЕТ нь бүтцийн (онолын) загвар бөгөөд тухайн эдийн засгийн талаарх *норматив* дүгнэлт өгөхөд чиглэнэ
- Тухайн улсын чухал онцлогуудыг тусгаж өгөх нь чухал байдаг
- Ихэнх алдартай ДСЕТ загваруудын хувьд хаалттай эдийн засгийн загвар байдаг.
  - Kyndland and Prescot (1982); Smets and Wouters (2003, 2007).
  - Эдгээр нь Америк, Европын холбооны хувьд тохиромжтой

Монголын Эдийн Засагт Тохирох ДСЕТ Загвар

- Монгол улсын хувьд
  - Жижиг, нээлттэй, уул уурхай суурьтай гэх мэт гол бүтцүүдийг загвартаа шингээх хэрэгтэй
- Монгол улсын хувьд мөнгөгүй ДСЕТ загвар байгуулах гэж байвал: Berg A. et al (2012, 2013); Melina G. (2016); Li, B.G. (2017)
- Мөнгөтэй ДСЕТ загвар байгуулах гэж байвал: Gali and Monacelli (2005); Adolfson (2007); Gan-Ochir (2018) гэсэн ажлууд чухал эх үүсвэр болдог.

Динамик оновчлолын аргууд

1. Вариацын тоолол - Calculus of variation
2. Динамик програмчлал - Dynamic programming
3. Оновчтой удирдлага - Optimal control
4. Лагранжийн үржүүлэгчийн арга - Lagrange multiplier method

Нэг хүнтэй, төгсгөлгүй орших эдийн засаг

$$\sum_{i=0}^{\infty} \beta^i u(c_{t+i}) \to \max$$
$$k_{t+1} = (1-\delta)k_t + i_t$$
$$y_t = f(k_t) = c_t + i_t.$$

Зорилго нь бүх цаг үеийн ханамжийн нийлбэрийг хамгийн их байлгахуйцаар бүх цаг хугацааны хэрэглээг оновчтой сонгох. Капиталын өөрчлөлтийн дүрэм болон нөөцийн хязгаарлалтын тэгшитгэлээр энэхүү зорилго нь хязгаарлагдана. Хязгаарлалттай **оновчлол** болон **тэнцвэр** микро суурьтай загварын тулгуур байдаг.

Вариацын тоолол ашиглан бодох

Нөөцийн хязгаарлалт болон капиталын өөрчлөлтийн хуулийг ашиглан $c_t = f(k_t) - k_{t+1} + (1-\delta)k_t$ гэж бичиж болох бөгөөд бүх цаг хугацааны ханамжийн утгыг дараах байдлаар бичнэ.

$$V = \sum_{i=0}^{\infty} \beta^i u(f(k_{t+i}) - k_{t+i+1} + (1-\delta)k_{t+i})$$

Вариацын тооллыг ашиглан оновчлол хийхдээ эндоген хувьсагчдын s-1 болон s+1 үеийн утгууд өгөгдсөн гэж үзээд s үеийн утгыг сонгох замаар зорилгын функцын утгыг оновчлохыг эрмэлздэг. Тэгэхээр k_{s-1} болон k_{s+1} утгууд өгөгдсөн гэж үзээд k_t -ийн хувьд нэгдүгээр эрэмбийн нөхцөлийг бичвэл:

Вариацын тоолол ашиглан бодох

$$\frac{\partial V}{\partial k_s} = \beta^{s-t} u'(f(k_s) - k_{s+1} + (1-\delta)k_s)(f'(k_s) + (1-\delta)) -$$
$$-\beta^{s-t-1} u'(f(k_{s-1}) - k_s + (1-\delta)k_{s-1}) = 0.$$

Дээрх нэгдүгээр эрэмбийн нөхцөлийг хялбарчилсанаар дараах Эйлерийн тэгшитгэл (динамик оптимизацийн бодлогуудын нэгдүгээр эрэмбэйн нөхцөл) -ийг гарган авна.

$$f'(k_s) + (1-\delta) = \frac{u'(f(k_{s-1}) - k_s + (1-\delta)k_{s-1})}{\beta u'(f(k_s) - k_{s+1} + (1-\delta)k_s)}.$$

Дээрх ялгаварт тэгшитгэлийг бодож, бодлогын функц (policy function) -ийг олсноор бодлого бодогдоно.

Динамик программчлал ашиглан бодох

- Үнэ цэнийн функц (Value Function) - ҮЦФ
- Хяналтын ба төлөвийн хувсагч (control and state variables)

Өмнөх жишээний хялбаршуулсан бүх цаг үеийн ханамжийн функц энэ тохиолдолд ҮЦФ болно. t үеийн капитал k_t нь төлвийн хувьсагч, t+1 үеийн капитал k_{t+1} нь хяналтын хувьсагч болно. ҮЦФ дараах байдалтай болно.

$$V(k_t) = \max_{\{k_s\}_{s=t+1}^{\infty}} \sum_{i=0}^{\infty} \beta^i u(f(k_{t+i}) - k_{t+1+i} + (1-\delta)k_{t+i})$$

Беллманы тэгшитгэл

ҮЦФ -ийг дараах байдлаар задалж бичиж болно.

$$V(k_t) = \max_{k_{t+1}} [u(f(k_t) - k_{t+1} + (1-\delta)k_t) +$$
$$+ \max_{\{k_s\}_{s=t+2}^{\infty}} \sum_{i=1}^{\infty} \beta^i u(f(k_{t+i}) - k_{t+1+i} + (1-\delta)k_{t+i})] =$$
$$= \max_{k_{t+1}} [u(f(k_t) - k_{t+1} + (1-\delta)k_t) +$$
$$+\beta \max_{\{k_s\}_{s=t+2}^{\infty}} \sum_{i=0}^{\infty} \beta^i u(f(k_{t+1+i}) - k_{t+2+i} + (1-\delta)k_{t+1+i})]$$

Үр дүнг ашиглан Беллманы тэгшитгэлийг дараах байдалтай бичнэ.

$$V(k_t) = \max_{k_{t+1}} [u(f(k_t) - k_{t+1} + (1-\delta)k_t) + +\beta V(k_{t+1})].$$

Нэгдүгээр эрэмбийн нөхцөл, дугтуйн онол

Дээрх Беллманы тэгшитгэлээс хяналтын хувьсагч k_{t+1} -аар уламжлал авч тэгтэй тэнцүүлвэл:

$$0 = -u'(f(k_t) - k_{t+1} + (1-\delta)k_t) + \beta V'(k_{t+1}).$$

Энхүү нэгдүгээр эрэмбийн нөхцөлд $V'(k_{t+1})$ илэрхийлэл агуулагдаж байгаа тул бид $V'()$ функцийн уламжлалыг тодорхойлох шаардлагатай. Тэгэхийн тулд ҮЦФ -аас төлөвийн хувьсагч k_t -ээр уламжлал авъя:

$$V'(k_t) = u'(f(k_t) - k_{t+1} + (1-\delta)k_t)(f'(k_t) + (1-\delta)).$$

Эндээс $V'(k_{t+1})$ -ийг олж 1 -р эрэмбийн нөхцөлд орлуулснаар Эйлерийн тэгшитгэл дараах байдалтай олдоно. Энд $c_t = f(k_t) - k_{t+1} + (1-\delta)k_t$

$$\frac{u'(c_t)}{u'(c_{t+1})} = \beta(f'(k_{t+1} + (1-\delta))).$$

Лагранжийн үржүүлэгч ашиглах

Лагранжийн үржигдэхүүн ашиглан дээрх динамик оновчлолын бодлогыг бодохын тулд доорх Лагранжийн функцийг байгуулна

$$max_{k_s,c_s,i_s} \sum_{i=0}^{\infty} \beta_i[u(c_{t+i}) - \lambda^1_{t+1}(k_{t+1+i} - i_{t_i}) - \lambda^2_{t+i}(f(k_{t+i} - c_{t+i} - i_{t+i}))]$$

Энэхүү функцаас t үеийн капитал, хэрэглээ, хөрөнгө оруулалтаар, лагранжийн үржүүлэгч уламжлал авна. Гарсан нэгдүгээр эрэмбийн нөхцөлүүдийг хялбарчлах замаар Эйлерийн тэгшитгэлийг олвол өмнө олсонтой ижил дараах байдлаар олдоно.

$$f'(k_s) + (1-\delta) = \frac{u'(f(k_{s-1}) - k_s + (1-\delta)k_{s-1})}{\beta u'(f(k_s) - k_{s+1} + (1-\delta)k_s)}.$$

Бодлогын функц, тогтвортой төлөв, лог-шугамчлал

- Динамик оновчлолын бодлогын хувьд олох зүйл нь фунциональ буюу үл мэдэгдэгч функц ($H()$) байна.Энэхүү функцийг "бодлогын функц"гэх бөгөөд төлөвийн хувьсагчдад үндэслэн хяналтын хувьсагчдын утгыг гаргах дүрэм юм. Бидний жишээний хувьд бодлогын функц $k_{t+1} = H(k_t)$ хэлбэртэй байна. Ө.х. дараагийн үеийн капиталын хэмжээг одоогийн капиталын хэмжээнд үндэслэн тодорхойлох дүрмийг гаргаснаар ҮЦФ -ийг хамгийн их байлгах юм.
- Гэвч бодлогын функцийг аналитик байдлаар олох боломж бараг байдаггүй. Тиймээс тоон аргачлал ашиглан ойролцоолуулан олж болно. ДСЕТ загвар байгуулж байгаа үед бодлогын фунцийг олохын оронд тогтовортой төлөв (steady state) -ийн орчимд логарифмтай болон логамрифмгүй шугаман дөхөлт ашиглан ойролцоолуулдаг.

Бейсийн ба Сонгодог статистик

- Сонгодог статистик болон бейсийн статистикийн хоорондох гол ялгаа нь бидний үнэлэх гэж буй параметр тогтмол тоо юу эсвэл санамсаргүй хувьсагч уу гэдэгт оршино.
- Сонгодог статистикт эх олонлогийн параметрийг тогтмол тоо гэж үзээд үнэлдэг бол бейсийн статистикт тодорхой тархалттай гэж үзэн тухайн параметрын тархалтыг олоход анхаарлаа хандуулдаг.

Жишээ 1

Нэгэн замын уулзвараар 10 секунтэд нэвтрэн өнгөрөх дундаж машины тоог хөдөлгөөн хяналтын мэргэжилтэн Пойссоны тархалттай бөгөөд $\lambda = 3$ эсвэл $\lambda = 5$ байна гэж таамагласан. Дата цуглуулахаас өмнө тэрээр өөрийн таамаглаж буй дундаж утгууддаа дараах байдлаар приор магадлал (prior probability) оноож байгаа.

$$P(\lambda = 3) = 0.7, \qquad P(\lambda = 5) = 0.3.$$

Дараагийн өдөр нь дамжин өнгөрч буй машины тоонд ажиглалт хийсэний үндсэн дээр дундажаар $\lambda = 7$ машин уулзвараар нэвтэрж буйг тогтоожээ. Тэгвэл мэргэжилтэний приор магдлал хэрхэн өөрчлөгдөх вэ?

Бодолт 1

Бейсийн теором: $P(C/D) = \frac{P(D/C)*P(C)}{P(D)}$.

$$P(\lambda = 3|X = 7) = \frac{P(\lambda = 3)P(X = 7|\lambda = 3)}{P(\lambda = 3)P(X = 7|\lambda = 3) + P(\lambda = 5)P(X = 7|\lambda = 5)}$$

Пойссоны тархалтын хүснэгт эсвэл эксэл ашиглан
$P(X = 7|\lambda = 3) = 0.022,\ P(X = 7|\lambda = 5) = 0.104$ гэж олно.

$$P(\lambda = 3|X = 7) = \frac{0.7 * 0.022}{0.7 * 0.022 + 0.3 * 0.104} = 0.328.$$

Үүнтэй ижлээр $P(\lambda = 5|X = 7) = 0.672$ гэж олдоно.

Жишээ 1 -ийн дүгнэлт

Анх мэргэжилтэн $P(\lambda = 3) = 0.7,\ P(\lambda = 5) = 0.3$ гэсэн урьдчилсан итгэл үнэмшилтэй байсан ч шинэ ажиглалт болох дундаж дамжин өнгөрөх машины хэмжээ 7 гэсэн мэдээлэл орж ирсэний дараа анхы итгэл үнэмшилээ өөрчилж $P(\lambda = 3|X = 7) = 0.328,\ P(\lambda = 5|X = 7) = 0.672$ болгож өөрчилсөн. Шинэ мэдээлэл орж ирсэний дараах магаддлалыг "постериор магадал"гэдэг.

Ерөнхий тохиолдол

Өмнөх жишээний хувьд параметр нь зөвхөн хоёрхон утга авахаар өгөгдсөн. Харин ерөнхий тохиолдолд Бейсийн үнэлгээ ашиглаж байгаа үед параметр нь төгөсгөлгүй олон утгууд авах бөгөөд тодорхой магадлалын тархалтаар тархана гэж үздэг. Параметрийн приор магадлалын тархалт $h(\theta)$ болон ажиглагдсан мэдээлэл y -ийг ашиглан постериор магадлалын тархалт $k(\theta|y)$ -ийг олохыг зорьдог. Ингэхэд бидэнд параметр өгөгдсөн үед санамсаргүй хувьсагчийн нөхцөлт тархалт $g(y|\theta)$ ямар байх нь мэдэгдэж байх шаардлагатай.

$$k(\theta|y) = \frac{g(y|\theta)h(\theta)}{\int_{\infty}^{\infty} g(y|\theta)h(\theta)d\theta}$$

Параметрын утгаа яаж тогтоох вэ?

- Загвар байгуулахад параметрийн тархалтаас илүүтэй скалар утга нь илүү чухал байдаг. Тархалтын мэдээллийг ашиглан голч (mean), медиан, модын аль нэгийг нь загвар байгуулахад ашигладаг.
- Хэрвээ параметрын квадрат алдааг хамгийн бага байлгахуйцаар сонгох бол голчийг, абсолют алдааг бага байлгахуйцаар сонгох бол медианыг авч ашиглана.

Нээлттэй эдийн засгийн ДСЕТ загварын онцлог

- Загварын хэмжээ томорно
- Худалдаалагддаг, худалдаалагддаггүй бараа үйлчилгээг ялгах
- Понзигүй байх хязгаарлалт тавих
- Хамгийн чухал нь загварыг хаах. Uribe and Schmitt-Grohe (2003) -д жижиг нээлттэй эдийн засгийн ДСЕТ загварыг хаах 4 аргыг санал болгосон.
  - Эндоген дискаунт фактор ашиглах (Edogenous discount factor)
  - Гадаад өрийн хэмжээнээс хүүгийн түвшин хамааруулах (Debt-elastic interest rate)
  - Гадаадын хөрөнгө оруулалтын өөрчлөлтөд зардал тооцох (Portolio adjustment cost)
  - Төгс хөрөнгийн зах зээлтэй гэж үзэх (Complete asset markets)

Загварын онцлог

- Traded, non-traded, mining firms are included
- First order conditions are derived from Lagrangian function
- Finding steady states of endogenous variables from behavioural equations
- Linearizing first order approximation around steady state
- Identified structural shocks using Bayesian estimation
- Deep parameters are calibrated from past literatures
- Define pandemic scenario and simulate external debt evolution

Household

- Household's preference function is non-separable
- Government imposes lump-sum tax on households' income
- Convex portfolio adjustment cost, $\frac{\theta_D}{2}(b_t - b)^2$, closes our DSGE model and ensures unique steady state.
- Investment adjustment cost functions is similirar to Christiano et al. (2005): $[1 - \frac{\Theta_I}{2}(\frac{i_t}{i_{t-1}} - 1)^2]i_t$.
- Consumption and investment consists of traded and non-traded goods.

Firms

- Both tradable and non-tradable firms have Cobb-Douglas production function with AR(1) technology shock
- Mining firm's output and price follows AR(1) process. Main drivers are previous period's values and exogenous shocks.
- Households are ultimate owner of firms, so government taxes are imposed on household's income but not on firm's profit.

Government

- Tax revenue consists of tax on households' income and mining royalty.
- Government spends all incomes
- Government spending consists of both tradable and non-tradable goods
- The total government spending follows the AR(1) process

Market clearing

The market clearing condition for the non-tradable goods sector

$$y_t^N = c_t^N + i_t^N + g_t^N.$$

Market clearing for the capital stock is

$$k_{t-1} = k_t^T + k_t^N.$$

The capital allocation decision between tradable and non-tradable sectors is decided in the period t, but the total capital stock amount is predetermined in the period t-1.
The labor market clearing condition is

$$h_t = h_t^T + h_t^N.$$

Calibration

Table 1. Structural Parameter Calibration.

Greek Symbol	Short Definition	Calibrated Value
β	Discount factor	0.99
α_T	Capital share in tradable	0.4
α_N	Capital share in non-tradable	0.33
ω	Frisch elasticity	1.6
σ	Intertemporal elasticity	2
ε	Substitution elasticity between traded and non-traded	1.44
θ_D	Portfolio adjustment cost	0.001
δ	Quarterly depreciation	0.025
θ_I	Investment adjustment cost	2.48
α	Share of tradable	0.58
G	Government spending share	0.13
M	Mining share in GDP	0.21
ro	Royalty rate	0.2

Source: Author's estimation and calibration.

Estimation

Table 2. Parameter estimation result.

Parameters		Prior			Posterior	
Greek	Short Definition	Density	Mean	SD	Mean	90% Interval
ϱ_T	Traded sector's pers.	Beta	0.6	0.1	0.7589	0.7061–0.8307
ϱ_N	Non-traded sector's pers.	Beta	0.6	0.1	0.5825	0.5582–0.6246
ϱ_v	Preference shock pers.	Beta	0.6	0.1	0.795	0.7715–0.8197
ϱ_g	Government spending pers.	Beta	0.6	0.1	0.8681	0.8595–0.8759
ϱ^{rf}	Foreign interest rate pers.	Beta	0.6	0.1	0.9462	0.936–0.9554
ϱ_M	Mining output pers.	Beta	0.6	0.1	0.9471	0.943–0.9639
ϱ_{PM}	Mining price pers.	Beta	0.6	0.1	0.9703	0.9684–0.9707
σ_{AT}	SD of traded sector's tech.	IG	0.01	Inf.	0.1296	0.1265–0.1446
σ_{AN}	SD of non-traded sector's tech.	IG	0.01	Inf.	0.0048	0.0031–0.006
σ_v	SD of preference shock	IG	0.01	Inf.	0.3929	0.3755–0.4523
σ_g	SD of government spending	IG	0.01	Inf.	0.1606	0.1502–0.1769
σ_{rf}	SD of foreign interest rate	IG	0.01	Inf.	0.0015	0.0014–0.0015
σ_M	SD of mining output	IG	0.01	Inf.	0.0959	0.0933–0.0982
σ_{PM}	SD of mining price	IG	0.01	Inf.	0.2567	0.2428–0.2703

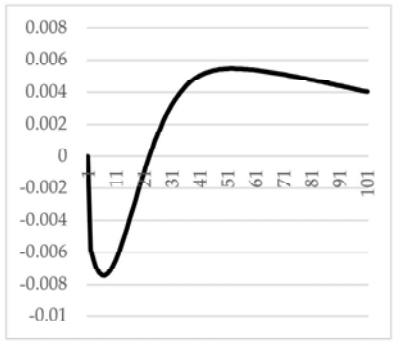
Source: Author's estimation. Note*: SD—standard deviation, IG—inverse gamma, pers.—persistence, tech.—technology.

IRF

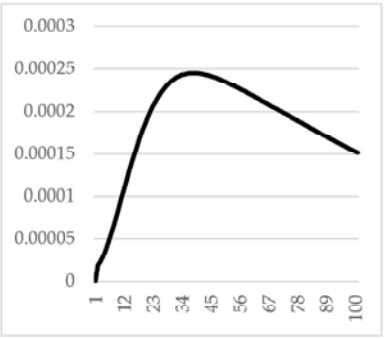
- The traded sector's productivity shock, the commodity price shock, the mining output shock, and the foreign interest-rate shock have a decreasing effect on external debt accumulation
- The non-traded sector's productivity shock, the household preference shock, and the government spending shock have an increasing effect on the same

Dutch-Disease

Increased mining production crowds out the traded sector's output and increases the real exchange rate.



(a) Traded sector production to mining output shock



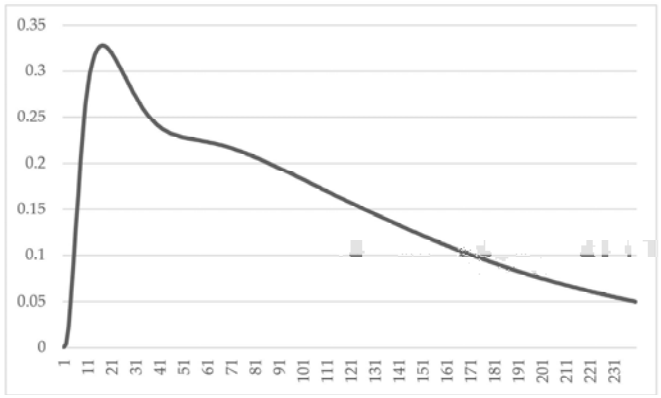
(b) Real exchange rate to mining output shock

COVID-19 Impact of External Debt: Background

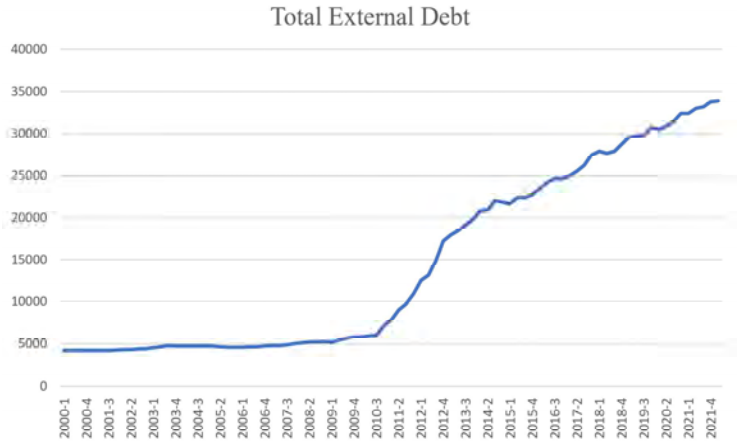
- One-time forgiveness of pension-backed debts
- Personal income tax and social security tax were fully or partially waived-off
- Implementation of a fiscal stimulus package of MNT 10 trillion
- Our pandemic assumption:
  1. Households' preferences decreased by one standard deviation for four consecutive quarters
  2. Mining production and mining price declined by one standard deviation for four consecutive quarters
  3. Government spending increased by one standard deviation for eight consecutive quarters
  4. Foreign interest rate decreased by one standard deviation for four consecutive quarters
  5. Traded and non-traded sectors' productivity de-creased by one standard deviation for four consecutive quarters.

Simulated External Debt Evolution

Increase by 30% from its steady state over the next 10–28 quarters.



Reality vs Simulation



Санал, Зөвлөмж

- Хил хаалттай учраас импортын эрэлт бага байгаа нь валютын ханшийг барих боломжийг олгож байгаа
- Хил нээгдвэл урсгал тэнцлийн алдагдал нэмэгдэх, гадаад өрийн дарамт нэмэгдэхээр байна.
- Хил нээгдвэл валютын ханшийг сулруулахаас өөр аргагүй. Үр дүнд нь гадаад өрийн төгрөгөөрх дүн өснө.
- Эдийн засгийн урт хугацааны өсөлтийг бүтээхүйц зүйлсэд анхаарч богино хугацааны эрэлтийг дэмжсэн бодлогууд явуулахаас татгалзах
- Нийлүүлэлтийн гаралтай аливаа шокод эрэлтийн бодлогоор хариу үзүүлэх нь үнэ, ханшийн тогтворгүй байдал үүсэх гол шалтгаан болдог
- Цаг хугацаагаар тууштай байх нь хамгийн чухал
- Азийн болон дэлхийн үйлдвэрлэлийн сүлжээ (value chain) -нд нэгдэх

АНХААРАЛ ХАНДУУЛСАНД БАЯРЛАЛАА!

Jan. 12 to Jan.19, 2023

Training in compiling and analyzing large sample data in R.

- Number of trainees ---- 12
- Venue --- BiG Center, Seminar room
- Date, time, and contents

Date & Time	Content	Trainer
Jan. 12 (Thu) 9:00 to 12:30	• Program environment -Rstudio • Writing code in program • Objects, types of objects, common functions used in R • Practice & exercise	Soyolmaa.B
Jan. 13 (Fri) 9:00 to 12:30	• Read and write quantitative data • Data exercise • Transform data: create variable, insert label • Analyzing statistics	Altantsetseg.B
Jan. 17 (Tue) 9:00 to 12:30	• GGPLOT2-visualize data • DPLYR- transform data • Practice & exercise	Altantsetseg.B
Jan. 19 (Thu) 9:00 to 12:30	• DPLYR-transform data • TIDYR-clean data	Soyolmaa.B

"R program" Training Attendee List

№	Name			
1	Nyamtsetseg.G		7	Zolzaya.T
2	Badamtsetseg.Ts		8	Munkhtsetseg.T
3	Myagmarjav.T		9	Tuguldur.G
4	Narantsatsralt.N		10	Oigonbayar
5	Ulziisaikhan.J		11	Gandi.M
6	Munkhdelger.Ts		12	Chuluunchimeg.A

R программын сургалт: Тоон өгөгдөл дүрслэх, хувиргах

Дата анализын үе шат

Агуулга

- Дүрслэх
- Хувиргах

Дата дүрслэх

```
install.packages("tidyverse")
library(tidyverse)
```

- Tidyverse
  - ggplot2
  - tibble

Tibbles

- Бид өмнө нь data.frame үзсэн.
- tibbles нь бас нэг тоон өгөгдөл бөгөөд уламжлалт тоон өгөгдлөөс зарим шинж чанараар өөр. Илүү уян хатан.
- tidyverse дотор байдаг
- Tibble үүсгэхдээ
  - as_tibble(data)
  - tibble(x = 1:5, y = 1, z = x ^ 2 + y)

R программын сургалт

Агуулга

- R-ийн давуу тал
- Тоон өгөгдөл унших
- Анхан шатны түвшинд програм бичих

R- ийн давуу тал

- Дата боловсруулахад амар
  - Ихэнх программаас дата импортолдог
  - Датанаасаа дэд олонлог үүсгэх, шинэ хувьсагч үүсгэх, тодорхой ажиглалт, хувьсагчийг сонгоход хялбар
  - Уян хатан
- Датаг дүрслэх хэрэгслүүд нь маш өргөн хүрээтэй
  - График, хүснэгт хийхэд хялбар, уян хатан

Программын харьцуулалт: Хэрэглэхэд хялбар байдал

Excel

- Программ сурах
  - Ихэнх хүн анхан шатны мэдлэгтэй тул эхний сурах агуулга бага
  - Тоон өгөгдлөө оруулчихвал үндсэн график зурахад хялбар
- Шинжилгээг давтах боломж
  - Товч дарж үйлдэл хийдэг нь хялбар боловч дахин давтахын тулд ой санамж, үйлдлээ давтаж хийхэд найдах болдог, өөр тоон өгөгдөл дээр дахин эхнээс нь хийх болно.
  - Энгийн цөөн шинжилгээнд асуудал биш байж болох ч, төвөгтэй шинжилгээ хийх бол асуудал болдог.

R

- Программ сурах
  - Программын хэл тул эхний сурах агуулга их, магадгүй хэдэн долоо хоног болно
  - Нэгэнт танил болчихвол цаашид хэрэглэхэд маш хялбар
- Шинжилгээг давтах боломж
  - Ашиглахад арай төвөгтэй боловч шинжилгээг түхайн болон өөр тоон өгөгдөл дээр ч нэг программаар (кодоор) хийх боломжтой

Программын харьцуулалт: Дүрслэл

Excel

- Энгийн зургийг хялбархан хурдан зурах боломжтой
- Өөр хоорондоо өгөгдлийн зарим нэг шинжийг энгийнээр зураад ярилцахад тохиромжтой

R

- Нарийн төвөгтэй графикийг ойлгомжтой, гоёмсогоор дүрслэх бол
- Хэд хэдэн талуудад төвөгтэй тоон өгөгдлийг танилцуулах бол тохиромжтой

Программын харьцуулалт: Статистик шинжилгээ

Excel

- Энгийн статистикууд, арифметик үйлдэл хийхэд хангалттай
- Үндсэн хүснэгт бэлдэх
- PPT-д оруулахад хялбар
- Их хэмжээний тоон өгөгдөл дээр ажиллах боломжгүй

R

- Тоон өгөгдөлд их хэмжээний шинжилгээ хийх боломжтой
- Тренд, хэлбэлзлийг харна
- Үнэлэгдсэн статистикуудын хэр найдвартайг харах боломжтой
- Тоон өгөгдлийг цэвэрлэх, зохион байгуулах боломжтой
- Дүрслэх маш олон боломжтой
- Сонирхсон ямар ч шинжилгээг хийх боломж

Программын харьцуулалт: Үнэ, хэрэглэгчид

Excel

- Харьцангуй хямд
- Жилийн лиценз Office 365-аар 70 орчим доллар

R

- Үнэгүй, олон нийтэд нээлттэй
- Дэмждэг олон тооны форум, цахим хуудас, олон нийт

Тоон өгөгдөл унших

Object

- R –д үүсгэсэн үр дүнг нэр өгч хадгалдаг. Үүнийг object гэдэг. Эдгээр нь олон төрөл: хувьсагч, тоон цуваа, үсгэн тэмдэгт, функц, гэх мэт.
- Object нь анги(class), төрөлтэй (type) байна.
  - Class
    - Vectors
    - Matrices
    - Lists
    - Data frames
  - Type
    - Numeric, character, logical, NA

Data frame

- Data frame нь хэд хэдэн хувьсагчид бүхий object. Мөр нь ажиглалт, багана нь хувьсагчид байдаг матриц гэж төсөөлж болно.
- Матрицаас ялгаатай нь data frame янз бүрийн төрлийн хувьсагчид агуулж болно.
- Матрицыг data frame болгож болно.

Data frame, data file

- R програмд
  - Data frame нь дата (датаны олонлог)
  - Data file нь хэд хэдэн дата, бусад обьектуудыг агуулж болно.

Data frame

- Бид нар дата фрэйм (dataframe) дотроос нэг хувьсагчийг (var) сонгож, эсвэл шинэ хувьсагч үүсгэж болно.
  - dataframe$var
- Байн байн dataframe гэж бичихгүй гэвэл дараах ***with*** функцыг ашиглаж болно.
  - with(dataframe, dataframe-ийн хувьсагчдыг ашигласан илэрхийлэл)
- Үүнтэй төстэй ***attach*** аргыг ашиглаж болно. Гэхдээ ***detach*** хийхээ мартаж болохгүй.

Тоон өгөгдлийн дэд олонлог

- Бид заримдаа бүхэл дататай биш түүний дэд олонлогтой ажиллах шаардлагатай болдог. Үүнийг ***subset*** комманд ашиглан хийж болно.
  - subset(dataframe, criterion)

Тоон өгөгдлийн талаарх анхан шатны мэдээлэл

- Датагаа ачаалласныхаа дараа хувьсагчдын талаар хурдан зарим мэдээллийг авч болно.
  - head(dataframe)-датаны эхний мөрүүдийг харуулна
  - str(dataframe)-бүтцийг жагсааж харуулна, хувьсагчийн нэр, төрөл, эхний хэдэн утга
  - colMeans(dataframe)-бүх хувьсагчдын дунджыг харуулна
  - summary(dataframe)- статистик шинж чанар

Дата файл

- ***R*** өөрийн гэсэн дата файлын форматтай дурын төрлийн нэг болон хэд хэдэн обьектуудыг агуулж болно. Ажлын талбарт байгаа хувьсагчдыг файл болгон хадгалж болно.
  - файлын өргөтгөл нь .Rdata
  - save(v1,v2,…,file="mydata.RData")
  - save(list=ls(),file="mydata.RData")
- Хадгалсан файлаа дараа нь ажлын талбарт ачааллаж болно.
  - load(mydata.RData)

Текст файл импортлох, экспортлох

- R-ийн read.table комманд текст файлуудыг уншиж data frame болгон хадгалдаг.
  - newdata<- read.table(filename,…)
    - header=TRUE
    - sep=","
    - dec=","
- Data frame-д байгаа датаг текст файл болгон экспортолж болно.
  - write.table(mydata, file="filename")

Бусад төрлийн файл импортлох, экспортлох

- R бусад хэлбэрийн датаг импортолдог. ***haven*** гэдэг пакеж ашиглан хийх боломжтой.
  - Stata – read_dta
  - SPSS – read_spss
  - SAS – read_xport, read_ssd
  - Excel- read_excel

Агуулга

- Тухайлсан хувьсагч үүсгэх
- Статистик үзүүлэлтүүд харах
  - Дискрет тархалт
  - Тасралтгүй тархалт
  - Суурь статистик
  - Санамсаргүй тоо сугалах
- Статистик шинжилгээ
  - Итгэх завсар
  - t тест

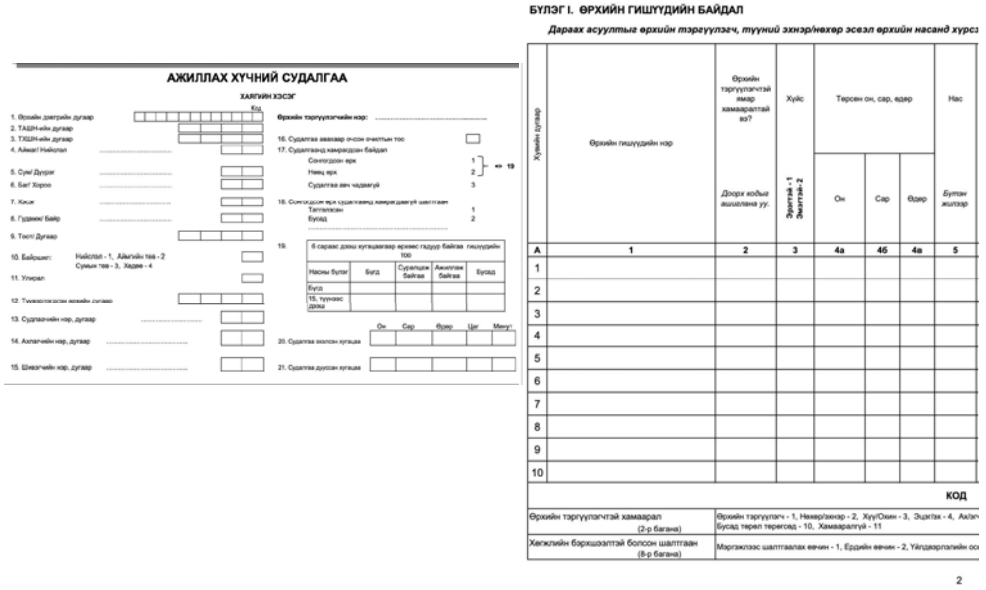
Дескриптив статистик

Ажиллах хүчний судалгаа

Тухайлсан хувьсагч үүсгэх

2018 оны ажиллах хүчний судалгааны тоон өгөгдөл

- Улсын хэмжээнд
  - 12000 орчим өрх
  - 44000-48000 хүн
- www.1212.mn
  - Микро мэдээллийн сан
  - Ажиллах хүчний судалгаа
  - Анхан шатны мэдээлэл
    - Бүртгүүлнэ
    - Ямар зориулалтаар ашиглах гэж байгаагаа товч бичнэ
    - Сонгосон оны өгөгдлөө татна
    - Өгөгдөл SPSS хэлбэртэй

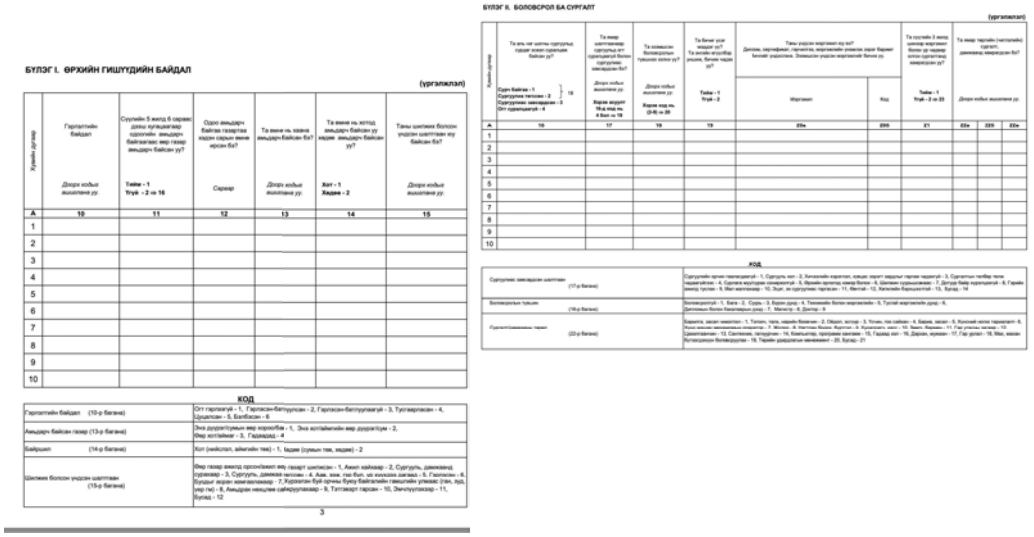

АЖИЛЛАХ ХҮЧНИЙ СУДАЛГАА

ХАЯГИЙН ХЭСЭГ

БҮЛЭГ I. ӨРХИЙН ГИШҮҮДИЙН БАЙДАЛ

Оролцогсдын ерөнхий шинж чанар

- Өрхийн шинж чанар
  - Байршил
  - Ам бүлийн тоо
- Хувь хүний шинж чанар
  - Нас
  - Хүйс
  - Боловсрол
  - Гэрлэлтийн байдал


БҮЛЭГ I. ӨРХИЙН ГИШҮҮДИЙН БАЙДАЛ

БҮЛЭГ II. БОЛОВСРОЛ БА СУРГАЛТ

Оролцогсдын ерөнхий шинж чанарын хувьсагчид үүсгэх: Асуулгаа харна

- Өрхийн шинж чанар
  - Байршил (LOCATION)
  - Ам бүлийн тоо (HHSIZE)
- Хувь хүний шинж чанар
  - Нас (I5)
  - Хүйс (I3) Эр-1, Эм-2
  - Боловсрол (II18)
  - Гэрлэлтийн байдал (I10)

КОД

Гэрлэлтийн байдал (10-р багана)	Огт гэрлээгүй - 1, Гэрлэсэн-батлуулсан - 2, Гэрлэсэн-батлуулаагүй - 3, Тусгаарласан - 4, Цуцалсан - 5, Бэлбэсэн - 6
Сургуулиас завсардсан шалтгаан (17-р багана)	Сургуулийн орчин таалагдаагүй - 1, Сургууль хол - 2, Хичээлийн хэрэгслэл, хувцас зэрэгт зардлыг гаргаж чадахгүй - 3, Сургалтын төлбөр төлж чадаагүйгээс - 4, Сурлага муу/сурах сонирхолгүй - 5, Өрхийн орлогод нэмэр болох - 6, Шилжин суурьшсанаас - 7, Дотуур байр хүрэлцээгүй - 8, Гэрийн ажилд туслах - 9, Мал маллахаар - 10, Эцэг, эх сургуулиас гарсан - 11, Өвчтэй - 12, Хөгжлийн бэрхшээлтэй - 13, Бусад - 14
Боловсролын түвшин (18-р багана)	Боловсролгүй - 1, Бага - 2, Суурь - 3, Бүрэн дунд - 4, Техникийн болон мэргэжлийн - 5, Тусгай мэргэжлийн дунд - 6, Дипломын болон бакалаврын дээд - 7, Магистр - 8, Доктор - 9
Сургалт/дамжаанд тэрэл (22-р багана)	Барилга, засал чимэглэл - 1, Тогооч, талх, нарийн боовчин - 2, Оёдол, эсгүүр - 3, Үсчин, гоо сайхан - 4, Бариа, засал - 5, Хүнсний ногоо тариалалт- 6, Хүнд машин механизмын оператор - 7, Жолоо - 8, Нягтлан бодох, бүртгэл - 9, Худалдагч, касс - 10, Зөөгч, бармен - 11, Гар утасны засвар - 12, Цахилгаанчин - 13, Сантехник, гагнуурчин - 14, Компьютер, программ хангамж - 15, Гадаад хэл - 16, Дархан, мужаан - 17, Гар урлал - 18, Мах, махан бүтээгдэхүүн боловсруулах - 19, Төрийн удирдлагын менежмент - 20, Бусад - 21

Хөдөлмөрийн гол үзүүлэлтүүд

- Хөдөлмөрийн нөөц
- Ажиллах хүчин
  - Ажиллагсад
  - Ажилгүйчүүд
- Ажиллах хүчний оролцооны түвшин
- Хөдөлмөр эрхлэлтийн түвшин
- Ажилгүйдлийн түвшин

Оролцогсдын ерөнхий шинж чанарын хувьсагчид үүсгэх

- Хувьсагч үүсгэх (өмнө үзсэн)
- Хувьсагчийн утга солих
- Хувьсагчид тайлбар өгөх
- Хувьсагчийн утгад тайлбар өгөх

Тодорхойлолтууд

- Хөдөлмөрийн нөөц: 15 ба түүнээс дээш насны хүн ам
- Ажиллах хүчин: Ажилтай + Ажилгүй
  - Ажилтай: Сүүлийн долоо хоногт ядаж нэг цаг ажилласан
  - Ажилгүй: Ажилгүй, ажил хийхэд бэлэн, ажил хайж байгаа

Хувьсагч үүсгэх

- Хөдөлмөрийн нөөц (age>=15)
- Ажилтай (III39, III40)
- Ажилгүй (V90, V93)

Статистик үзүүлэлтүүд харах

Статистик үзүүлэлтүүд харах

- Дискрет тархалт
- Тасралтгүй тархалт
- Суурь статистик
- Санамсаргүй тоо сугалах

Дискрет санамсаргүй хувьсагч

- Дискрет санамсаргүй хувьсагч
  - Төгсгөлөг эсвэл тоологддог боловч төгсгөлгүй олон утга авдаг хувьсагч
    - Өрхийн ам бүлийн тоо: 0, 1, 2, 3,...
- Дискрет санамсаргүй хувьсагч нь авч болох боломжит утгууд болон утга бүрт харгалзах магадлалаар бүрэн тодорхойлогддог.

Тасралтгүй санамсаргүй хувьсагч

- Тасралтгүй санамсаргүй хувьсагч
  - Бодит тоон утга авдаг хувьсагч (0 магадлалтай)
    - Өрхийн орлого
- Тасралтгүй санамсаргүй хувьсагчийн хувьд магадлал нь түүний утга тодорхой интервалд байх магадлал буюу магадлалын нягтын функц (pdf)-ийн доорх талбайгаар тодорхойлогддог.
- pdf-ийн доорх талбай бүхэлдээ 1-тэй тэнцүү байна.

Суурь статистик

- Дундаж, медиан, стандард хазайлт, корреляци
- R дасгал
- mean, median, sd, summary, cor

Тодорхойлолтууд

- Ажиллах хүчний оролцооны түвшин
  - Хөдөлмөрийн нөөцөөс хэдэн хувь нь ажиллах хүчинд байна
- Хөдөлмөр эрхлэлтийн түвшин
  - Хөдөлмөрийн нөөцөөс хэдэн хувь нь ажилтай байна
- Ажилгүйдлийн түвшин
  - Ажиллах хүчнээс хэдэн хувь нь ажилгүй байна

Санамсаргүй тоо сугалах

- R өгсөн тархалтаас санамсаргүй түүвэр хийдэг.
- Бернуллийн тархалт 1 утга авах магадлал p=0.5: rbinom(10,1,0.5)
- Стандарт нормаль тархалт : rnorm(10)

- Санамсаргүй тоо сугалахад “seed” чухал. Жишээ нь: Судалгааны үр дүнг давтан гаргах боломжтой байх. Энэ нь санамсаргүй тоо үүсгэгчид тодорхой нэг төлөв зааж өгнө гэсэн үг.
- set.seed(234)

Статистик шинжилгээ

Итгэх завсар

- $\{Y_1, Y_2, \ldots, Y_n\}$ нь $N(\mu, 1)$ гэсэн эх олонлогоос авсан санамсаргүй түүвэр байг. Түүврийн дундаж нь

$$\bar{Y} \sim N(\mu, \frac{1}{n})$$

- $\bar{Y}$ -г стандартчилбал стандарт нормаль тархалттай болох ба

$$P\left(-1.96 < \frac{\bar{Y} - \mu}{\frac{1}{\sqrt{n}}} < 1.96\right) = 0.95$$

$$P(\bar{Y} - 1.96/\sqrt{n} < \mu < \bar{Y} + 1.96/\sqrt{n}) = 0.95$$

T test

- Таамаглал H_0, H_A (нэг талт, хоёр талт)
- **Теорем**

  CLM-ийн нөхцлүүд биелж байвал

$$\frac{(\hat{\beta}_j - \beta_j)}{se(\hat{\beta}_j)} \sim t_{n-k-1}$$

  энд: k+1 нь загварын мэдэгдэхгүй байгаа параметрүүдийн тоо юм.

T test

- R дасгал

Remote lecture by Dr. Kunimitsu from Japan

February 8（Wed）, 14:00 – 16:00

CGE modeling using GTAP database 9

- Advantage/Disadvantage applying GTAPinGAMS（10min）
- Data preparation process of GTAP9inGAMS（20min）
  - Filtering
  - Aggregation
  - Attention in using GTAP10 data
  - Construction of SAM
  - Overview of GTAPinGAMS model（Lanz and Rutherford, 2017）（20min）
  - What is MCP model
  - Structure of LR model
- Policy simulation method（25min×2）
  - Ex-1：Impacts of reduction in non-tariff barriers on the export expansion of Japanese agriculture and food industries to Asian countries and their domestic production
  - Ex-2：Predictability and Limits on Food Price Fluctuations in the Months Ahead ― Using Global CGE Model and Crop Model with Seasonal Climate Forecasts ―

Participants List
Oyunzul ERI (Oyunzul Tserendorj)
Enkhsaikhan (ERI) (Enkhsaikhan)
Nyambaatar (ERI) (nyamb)
Uurtsaikh Enkhtur
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Reitaku University
National Agriculture and Food Research Organization (NARO)

Policy simulation based on the global Computable General Equilibrium model 1

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NARO Rural Engineering Research Division

Contents

Merits of GTAPinGAMS compared to GTAP soft wares

1. Easy handling for data and model building

- Generally, policy simulation was conducted as the following process by using soft wares.
  1. Data building
  2. Coding the model equations
  3. Compiling the model codes
  4. Inputting policy shocks
  5. Run
  6. Interpretation of results

Soft wares used in the case of the GTAP and GAMS ways.

- In the GTAP method, it is necessary to use multiple pieces of software to perform work for each process. However, with GAMS, most of the work can be done only with GAMS IDE or GAMS studio.

Process	GTAP		GAMS
1.Data building	Data building and checking:	Viewhar.exe	GDXviewer.exe
	Aggrigation:	agghar.exe	
2.Coding the model equations	Coding:	Tabmate.exe	
3.Compiling the model codes	Compiling:	GEMpack	
4.Inputting policy shocks	Coding:	Tabmate.exe	gamside
		gpconfig.exe,	
5.Run	Original GTAP model:	RunGTAP, RunDynam	
	Own model:	Gempack+Fortran	
		gemsim.exe	
6.Interpretation of results		Analysge.exe	–

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2. Easy modeling

- GAMS only needs to describe the CGE model's equations (nonlinear formula) directly.
  - We code the model by inputting nonlinear equations in the file.
  - There are several tools which ease model coding, such as MPSGE.
- GEMPACK, on the other hand, often adopts a method of linearly approximating a nonlinear equations to describe it.
  - We code the model by inputting linearized equations in which nonlinear equations are differentiated.
  - There are two ways to simulate with GTAP model.
    - Analysis using software provided by GTAP
      - Comparative static analysis : RunGTAP ＜･･･https://www.youtube.com/watch?v=-CR87dnHpHQ
      - Recursive dynamic analysis : RunDynam＜･･･https://www.copsmodels.com/gprdyn.htm
    - Analysis using GEMPAC software＜････https://www.copsmodels.com/gempack.htm
      - Simulation (Gemsym or compiling model with GEMPAC and Fortran)

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Merits of GEMPACK

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Infeasible solution especially in the large-scale model

- GAMS finds the solution while internally linearly approximating the nonlinear simultaneous equations.
  - Sometimes, model cannot be solved due to complexity or constraint at local optimal values
  - Usually, solution time is longer than GEMPACK.
- GEMPACK, on the other hand, often describes the model linearly, solves the model as a system of linear equations, takes into account the nonlinearity of the function, and computes an equilibrium solution.

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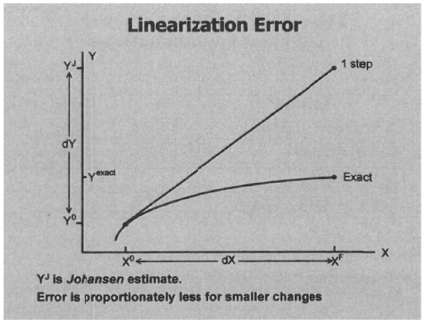
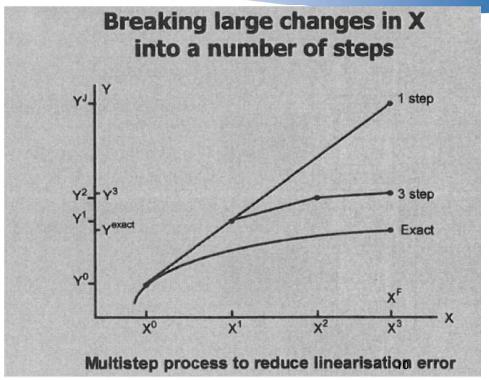
Features of GEMPACK

- Solving linear approximation models



Features of GEMPACK(2)



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Features of GEMPACK(3)

Extrapolating from Johansen and Euler approximations

Method	y	Error
Johansen (1-step)	150%	50%
Euler 2-step	125%	25%
Euler 4-step	112.3%	12.3%
Euler ∞-step (exact)	100%	0

The error follows a rule (double steps, halve error).
Use results from 3 approximate solutions to estimate exact solution + error bound.

Easy traceability in GTAP ways

- The contribution of each variable to the simulation results can be analyzed in sequence by using Analysge.exe

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Process for data building in GTAPinGAMS (build.gms)

1. Create an empty root directory for GTAP.
2. Unzip gtap9ingams.zip in this directory.
3. Install the GTAP data file flexagg9aY11.zip into the gtapdata subdirectory.
4. Create the "map" file for regional integration and sectoral integration:
   ¥defines¥***.map
   - ex: g20.map
5. Connect to the build directory and execute gams "build.gms".
   - Choose the different year data, if you wish.

Contents

- Pros and cons of using GTAPinGAMS
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  - Building global SAM data
- The CGE model published by GTAPinGAMS (Lanz and Rutherford, 2017)
  - What is the Mixed Complimentary Problem (MCP) type CGE model
  - The structure of Lanz and Rutherford's model
- Examples of policy simulation by using the global CGE model
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  - Example 2:Regional aggregation biases and their mitigation method for the global computable general equilibrium model

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Data files in GTAP

- GTAP data
  - HAR files (ViewHAR)
    - Base data:gsddat.har
    - GHG emission data:gsdemiss.har
    - Parameters for simulation:gsdpar.har
    - Sectors and countries/regions:gsdset.har
    - Tax data:gsdtax.har
    - Trade data:gsdview.har
  - In order to aggregate sectors and regions, the GTAP way requires GTAPAgg.exe, but GTAPinGAMS uses the gams code with the mapping file to aggregate data after transforming the har file to the gdx file.

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SAM in the GTAP database

	Imp	Dom	Exp	Act	Fact	Imp Duty	Exp Tax	Imp Tax	Dom Tax	Fact Tax	Trade Marg	MargExp	Trade	Reg HH	PrivExp	Prod Tax (prod)	Dir Tax (end)	Govt	CGDS	Tot
Imp	0	0	0	VIFM	0	0	0	0	0	0	0	0	0	0	VIPM	0	0	VIGM	VIFM	VIM
Dom	0	0	0	VDFM	0	0	0	0	0	0	0	0	0	0	VDPM	0	0	VDGM	VDFM	VDM
Exp	0	0	0	0	0	0	0	0	0	0	0	VST	VXWD	0	0	0	0	0	0	VXWD
Act	0	VDM	VXMD + VST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	VOM
Fact	0	0	0	VFM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	VFM
Imp Duty	MTAXS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MTAXS
Exp Tax	0	0	XTAXD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XTAXD
Imp Tax	0	0	0	IFTAX	0	0	0	0	0	0	0	0	0	0	IPTAX	0	0	IGTAX	IFTAX	ITAX
Dom Tax	0	0	0	DFTAX	0	0	0	0	0	0	0	0	0	0	DPTAX	0	0	DGTAX	DFTAX	DTAX
Fact Tax	0	0	0	ETAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ETAX
Trade Marg	VTMFSD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	VTWR
Marg Exp	0	0	0	0	0	0	0	0	0	0	VTWR	0	0	0	0	0	0	0	0	VTWR
Trade	VXWD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	VXWD
Reg HH	0	0	0	0	VOA-VDEP	MTAX	XTAXD	IPTAX, IGTAX, IFTAX	DPTAX, DGTAX, DFTAX	ETAX	0	0	0	0		PTAX	PTAX	0	0	INCOME
PrivExp	0	0	0	0	0	0	0	0	0	0	0	0	0	PRIVEXP	0	0	0	0	0	PRIVEXP
Prod Tax	0	0	0	PTAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PTAX
Dir Tax	0	0	0	0	PTAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PTAX
Govt	0	0	0	0	0	0	0	0	0	0	0	0	0	GOVEXP	0	0	0	0	0	GOVEXP
CGDS	0	0	0	0	VDEP	0	0	0	0	0	0	VTMFSD - VST	VIWS – VTMFSD – VXWD	SAVE	0	0	0	0	0	REGINV
Tot	VIM	VDM	VXWD	VOM	VFM	MTAXS	XTAXD	ITAX	DTAX	ETAX	VTWR	VTWR	VXWD	INCOME	PRIV EXP	PTAX	PTAX	GOV EXP	REGINV	

Filtering

- Most numerical problems with GTAPINGAMS models can be traced to density of the source data in which we find large numbers of small coefficients. These coefficients portray economic flows which are a negligible share of overall economic activity, yet impose a significant computational burden during matrix factorization.
- In order to "filter" these economically insignificant value and reduce dimensionality of the problem, GTAPINGAMS includes a GAMS program (FILTER.GMS) which removes small values which are smaller than a specified tolerance level. An input to this program (ND) determines the filter tolerance, i.e. the number of decimals for the smallest coefficient to be retained in the data. For example, when nd = 4, the smallest coefficient in the benchmark social accounting matrix is 0.0001.

Table 6: Filtering results for entire dataset (2011 data)

	Nonzeros	Nonzeros After Filtering			% Reduction in Nonzeros		
	Before	nd = 4	nd = 5	nd = 6	nd = 4	nd = 5	nd = 6
Domestic Intermediate vdfm	478800	233267	290668	342177	51	39	29
Imported Intermediate vifm	476798	186521	247571	300255	61	48	37
Bilateral trade vtwr	776358	175449	314173	463832	77	60	40
Transport margins vxmd	1097628	400882	591129	766803	63	46	30

Data modification tool

- build.gms
  - $set fs %system.dirsep%
  - $set code ..%fs%code%fs%
  - $set nd 5
  - $set yr 11
  - $call gams %code%flex2gdx —yr=%yr% o=flex2gdx_%yr%.lst ＜・・・・・Translate GTAP Distribution Data into GDX
  - $call gams %code%filter —yr=%yr% —nd=%nd% o=filter%yr%_%nd%.lst ＜・・・・・Generate a Sparse Version of the GTAP Dataset
  - $set ds g20
  - $call gams %code%gtapaggr —yr=%yr% --source=gtapingams --target=%ds% o=%ds%_%yr%.lst ＜・・・・ Aggregation Program for the GTAP9 Database
  - $call gams %code%cdecalib —yr=%yr% —ds=%ds% o=cde_%ds%_%yr%.lst ＜・・・・Calibrate the CDE Demand Systems

Recalibrate the Dataset

- Removing small entries from the dataset implies that the resulting filtered dataset no longer represent a micro-consistent matrix. The filter.gms does not use a nonlinear optimization framework to rebalance the data, but this program moves imbalances resulting from omitted coefficients into either factor supplies or investment demand depending on the sign of imbalance which appears following filtering.
- This approach to reconciliation is simple to implement provided that the inconsistencies resulting from filtering are small. However, the reconciliation methodology implemented in filter.gms is less useful for large scale recalibration exercises.

Data aggregation

- In order to save computational burden, most previous studies have aggregated countries/regions and industrial sectors from the original GTAP data.
  - GTAP data
    - HAR files （ViewHAR）
      - Base data：gsddat.har
      - Parameters for simulation：gsdpar.har
      - Sectors and countries/regions：gsdset.har
      - Tax data：gsdtax.har
      - Trade data：gsdview.har
- To aggregate data, GTAP provides utilities, such as “GTAPAgg.exe,” but in GTAPinGAMS, “gtapaggr.gms” is used.
  - To run gtapaggr.gms requires map file, such as g20.map.

  < See g20.map file>
- Although data aggregation is convenient, there will be some problems. This will be shown in the last slide “Regional aggregation biases and their mitigation method for the global computable general equilibrium model.”

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See how build.gms runs!

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What is the Mixed Complimentary Problem (MCP) type CGE model

- The global CGE model provided in GTAPinGAMS is described in MCP format.
- MCP type model can be coded by the plane text with Path solver or by the MPSGE solver with Path solver.
- There may be several pros and cons in MCP type CGE model, and it depends on preference of modelers and subjects analyzed.
- Next slides explain the simple MCP type CGE model.
  - 2 commodities and two input factors, but no intermediate inputs.

Dual approach for CGE model building

- Production side:

$$c_i(r,w) = \min[r \cdot k + w \cdot l]$$

$$st: f_i(k,l) = 1$$

c: average cost per one product, i: products, f: production function which produces one unit of product.

r: capital price, w: wage, k:capital stocks (per one unit product), l: labor input (per one unit product)

- Demand side:

$$c^U(p_1,p_2) = \min_{d_1,d_2}[p_1 d_1 + p_2 d_2]$$

$$st: u(d_1,d_2) = 1$$

c^U: unit expenditure, u: utility level for consumption (per one unit level of utility),

d_1, d_2: consumption quantity for commodity 1 and 2. p_1, p_2: price of d_1 and d_2, respectively.

- Budget constraint:

$$c^U(p_1,p_2) \cdot u = m$$

m: household income

Dual approach for CGE model building (2)

- market equilibrium condition:

$$q_i = a_i^U u$$

q_i: supply quantity of commodity, a_i^U: Unit compensation demand (Based on the Hicks compensation demand function) and as follows (based on Shepherd's lemma),

$$a_i^C = \frac{\partial c^u(p_1,p_2)}{\partial p_i}$$

- Derived demand for production factors:

$$k = \sum_i a_i^K q_i \quad , \quad l = \sum_i a_i^L q_i$$

a_i^f : Unit derived demand for capital or labor and as follows:

$$a_i^K = \frac{\partial c_i(r,w)}{\partial r} \quad , \quad a_i^L = \frac{\partial c_i(r,w)}{\partial w}$$

Comparison between the conventional approach and dual approach

Conventional approach

$$q_i = f_i(k_i,l_i)$$

$$p_i \frac{\partial f_i(k_i,l_i)}{\partial k_i} = r$$

$$p_i \frac{\partial f_i(k_i,l_i)}{\partial l_i} = w$$

$$m = rk + wl$$

$$k = \sum_i k_i \quad , \quad l = \sum_i l_i$$

$$q_i = d_i^M(p_1,p_2,m)$$

Dual approach (GTAPinGAMS model)

$$c_i(r,w) = p_i$$

$$a_i^K = \frac{\partial c_i(r,w)}{\partial r} \quad , \quad a_i^L = \frac{\partial c_i(r,w)}{\partial w}$$

$$c^U(p_1,p_2)u = m$$

$$a_i^C = \frac{\partial c^U(p_1,p_2)}{\partial p_i}$$

$$m = rk + wl$$

$$k = \sum_i a_i^K q_i \quad , \quad l = \sum_i a_i^L q_i$$

$$q_i = a_i^C u$$

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Outline of GTAPinGAMS CGE model

- For details, please refer to the following paper

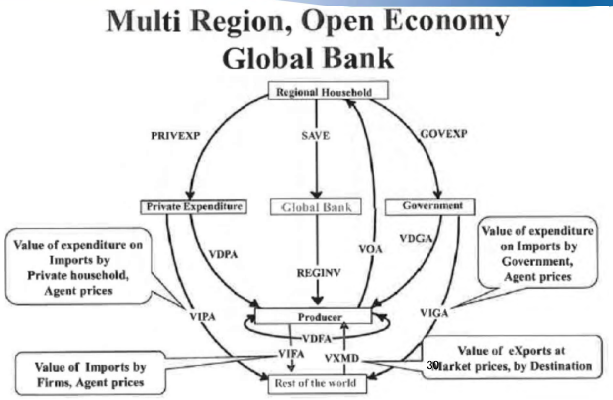
Bruno Lanz, Thomas F. Rutherford (2016) GTAPINGAMS, version 9: Multiregional and small open economy models with alternative demand systems

notation (1)

Table 1: Definitions of set indices

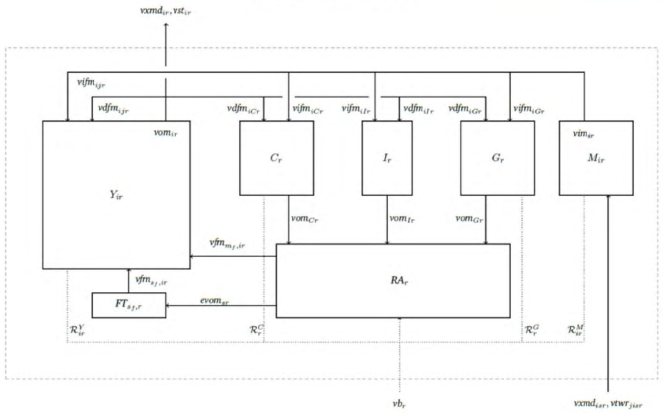
Set	Definition
i, j	Sectors, an aggregation of the 57 sectors in the GTAP 9 database
g	Production sectors i, plus private consumption "C", public demand "G" and investment "I"
r, s	Regions, an aggregation of the 140 regions in the GTAP 9 database
f	Factors of production (consisting of *mobile factors*, $f \in m_f$, four categories of skilled labor (i. officials, mangers and legislators (ISCO-88 Major Groups 1-2), ii. technicians and associated professionals, iii. clerks, and iv. service and market sales workers), unskilled labor, capital, and *sector-specific*, $f \in s_f$, agricultural land and other resources)

Standard GTAP CGE model and GTAPinGAMS model



Macroeconomic structure and related variables

Figure 1: Regional economic structure



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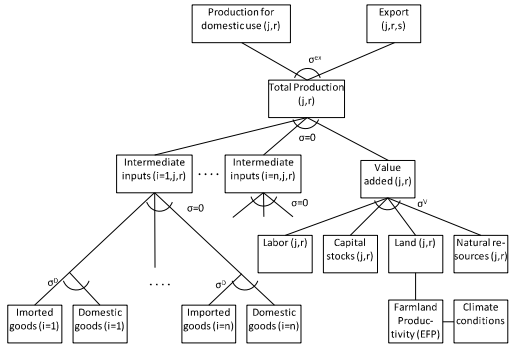
notation (2)

Table 2: Definitions of activity levels (quantity variables)

Variable	Definition	GAMS variable	Benchmark (GTAP) value
Y_{ir}	Production	`Y(i,r)`	`vom(i,r)`
C_r	Discretionary consumption	`Y("c",r)`	`vom("c",r)`
G_r	Aggregate public	`Y("g",r)`	`vom("g",r)`
I_r	Aggregate investment	`Y("i",r)`	`vom("i",r)`
M_{ir}	Aggregate imports	`M(i,r)`	`vim(i,r)`
X_{ir}	Trade flows to or from rest of world regions	`X(i,r)`	`vem(i,r)`
FT_{fr}	Factor transformation	`FT(f,r)`	`evom(f,r)`
YT_j	International transport services	`YT(j)`	`vtw(j)`

Structure of the CGE model

- Production (cost) structure:
  - Production is formulated with a nested CES functions.
  - Total production is obtained by adding intermediate inputs (which were calculated by inputting imported goods and domestic goods) to the added value (which was calculated by inputting the four production factors, i.e. labor, capital, land, and natural resources).
  - Furthermore, domestic production and exports are separated according to domestic and world prices from total production.
  - Imports are a CES–type function that takes Armington's assumption into account, and exports are a CET–type function.



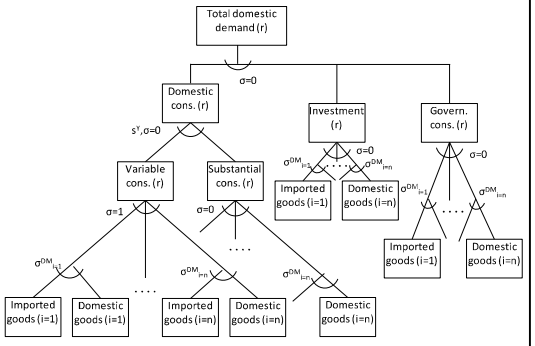
notation (3)

Table 3: Definition of price variables

Variable	Definition	GAMS variable
p_r^C	Final demand price index for the Cobb-Douglas demand system	`P("C",r)`
p_r^G	Public provision price index	`P("G",r)`
p_r^I	Investment price index	`P("I",r)`
p_{ir}^Y	Supply price, gross of indirect producer taxes[8]	`P(i,r)`
p_{ir}^M	Import price, gross of export taxes and tariffs.	`PM(i,r)`
p_{ir}^E	Export price from endogenous or exogenous regions.	`PE(i,r)`
p_j^T	Marginal cost of transport services	`PT(j)`
$p_{f,r}^F$	Factor prices for factors (mobile factors m_f include labor, land and resources)	`PF(f,j)`
$p_{sf,ir}^S$	Price of sector-specific primary factors	`PS(sf,i,j)`

Model structure (consumption side)

- Consumption is formulated with a LES (Linear Expenditure System) type consumption function that separates substantial consumption and variable consumption.
- In the variable consumption part, the Armington function determines the consumption level of each type of goods that combines imported goods and domestic goods.
- After that, the structure is such that the total amount of consumption is calculated by considering the substitutability of each good.
- Demand for investment goods and demand for government consumption are obtained by aggregating integrated goods, which consist of imported goods and domestic goods, using Leontief–type functions.



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notation (4)

Table 4: Additional variables for LES and CDE demand systems

Variable	Definition	GAMS variable
SD_r	Subsistence demand	`Y("sd",r)`
DD_r	Discretionary demand	`Y("dd",r)`
p_r^{DD}	Discretionary demand price index	`P("dd",r)`
p_r^{SD}	Subsistence demand price index	`P("sd",r)`
p_{iCr}^{A}	Armington composite price representing the market price of goods entering CDE demand.	`PA(i,r)`

notation (5)

Table 5: Tax and subsidy rates (net basis unless noted)

Parameter	Definition		GAMS Parameter
t_{ir}^{o}	Output taxes (gross basis)		`rto(i,r)`
t_{fir}^{f}	Factor taxes		`rtf(f,i,r)`
t_{ijr}^{fd}	Intermediate input taxes	Domestic	`rtfd(i,j,r)`
t_{ijr}^{fi}		Imported	`rtfi(i,j,r)`
t_{ir}^{pd}	Consumption taxes[9]	Domestic	`rtfd(i,"C",r)`
t_{ir}^{pi}		Imported	`rtfi(i,"C",r)`
t_{ir}^{gd}	Public demand taxes	Domestic	`rtfd(i,"G",r)`
t_{ir}^{gi}		Imported	`rtfi(i,"G",r)`
t_{ir}^{gd}	Investment demand taxes	Domestic	`rtfd(i,"I",r)`
t_{ir}^{gi}		Imported	`rtfi(i,"I",r)`
t_{isr}^{xs}	Export subsidies		`rtxs(i,s,r)`
t_{isr}^{ms}	Import tariffs		`rtms(i,s,r)`

Model structure (taxes, subsidies)

- The following taxes and subsidies are set to cover the tax systems of each country.
  - production tax,
  - factor tax,
  - intermediate input tax,
  - consumption tax,
  - public sector purchase tax,
  - investment tax,
  - export subsidies,
  - Import tax

Two coding ways are used to describe the model.

- MCP (Mixed Complementarity Problem) format:
  - This is a method of solving the optimization problem under the constraint that the economic variables are not non-negative.
  - The model formulas are derived by the dual approach.
  - When solving the model, we use the solver "PATH".
- MPSGE format:
  - MPSGE is the GAMS solver for CGE models developed by T. Rutherford.
  - This solver can be used to easily describe models in MCP format.
  - When solving the model, we use the solver "MPSGE" in addition to "PATH."
- Please check two kinds of model, i.e. "¥gtap9ingams¥code¥mcp.gms," and "¥gtap9ingams¥code¥mge.gms" by your selves.

Demonstration of the global CGE model

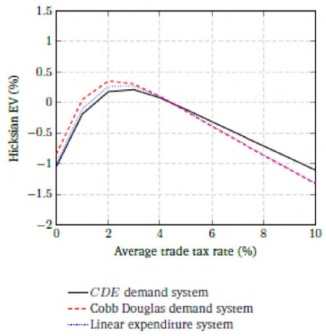
Example of policy simulation (tgrid.gms)

The GAMS programs in the forensics directory provide a template for how to conduct counterfactual policy simulations, using Excel PivotTables and PivotCharts to synthesize model output.

< See how tgrid.gms runs! >

After execution of tgrid.gms, we can get the following results.

Figure 18: Demand System Sensitivity (CHN)



Data check

Run "test.gms" in the build directory to evaluate benchmark consistency of the generated datasets.

< See test.gms file and how it runs! >

- "bmkchk.gms" called in test.gms checks for the modified dataset in both MGE and MCP formats. This routine produces a replication check for the GMR model and all the single region SOE models:
  - MGE: CGE model coded by MPSGE style
  - MCP: CGE model coded by MPC style
  - GMR: Global CGE model
  - SOE: Independent country model

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NARO 農研機構
National Agriculture and Food Research Organization

Impacts of reduction in non-tariff barriers on the export expansion of Japanese agriculture and food industries to Asian countries and their domestic production

Yoji Kunimitsu**
(National Agriculture and Food Research Organization, and Reitaku University)
Mitsuru Okiyama
(Reitaku University)
Suminori Tokunaga
(Reitaku University)

Purposes

- The purposes are;
  - to clarify how changes in trade policy, such as the reduction of tariffs and non-tariff barriers, affect the exports to Asian countries and domestic production of agriculture and food industries.
  - to present policy implications for future Japanese exports of agriculture and food industries, based on the simulation results.

3

Background

- Policy situation in Japan
  - An export target of 5 trillion yen for agriculture and food products by 2030. (Now it is 1.2 trillion yen in 2021)
  - Act on Promotion of Exports of Agriculture and Food products (Enacted in 2020)
    - In order to promote the export of agriculture and food products, Japan discusses with partner countries, mainly in Asia.
    - In order to comply with the food safety regulations of export destination countries, Japan improves the domestic environment.
- Generally, tariff rates in countries around the world are already at low levels and there is little rooms for research, so the future analysis task is to clarify the impact of reducing non-tariff barriers that do not appear in tariff rates (Berden and Francois, 2015; Orefice, 2017)
- Previous studies used CGE models to quantitatively assess the impact of the elimination of non-tariff barriers on international trade (Webb, Strutt, Gibson, Walmsley, 2020; Hosoe, 2018).
- However, there was few previous studies that analyze the impact of non-tariff barriers on the the agriculture and food products between Japan and Asian countries.

2

Features of this study

- Simulation analysis using the Quasi-dynamic global CGE model
- Eight Asian countries with strong ties to Japan are targeted in addition to the United States (USA) and the European Union (XEU), which are major food exporters, using the results of estimation of the ad valorem equivalent rate (ave) of non-tariff barriers.
  - Indonesia (IDN), Cambodia (KHM), Laos (LAO), Malaysia (MYS), Philippines (PHL), Singapore (SGP), Thailand (THA), Vietnam (VNM)
- The effects of elimination of non-tariff barriers and the effects of elimination of tariffs are quantitatively compared.
- In order not to cause the health damage of the people or the destruction of the ecosystem, this study does not assume the reduction of barriers on technical factors, such as food quarantine and tests. However, only the reduction of barriers related to non-technical factors, such as administrative procedures in trade is analyzed.

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Methodology

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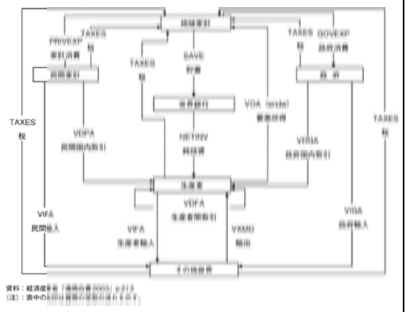
(1) Base model

- Global CGE model developed by Lanz and Rutherford (2016)
  - The production part is a nested CES (Constant-Elasticity-of-Substitution) function.
  - As for intermediate inputs, imports and domestic products are combined under a certain degree of substitutability according to Armington's assumption.
  - The consumption sector is a linear expenditure system (LES) type functionRA (Representative Agent), which integrates the household budget and the government, determines consumption and government expenditure based on total income (household income + tax revenue).
  - Production tax, factor tax, intermediate input tax, consumption tax, public sector purchase tax, investment tax, export subsidies and import tax are taken into account



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(2) Quasi-dynamic CGE model

- The problem in dynamic CGE model
  - In a typical dynamic CGE model, total investment is determined by the level of total savings, but the allocation of investment by industry and region must be set by the modeler.
    - What should we formulate the investment function by industry and by region?
    - A commonly used assumption is an equation that allocates investment in proportion to changes in capital service prices one period ago as;

$$I_{i,r,t} = INV \cdot \left(\frac{PK_{i,r,t-1}}{PK_{i,r,t-1}} \right)^{\eta} \text{ , and } \quad PK_{i,r,t} = \phi \cdot MPK_{i,r,t}$$

    - However, there is a high possibility that the above formula deviates from reality. ・・・・ Econometric analysis gives a poor fit when estimating the above formula.
    - In the first place, even if a company knows the price of its own investment goods (factory construction price), it does not know the service price (demand price) of the capital of the industry as a whole.
  - Under the assumptions above, the capital's growth rate is different from the labor's growth rate. Therefore, the economy will never reach a steady state.
- If the dynamic CGE model is simulated for a long period of time with the above problems, the simulation results will deviate from reality.

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(2) Quasi-dynamic CGE model (cont.)

- Capital stocks in year t at region r ($K_{r,t}$)

$$K_{r,t} = (1-\delta_{r,t})K_{r,t-1} + I_{r,t} = (1-\delta_{r,t}+\alpha_{r,t})K_{r,t-1}$$

  - δ is the rate of replacement of the old capital stock by the newly added investment I.
  - α is the ratio of newly added investment to existing capital stock, and assumed as $\alpha_t = I_t / K_{t-1}$
- In the first place, I must satisfy the macroeconomic constraint (total investment = total saving), and I increases when the economy is good. Therefore, α and δ in the above formula do not become constant values in time series.
- However, we assumed the followings:
  - In years when investment can increase, companies actively replace existing facilities that have not reached the end of their useful life but are slightly older.
  - On the other hand, when sales are declining, new investment becomes difficult, so companies continue to use old facilities without replacing them.
- Then, $(1-\delta+\alpha)$ would grow at a constant rate.

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(2) Quasi-dynamic CGE model (cont.)

- In general, a company's investment strategy is to adjust δ and α to prepare production facilities in line with future demand trends. Therefore, $(1-\delta+\alpha)$ is considered to match the growth rate of product demand (≒capital demand).
- Assuming that the growth rate of demand is proportional to the population growth rate (nt) of each country:

  $(1-\delta_t+\alpha_t)=n_t$: n_t is the growth rate of population in year t.

  $$K_{i,r,t}=(1+n_{r,t})K_{i,r,t-1}=(1+n_{r,t})(1+n_{r,t-1})\cdots(1+n_{r,t_0+1})K_{i,r,t_0}=pop_{r,t}K_{i,r,t_0}$$

  - Here, $pop_{r,t}=(1+n_{r,t})(1+n_{r,t-1})\cdots(1+n_{r,t_0+1})=POPT_{r,t}/POPT_{r,t_0}$
- Labor supply:

  $$L_{i,r,t}=pop_{r,t}\,L_{i,r,t_0}$$
- Farmland and Natural resources:

  $$LND_{i,r,t}=(LAND_{r,t}/LAND_{r,t_0})\,LND_{i,r,t_0}$$

  $$RES_{i,r,t}=RES_{i,r,t_0}$$

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Methodology (3)(Modeling non-tariff barriers)

- Non-tariff barriers are measured by ad valorem equivalent rate (ave), which is calculated by replacing the level of the non-tariff barrier with the tariff rate.
- When non-tariff barriers are eliminated, "ave" of non-tariff barriers assumes to become negative, and the import price (domestic price of imported products) rises.

$$PM_{i,s}=PX_{i,s}\bullet(1-rt^{XS}_{i,s,r})\bullet(1+rt^{MS}_{i,s,r})/(1-ave_{i,s,r})$$

PM: Import price, PX: World price of imported goods (no export subsidies/tariffs, with ave)

rt^{XS}: export subsidy, rt^{MS}: tariff rate

ave: ad valorem equivalent rate of non-tariff barriers

Currently, ave = 0 and 1-ave = 1

A reduction in non-tariff barriers is evaluated as a negative value of ave, and an increase as a positive value.

- For example, if ave is 0.1, the removal of non-tariff barriers (ave=-0.1) will increase PM by 1/(1+0.1)=0.91 times the current level.

(3) Quasi-dynamic CGE model (cont.)

- Characteristics of Quasidynamic World CGE Models
  - The economic level for each year is calculated directly from POPTt/POPTt0 and LANDt/LANDt0.
  - The growth rate of each country's capital stock and labor supply matches the population growth rate of each country (≒increase rate of demand for goods and services). Of course, it is also possible to set the growth rate of capital stock higher than the population growth rate. < Kaldor's (1956) stylized facts.
  - Even large-scale models can independently simulate economic conditions 100 years into the future.
    - For example, when predicting the economic situation in 2100 due to future climate change, if you directly enter the results of 2100 population predictions and agricultural land predictions, you will get an answer with calculations for only a single year.
  - Simulations that go back in time are also possible.

- See below for details
  - Kunimitsu, Y. & Iizumi, T. (2022.10) Reproducibility of forecasting agricultural price fluctuations several months ahead of the harvest time, JARQ, 56(4), in printing

10

(2)Modeling non-tariff barriers

- Once the non-tariff barriers are eliminated, there is no need to pay the costs associated with the various procedures related to the non-tariff barriers. This finally results in a decrease in incomes of regional representative agent (household and government).
- In addition, tariff revenue (RA_RTM) will decrease as the price of imported goods will decrease.

$$RA\_NTB=XMD_{i,s,r}\{ave_{i,s,r}/(1-ave_{i,s,r})(1+rt^{MS}_{i,s,r})\}\{(1-rt^{XS}_{i,s,r})vxmd_{i,s,r}\cdot PX_{i,s}+\sum_j(PT_j\cdot vtwr_{j,i,s,r})\} \quad (2)$$

$$RA\_RTM=XMD_{i,s,r}\{rt^{MS}_{i,s,r}/(1-ave_{i,s,r})\}\{(1-rt^{XS}_{i,s,r})vxmd_{i,s,r}\cdot PX_{i,s}+\sum_j(PT_j\cdot vtwr_{j,i,s,r})\} \quad (3)$$

- XMD: Import volume (value normalized to 1.0 for 2011)
- vxmd: value of imports, vtwr: value of production of transport services, price of PT transport services
- ave/(1-ave) is the difference between non-tariff barriers after the change in ave (1/(1-ave)) and before the change (1)
  - If ave is 0, the right side of equation (2) is 0, the first brace on the right side of equation (3) is rt^{MS}, and RA_TMS is only tariff revenue.

Data

- Base data: GTAP ver10 (year 2014)
- Original 65 sectors were merged into 25 industrial sectors
- Original 141 countries/regions were merged into 29 countries/regions

Table-1 Industrial sectors of the world CGE model

No	Identifier	Contents	No	Identifier	Contents
1	pdr	Paddy rice	14	oxt	Resource & Energy
2	wht	Wheat	15	cmt	Bovine meat products
3	gro	Other cereal grains (including maize)	16	omt	Other meat products
4	v_f	Vegeables, fruits & nuts	17	vol	Vegetable oils & fats
5	osd	Oil seeds	18	mil	Dairy products
6	c_b	Sugar cane & Sugar beet	19	pcr	Processed rice
7	pfb	Plant-based fibers	20	sgr	Sugar
8	ocr	Other crops	21	ofd	Other food products
9	ctl	Bovine cattle, sheep, goats & horses	22	b_t	Beverages & tobacco
10	oap	Other animal products	23	man	Manufacturing
11	rmk	Raw milk	24	sev	Service
12	frw	Forestry & Wool silk	25	trp	Transportation
13	fsh	Fishing			

(Note) 21 industries from 1 to 13 and 15 to 22 are classified as"agriculture and food industries."

Table-2 Countries/Regions classified in the global CGE Model

No	Identifier	Countries/Regions	No	Identifier	Countries/Regions
1	BGD	Bangladesh	16	THA*	Thailand
2	BRN*	Brunei Darussalam	17	TWN	Taiwan
3	CHN	China	18	USA*	United States of America
4	IDN*	Indonesia	19	VNM*	Viet Nam
5	IND	India	20	XAF	Africa
6	JPN*	Japan	21	XAS	Rest of ASIA South
7	KHM*	Cambodia	22	XCA	Central America
8	KOR	Korea Republic of	23	XER	Rest of Europe
9	LAO*	Lao People's Democratic Republic	24	XEU*	European Free Trade Association
10	MNG	Mongolia	25	XME	Middle East
11	MYS*	Malaysia	26	XNA	Rest of North America
12	PAK	Pakistan	27	XOC	Oceania
13	PHL*	Philippines	28	XSA	South America
14	RUS	Russian Federation	29	XTW	Rest of the World
15	SGP*	Singapore			

(Note) Countries/regions with "*" are those for which initial shocks were set in the simulation (World Bank (2019) estimated and published the AVE values).

Simulation method by scenarios

- The targeted trading partners were Asian countries with deep food trade ties with Japan, i.e. Indonesia (IDN), Cambodia (KHM), Laos (LAO), Malaysia (MYS), Philippines (PHL), Singapore (SGP), Thailand (THA), and Vietnam (VNM).
- In addition to these Asian countries, the United States of America (USA) and the European Union (XEU) were included for comparison, for a total of 10 countries/regions.
- Of the 20 items in the agriculture and food industries, 17 items were selected, excluding wheat (wht), sugar cane and sugar beets (c_b), and raw milk (rmk), for which the World Bank's estimation results were not available.
- Elimination of non-tariff barriers targets only "non-technical factors" other than technical factors such as food quarantine, and does not take into consideration the impact of health damage (insurance and sanitary assumed zero risk).

Simulation method by scenarios (cont.)

- Case 0 (BAU, Business as usual case) (reference case):
  The initial level of each country's economic variables were set as the same level represented by the GTAP database, and population glowed based on the United Nation's estimate.
- Case 1 (NTB_UNI):
  Only the partner country removed non-tariff barriers (non-technical factors) in the agriculture and food industries on imports from Japan (ave of NTB in partner countries/regions = 0).
- Case 2 (NTB_BI):
  Elimination of non-tariff barriers (non-technical factors) in the agriculture and food industries in Japan and partner countries (ave of NTB in Japan and partner countries/regions =0).
- Case 3 (RTMS_NTB_BI):
  Elimination of tariffs and non-tariff barriers (non-technical factors) in the agriculture and food industries in Japan and partner countries. However, with regard to rice (pdr and pcr), considering the current situation of Japanese agricultural policy, it was assumed that tariff rates remained the same and that only non-tariff barriers (non-technical factors) were eliminated.

- Effects of the policy change were measured by subtracting Case 0 value from each case values.

Results

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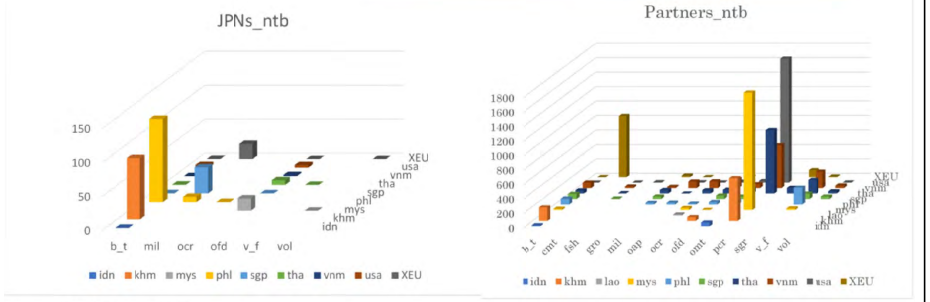
Setting status of non-tariff barriers (ave) in each country



(source) World Bank (2017).

Fig. 1 ave (%) set by Japan for imports from partner countries

(source) World Bank (2017).

Fig. 2 ave (%) set by the partner countr ies for Japan's exports

- The level of NTB is higher in partner countries than in Japan.
- Both Japan and the partner country have relatively high NTB in processed rice (pcr).

Changes in Domestic Production in the Agri-Food Industries

VADD	(Each case value - Case 0 value)						(100 million yen)	
	mys	sgp	tha	vnm	usa	XEU	Asia total	inc. ratio
Case 1 (NTB_UNI)								
Jpan	17.6	7.6	15.9	29.9	59.5	73.2	75.4	(0.09%)
Partner	-6.1	0.1	-9.8	-12.3	-9.6	-62.8	-34.0	(-0.01%)
JPN's 1st	pdr	ofd	ofd	ofd	pdr	cmt	ofd	
JPN's 2nd	pcr	v_f	v_f	ocr	pcr	ctl	pdr	
JPN's 3rd	rmk	fsh	pdr	fsh	ofd	ofd	v_f	
Case 2 (NTB_BI)								
Jpan	12.4	-8.6	3.0	27.8	45.8	48.3	38.3	(0.04%)
Partner	-1.1	8.9	5.4	-9.2	-0.8	-44.0	-1.5	(-0.00%)
JPN's 1st	pdr	ofd	v_f	ofd	pdr	cmt	pdr	
JPN's 2nd	pcr	v_f	pdr	ocr	pcr	ctl	v_f	
JPN's 3rd	rmk	fsh	oap	fsh	rmk	ofd	ofd	
Case 3 (RTMS_NTB_BI)								
Jpan	-4.7	-391.2	-291.9	37.0	-3,658.4	-3,709.3	-711.7	(-0.81%)
Partner	17.4	304.2	536.2	18.8	5,170.7	5,858.8	919.3	(0.31%)
JPN's 1st	pdr	wht	cmt	fsh	osd	cmt	cmt	
JPN's 2nd	b_t	pfb	mil	ofd	pcr	ctl	ctl	
JPN's 3rd	pcr	osd	b_t	ocr	pfb	osd	ocr	

- The domestic production of Japan's agriculture and food industries increased from 3.8 billion yen to 7.5 billion yen, equivalent to 0.04% to 0.09% of total domestic production.
- The domestic production in the partner country became negative in many cases, because the degree of non-tariff barriers in Japan was smaller than that of the partner country.
- When the tariff rates were eliminated on both Japan and partners, Japan's imports greatly exceeded exports, causing negative impacts on Japan's domestic production.

Exports of Japanese agriculture and food industries

X	(Each case value - Case 0 value)						(100 million yen)	
	mys	sgp	tha	vnm	usa	XEU	Asia total	inc. ratio
Case 1 (NTB_UNI)								
Jpan	25.0	17.4	34.9	59.5	80.7	135.1	144.7	(13.8%)
Partner	10.7	3.4	18.7	14.6	0.6	-34.6	48.5	(0.5%)
JPN's 1st	pcr	ofd	ofd	ofd	pcr	cmt	ofd	
JPN's 2nd	b_t	v_f	v_f	ocr	ofd	sgr	pcr	
JPN's 3rd	ofd	b_t	pcr	fsh	vol	mil	ocr	
Case 2 (NTB_BI)								
Jpan	25.0	17.6	35.0	59.6	80.6	135.3	145.0	(13.8%)
Partner	21.9	41.0	45.9	19.2	23.5	6.2	130.2	(1.2%)
JPN's 1st	pcr	ofd	ofd	ofd	pcr	cmt	ofd	
JPN's 2nd	b_t	v_f	v_f	ocr	ofd	sgr	pcr	
JPN's 3rd	ofd	b_t	pcr	fsh	vol	mil	ocr	
Case 3 (RTMS_NTB_BI)								
Jpan	43.1	21.1	59.6	144.6	226.5	1,017.7	364.8	(34.8%)
Partner	69.0	1,241.7	714.2	97.2	9,498.7	11,763.5	2,276.4	(21.7%)
JPN's 1st	pcr	ofd	ofd	ofd	ofd	cmt	ofd	
JPN's 2nd	b_t	v_f	v_f	ocr	pcr	ofd	cmt	
JPN's 3rd	fsh	fsh	b_t	fsh	v_f	fsh	b_t	

- In Case 1, Japan's exports to Asian countries by approximately 14.5 billion yen (13.8% of Japan's exports).
- Thailand and Vietnam are partners with which Japan's exports have increased significantly.
- Processed foods, such as ofd (other foods) and cmt (beef products), and pcr (polished rice) as well as fsh (fresh fish) marked high increase.
- Japan's export increases at the same level in the case of only partner's elimination (NTB_UNI) and mutual elimination (NTB_BI) cases.
- The trade impediment effect of non-tariff barriers (non-technical factors) was equivalent to 40% of the impediment effect of tariff rates.
- Overall, it falls short of the national target of 5 trillion yen.

Concluding remarks and policy implications

- The elimination of non-tariff barriers increase Japan's agriculture and food exports to eight Asian countries by about 13.8% and about 14.5 billion yen.
- When choosing Asian countries as partner countries, even if Japan and partner country mutually eliminated non-tariff barierres, the increase in exports from Japan was greater than the increase in exports from partner countries, resulting in a net increase in exports.
- The trade impediment effect of non-tariff barriers (non-technical factors) on exports was equivalent to 40% of the total impediment effect of tariff and non-tariff barriers. However, the net effect of tariff elimination on domestic production was negative, as imports from partner countries significantly increase.
- Thailand and Vietnam are among the most effective partner countries in Asia to change trade policy. In addition to these countries, changes in trade policies with the United States and the EU also have a high possibility of expanding exports in agriculture and food industries.

Concluding remarks and policy implications (2)

- Overall, elimination policy of non-tariff barriers can contribute to Japan's food security, but the increase in exports is not so large, and far smaller than Japan's policy target, 5 trillion yen, for agriculture and food exports.
- Therefore, in addition to policy efforts to advance trade negotiations with partner countries, policies that support the cost of certification and administrative procedures of trade are also effective measures to reduce non-tariff barriers.

- Remained subjects are;
  - to estimate AVE value of non-trade barriers including China and Taiwan, and simulate trade policy changes
  - to review the analysis according to the update of GTAP data.
    - This simulation does not reflect the expansion of new export sales channels for agriculture and food industries from Japan, which has increased rapidly since 2014.
  - to use a conventional recursive dynamic model.

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ご静聴ありがとうございました！

2023/2/3

Regional aggregation biases and their mitigation method for the global computable general equilibrium model

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Visiting Researcher in Reitaku University

Background and motivation

- Many economic simulations are leveraging an economic model that is scaled down by aggregating multiple countries due to computational issues, such as solution time, memory requirements, and numerical stability, despite the evolution of databases.
- For example, in the field of evaluations on future climate change and trade liberalization, previous studies used the GTAP database which consist of more than 100 countries / regions, but they aggregated countries / regions and simulated future situations by the small-scale model with about 20 regions.
- It has been pointed out that the simulation results of major economic indexes, such as changes in trade and social welfare levels, depend on the aggregation level selected (Britz and Mensbrugghe, 2016). That is, the information of the available database resolutions may not be fully utilized in global economic models like the Computable General Equilibrium (CGE) model and the econometric model.
- Having said so, when it is difficult to obtain the result of a full-scale model it is difficult to quantify the regional aggregation biases. Recently, several simulation methods using large-scale model have been proposed (Britz and Mensbrugghe, 2016; Kompas and Ha, 2019).

Background and motivation (cont.)

- Factors of occurrence in regional aggregation biases (Britz and Mensbrugghe, 2016).
  1. **The initial shocks assumed in individual countries are averaged by regional aggregation.**
  2. **Regional aggregation simplifies the trade structure between countries and regions.**
  3. **The economic structure or cost components in the aggregated region is averaged from the countries concerned.**
  4. **Trade between countries within the aggregated regions disappears with the aggregation.**
- Nevertheless, if the regional aggregation bias due to these factors occurs systematically under certain rules, it would be possible to deal with the problem. The problem may not be so great if the simulation results are interpreted with the underestimation in mind.
- On the other hand, if the regional aggregation bias makes simulation results too big or too small depending on the country, the reliability of the evaluation results will be greatly impaired.

The purpose and features of this study

- The purpose is
  - to quantify the regional aggregation biases that occur in the simulation of the global CGE model for measuring induced effects of initial shocks.
  - Specifically, we target the crop yield fluctuations under future climate change and policy measures for trade liberalization as the initial shocks
- The features are:
  - The large-scale global CGE model consisting of 140 countries, which is rarely addressed in existing studies, is used as a reference, when assessing the impact of each country using GTAP's global economic database.
  - We build the global CGE models by changing the degree of regional aggregation in order to clarify the relationship between regional aggregation level and aggregation biases.
  - We compare the results between future climate change impacts and global trade liberalization measures, which have been evaluated by the CGE model in many previous studies without consideration of regional aggregation biases.

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Method

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Analytical scheme

- Initial shocks
  - Climate change impacts
    - Yield forecasts for major agricultural products (rice, wheat, corn, soybeans) calculated from the crop model using 2099 GCM climate forecast.
  - Trade liberalization measures
    - the implementation of a free trade policy that sets the import tariff rate on all goods to zero in all countries worldwide.
- Simulation results of global CGE models with different degree of regional aggregation (small-scale model, SSM; medium-scale model, MSM; and half-scale model, HSM) are compared to the large-scale CGE model (LSM) with less aggregated regions from GTAP database.
  - aggregation degree: SSM > MSM > HSM > LSM (≒Full-scale model)
- Simulation results of each country / region are aggregated after the simulation to adjust the target regions for comparison.
  - For example, simulated effects of 140 countries from LSM were merged into 19 regions to compare with SSM's results.

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Analytical scheme (2)

- Indexes for simulated effects
  - The change rate of each variable in agriculture and food sectors (Total output, Y_agf; Price, P_agf; Exports, X_agf)

$$\triangle V_r\,(\%) = (V_{r,2099} / V_{r,2014} - 1) \times 100$$

  - The change rate of social welfare level (equivalent variation per GDP, EV/GDP)

$$\triangle EV/GDP\,(\%) = EV_{2099} / GDP_{2014} \times 100$$

- Indexes for regional aggregation bias (RAB1 and RAB2)

$$RAB1_r\,(\%) = \triangle V_{r,m} - \triangle V_{r,LSM} \quad (m \in \textit{SSM, MSM and HSM})$$

$$RAB2_r\,(\%) = \triangle EV/GDP_{r,m} - \triangle EV/GDP_{r,LSM} \quad (m \in \textit{SSM, MSM and HSM})$$

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Analytical scheme (3)

- Indexes for the degree of aggregation biases against simulated effects as:

$$\text{ratio of bias}\ (\%) = \frac{\sqrt{1/n\sum_{r=1}^{n}(RAB1_{r,m})^2}}{\sqrt{1/n\sum_{r=1}^{n}(\triangle V_{r,m})^2}} \quad \text{or} \quad \frac{\sqrt{1/n\sum_{r=1}^{n}(RAB2_{r,m})^2}}{\sqrt{1/n\sum_{r=1}^{n}(\triangle EV/GDP_{r,m})^2}}$$

  - Above ratio of bias means the degree of bias against simulated effects. The numerator of the right hand side of equation is the root mean square (RMS) of biases and denominator is RMS of the simulated effects.
  - The calculation results have positive and negative signs for both the induced effect and regional aggregation biases in each country, but the deviation from 0 is important regardless of the sign.

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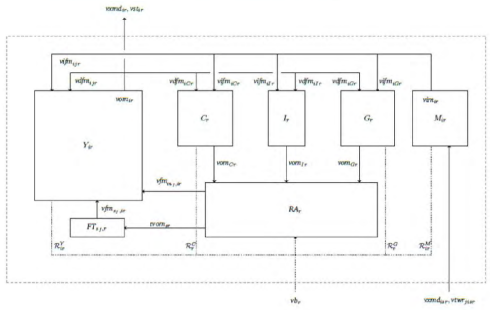
Global CGE model

- We used the global CGE model developed by Lanz and Rutherford (2016)
- Features of their model
  - The production part is formulated by the nested constant elasticity of substitution (CES) function
  - The intermediate inputs are composed of the imported and domestic goods under a certain degree of substitutability according to Armington's assumption
  - The consumption sector is defined by a linear expenditure system (LES)-type function
  - The investment and government consumption are represented by a Leontief-type fixed-rate demand function
  - The closure of the model is the same as the GTAP CGE model.



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Regional aggregation in the global CGE model

Categories	Independent countries / regions	Aggregated regions
Small scale model (SSM)		
G0	bra, can, chn, ind, jpn, tur, usa, cmr, xtw	x_af, x_ea, x_er, x_eu, x_lm, x_me, x_nf, x_oc, x_sa, x_su
Medium scale model 1 (MSM 1): Grouping by geographical proximity		
G01	Asia & Oceania (27 countries/regions)	z_af, z_ea, z_er, z_eu, z_lm, z_me, z_nf, z_su
G02	EU25 & Other EU (32 countries/regions)	z_af, z_ea, z_lm, z_me, z_nf, z_oc, z_sa, z_su
G03	Former Soviet & Middle East (24 countries/regions)	z_af, z_ea, z_er, z_eu, z_lm, z_nf, z_oc, z_sa
G04	North, Central & South America (28 countries/regions)	z_af, z_ea, z_er, z_eu, z_me, z_nf, z_oc, z_sa, z_su
G05	Africa (33 countries/regions)	z_ea, z_er, z_eu, z_lm, z_me, z_oc, z_sa, z_su
Medium scale model 2 (MSM 2): Randamlly selected		
G11	Randamlly selected (29 countries/ regions)	z_af, z_ea, z_er, z_eu, z_lm, z_me, z_nf, z_oc, z_sa, z_su
G12	Randamlly selected (29 countries/ regions)	z_af, z_ea, z_er, z_eu, z_lm, z_me, z_nf, z_oc, z_sa, z_su
G13	Randamlly selected (28 countries/ regions)	z_af, z_ea, z_er, z_eu, z_lm, z_me, z_nf, z_oc, z_sa, z_su
G14	Randamlly selected (29 countries/ regions)	z_af, z_ea, z_er, z_eu, z_lm, z_me, z_nf, z_oc, z_sa, z_su
G15	Randamlly selected (29 countries/ regions)	z_af, z_ea, z_er, z_eu, z_lm, z_me, z_nf, z_oc, z_sa, z_su
Half scale model 1 (HSM 1)		
G101	Oceania, Asia, America and Middle-east (68 countries/regions)	z_af, z_er, z_eu, z_su
G102	Europe and Africa (73 countries/regions)	z_ea, z_lm, z_me, z_nf, z_oc, z_sa
Half scale model 2 (HSM2)		
G111	Oceania, Asia, Middle-east and Africa (69 countries/regions)	z_er, z_eu, z_lm, z_su
G112	America, Europe (72 countries/regions)	z_af, z_ea, z_me, z_nf, z_oc, z_sa
Large scale model (LSM)		
	GTAP 140 countries / regions, but Czech Republic (cze) and Slovakia (svk) were marged into Czech-Slovakia (czs)	

Within the same group, there is no country overlap. However, each group includes one of the 140 countries once.

Results for regions marked with "z_" are not used when assessing bias.

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CGE model (2)

- Global CGE models with different aggregation degree
  - Small-scale model (SSM) : **9 non-aggregated countries + 10 aggregated regions**
    - Following to Asia-pacific Integrated Model (AIM) used in Fujimori et al. (2019)
  - Medium-scale regional expansion model (MSM 1) : **about 27 non-aggregated countries + 10 aggregated regions**
    - This model is expanded SSM's aggregated regions to the original GTAP individual countries for each continent.
    - 5 sub-models (G01-G05 models) were composed by changing the selection of non-aggregated countries for each continent.
  - Medium-scale randomly selected model (MSM 2)
    - Targeted individual countries were selected randomly.
    - 5 sub-models (G11-G15 models)
  - Half-scale model (HSM1, HSM2) : **about 70 non-aggregated countries + 5 aggregated regions**
  - Large-scale model (LSM), for use as a reference : **140 countries / regions**
    - The countries of the GTAP database are less aggregated as much as possible (140 countries)
- Data base: GTAP 10 (year 2014)
  - Czech Republic (cze) and Slovakia (svk) were merged into Czech-Slovakia (czs)

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Sectors in the global CGE model

No	Ident.	Products	No	Ident.	Products
1	pdr *	Paddy rice	17	mil *	Dairy products
2	wht *	Wheat	18	pcr *	Processed rice
3	gro *	Cereal grains etc.	19	sgr *	Sugar
4	v_f *	Vegetables fruit nuts	20	ofd *	Other food products
5	osd *	Oil seeds	21	b_t *	Beverages & tobacco
6	c_b *	Sugar cane sugar beet	22	tex	Textiles, Apparel & Leather
7	ocr *	Other crops	23	lum	Wood products
8	ctl *	Bovine cattle, sheep, goats, horses	24	ppp	Paper products & Publishing
9	oap *	Other livestock	25	chm	Chemical products
10	rmk *	Raw milk	26	i_s	Ferrous metals
11	frs	Forestry, Wool, Silk-worm	27	nfm	Other metals
12	fsh *	Fisheries	28	omf	Other manufactures
13	oxt	Resource & Energy	29	cns	Construction
14	cmt *	Bovine meat products	30	trd	Trade, Accommodation & Food services
15	omt *	Other meat products	31	otp	Transportation
16	vol *	Vegetable oils and fats	32	sev	Other servicies

note: Sectors marked with "*" represent agriculture and food industry.

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Initial shocks and how to simulate

- Climate change impacts
  - Yield forecasts (rice, wheat, corn, soybeans) of the crop model, pDSSAT (Elliott et al., 2015), based on GCM's climate forecasts according to the RCP8.5 scenario that corresponds to the highest CO_2 concentration among scenarios.
  - Simulation (according to Szewczyk et al., 2020)

$$TFP_{i,r,t} = yield_{i,r,2099} / yield_{i,r,2014} \quad (i \in pdr, wht, gro, osd)$$

$$c_{i,r,t} = \left(\sum_f \theta_{f,i,r} \cdot pf_{f,r,t}^{(1-\eta_i)} \right)^{1/(1-\eta_i)} / TFP_{i,r,t}$$

TFP: total factor productivity. *yield*: crop yield forecasts by the crop model

c: average cost of each industry. θ: cost share of input factors

pf: factor price. η: substitution elasticity among input factors

- Trade liberalization measures
  - Implementation of a free trade policy that sets the import tariff rate on all goods to zero in all countries worldwide.

$rt^m_s = 0$ *(for all m and all s)*

rt^m_s: import tariff rate of imported goods, m, at region, s.

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Results

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Closure and software

- Exogenous variables
  - Labor supply, capital supply, farmland supply and natural resources were all fixed until 2099 in order to see the pure effects of initial shocks (climate change and trade liberalization)
- To solve the model, we employ filtering method proposed by Britz and Mensbrugghe (2016)
- Computation

GAMS ver. 39.3 (using solvers of MPSGE and PATH3) under Windows 10

CPU: 11th Gen Intel(R) Core(TM) i7-1185G7 @ 3.00GHz

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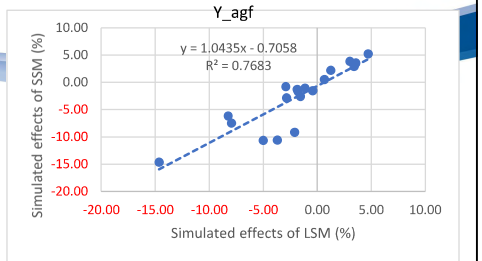
Regional aggregation bias in climate change impacts

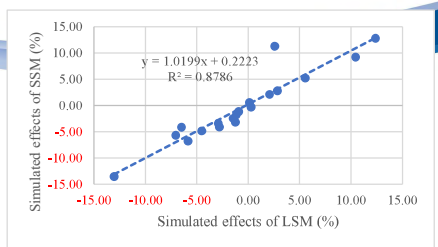
- Regional aggregation bias occurred not only in aggregated regions, but also in non-aggregated countries.
- The ratio of biases corresponded to 45% of simulated effects of SSM.
- There were 1 country (price) and 4 countries (exports) where the fluctuation directions in SSM and LSM were opposite (5th row).
- There were some countries where simulated effects were out-range of from sensitivity analysis (SA) of SSM (6th row).
- The regional aggregation bias of X_agf was larger than other variables.



Items	Simulated effects of LSM	Simulated effects of SSM	Biases (SSM-LSM)	Different direction	Out of SA range
Y_agf					
RMS / no. of "x"	4.99	6.12	2.75	0	12
Ratio of bias (%)			(45%)	(0%)	(63.2%)
P_agf					
RMS / num. of "x"	14.0	14.9	2.6	1	14
Ratio of bias (%)			(17.7%)	(5.3%)	(73.7%)
X_agf					
RMS / num. of "x"	10.9	10.4	4.0	4	17
Ratio of bias (%)			(38%)	(21.1%)	(89.5%)
EV/GDP					
RMS / num. of "x"	1.6	1.5	0.7	0	15
Ratio of bias (%)			(44.7%)	(0%)	(78.9%)

Regional aggregation bias in trade liberalization measures

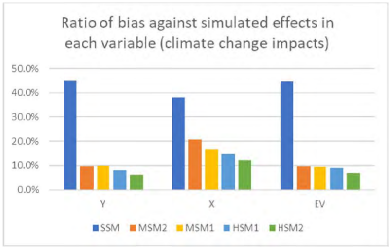
- Although simulated effects and biases were a bit larger than climate change impacts, the same tendency was found as climate change impacts.

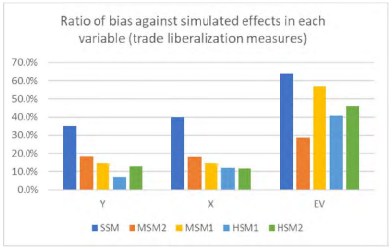


	Items	Simulated effects of LSM	Simulated effects of SSM	Biases (SSM-LSM)	Different direction	Out of SA range
Y_agf						
	RMS / no. of "x"	5.9	6.3	2.2	1	9
	Ratio of bias (%)			(35%)	(5.3%)	(47.4%)
P_agf						
	RMS / num. of "x"	3.6	3.7	1.2	0	10
	Ratio of bias (%)			(32.3%)	(0%)	(52.6%)
X_agf						
	RMS / num. of "x"	19.7	23.3	9.3	0	5
	Ratio of bias (%)			(40%)	(0%)	(26.3%)
EV/GDP						
	RMS / num. of "x"	0.6	0.5	0.3	1	12
	Ratio of bias (%)			(63.8%)	(5.3%)	(63.2%)

Regional aggregation bias and the aggregation degree of the global CGE model

- The following figures show RMS of biases by CGE models with different regional aggregation.





(note) SSM (small scale model), MSM2 (medium scale model with randomly selected) MSM 1 (MSM with expanded by continents, HSM (half scale model)

- The lower level of regional aggregation (as move from SSM to MSM1, MSM2, HSM1 and HSM2) brought about the lower degree of regional aggregation biases.

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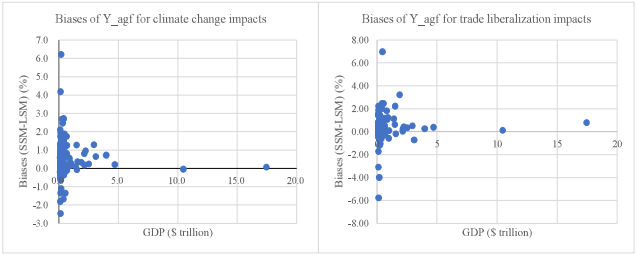
Where does the regional aggregation bias occur?

- The following figures show the relationship between the economic scale (GDP) and aggregation biases of each of the 140 countries as a scatter plot.
- The biases were obtained from the comparison of the simulation results of 2099 by MSM 1 and LSM.
- For MSM1's results, the simulated effects of non-aggregated countries from sub-model G01 to G05 were gathered.



- Low GDP countries tended have larger biases with positive and negative signs. This is because exports showed large regional aggregation biases and occurred parallelly, but the original export values were small in countries with small economies.

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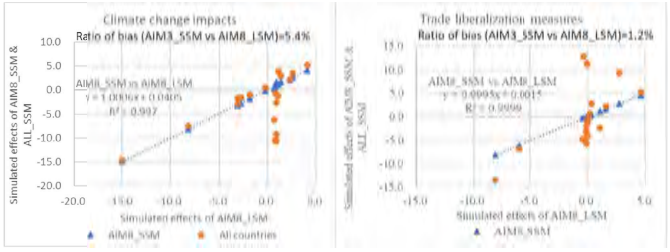
The case of the initial shocks only in non-aggregated countries

- The following figures show the effects of Y_agf by the shocks only in AIM's 8 countries (i.e. chn, jpn, ind, can, usa, bra, tur and cmr), which were treated as an non-aggregated country in the model. In this case, whether crop yields or tariff rates, the initial shocks of other regions were ignored.



- The round dots deviated for both cases, showing simulated effects from impacts of limited countries were different from those from impacts of whole world. The difference between these two cases was initial shocks in other regions other than AIM's 8 countries and trade between non-aggregated countries and other countries.
- Very small regional aggregation biases were shown by the relation line between SSM and LSM in 19 countries / regions in the case of only impacts in AIM 8 regions.

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Summary, conclusion and implications

- Regional aggregation bias accounted for more than 45% of the simulation results of global CGE model and reversed the direction of impact assessments in some countries.
- Regional aggregation bias tended to be higher in foreign trade variables and extended to domestic production. Especially in smaller economies, aggregation bias resulted in over- or under-evaluation.
- The lower the level of regional aggregation, the smaller the bias that occurred by the CGE model.
- In simulations that apply initial shocks only to specific countries, such as FTA impact assessments, aggregation bias is unlikely to occur even if a global CGE model that aggregates countries other than specific countries is applied.
- Therefore, regional integration bias cannot be ignored in studies such as climate change assessments and worldwide trade liberalization measures. In order to avoid bias occurrence, it is desirable to use a large-scale model that can fully utilize the information of the original global Social Accounting Matrix data.

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Summary, conclusion and implications (cont.)

- The remaining issues are;
- to clarify the aggregation bias regarding sector aggregation.
- In this study, the filtering method proposed by Britz and Mensbrugghe (2016) was applied for the numerical analysis of large-scale models, but it is worth trying other methods. For example, by applying the method proposed by Kompas et al. (2019) or other nonlinear simultaneous equation systems such as GEMPAC (Horridge, 2006), it will be possible to identify more detailed regional aggregation biases.
- Although this paper proposed the use of medium-scale models and half-scale models consisting of multiple subgroups as a useful second-best method, there is some rooms for further research on how to create subgroups. If it is possible to clarify the criteria by which subgroups can be created to reduce the regional aggregation bias, it may not be necessary to apply a large-scale model that requires a huge amount of calculation time.

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Thank you for your attention!

Any questions and comments are welcome.

- This study is supported by JSPS's Kakenhi (20K06269, 21H02294).

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Credibility check for LSM

- This analysis was based on the assumption that the LSM results did not include errors. Of course, the result of LSM was "feasible solution" which showed the convergence error of 1 × 10-8 or less in the numerical analysis of the model, but the error might have concentrated to the country with small value of the variable in the process of convergence iteration.
- To clarify this point, the LSM simulation results were replaced with the MSM1's simulation results.
- We found that the difference between the SSM's and MSM's simulation results was almost the same as the difference between the SSM's and LSM's results shown in this slide. Hence, the regional aggregation biases are not due to LSM's estimations.

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Credibility check for LSM (2)

- In addition, since the regional aggregation bias arises through exports, trade flexibility may be related to the magnitude of the bias. To confirm this point, we increased the elasticity of substitution for trade in the LSM by 0.7 and 1.3 times and checked changes in the regional aggregation bias.

- As a result, the RMS of the original regional aggregation bias in Y_agf (=2.75) decreased slightly to 2.40 when the elasticity of substitution was 0.7 times, and increased slightly to 2.96 when that was 1.3 times. However, since these changes were not large, it cannot be said that the occurrence of regional aggregation bias is significantly related to the flexibility of international trade.

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Toward Evidence-based Policy Making
--- Economic modeling and Data ---

Date and Time: **9:00 – 12:00, March 24 (Fri)**, 2023
Venue: **Ministry of Economy and Development, 3rd floor**
Participants: Staff of MED, MOF, BOM, ERI
Working Language: Mongolian (Translation Japanese-Mongolian if necessary)
Moderator: Mr. L. Enkh-Amgalan, Director General, Macroeconomic Policy Dep., MED

1. Inauguration
   Mr. L. Enkh-Amgalan/Mr. Yamashita 9:10 ~ 9:15
   Mr. B.Dashpurev, Acting State Secretary, MED 9:00 ~ 9:05
2. Economic Modeling Analysis in Mongolia
   Dr.G.Ragchaasuren, ERI/WB 9:15~ 9:35

✤ Remarks by Mr. B.Dashpurev, Acting State Secretary, MED

Q&A – Discussion 9:40 ~ 10:05

3. CGE model and trial policy simulations
   3-1.Static and Dynamic CGE model based on SAM2018 --- Ms. G.Nyamtsetseg, MED
   3-2.Public Sector Productivity --- Ms. G.Nyamtsetseg, MED 10:05 ~10:25

ꝏ ꝏ ꝏ Cofee Break ꝏ ꝏ ꝏ 10:25 ~ 10:40

   3-3.Child Money Program to Household ---Ms.J.Ulziisaikhan, MED
   Mr. B.Bodi-Ragchaa, MOF 10:40 ~11:00
   3-4.Impact of excessive expansionary fiscal policy:
   Reflection on 10 years of
   Fiscal Stability Law --- Mr.Nyambaatar Batbayar, ERI 11:00 ~ 11:25
   Q&A 11:25 ~ 11:40
4. Data for modeling works
   4-1.Compilation of Supply and Use Table and IO /Q&A 11:40 ~ 12:35~
   Ms.B.Bayamaa, Head of the National Accounts Division, NSO
   4-2. Compilation of Household Survey /Q&A 12:35 ~ 12:55
   Ms. M.Oyuntsetseg , Head of Household-based Research Division, NSO
   4-3. Compilation of Labor Force Survey /Q&A 12:55 ~ 13:40
   Ms. E. Gantuya, Chief Statistician,NSO
5. Clausing Remark 13:40 ~ 13:50
   Mr. L. Enkh-Amgalan, DG, MED/ Mr. M.Yamashita

CGE ЗАГВАРЫН ХЭРЭГЛЭЭ

Др. Г. Рагчаасүрэн
(Дэлхийн банк)

2023.03.24

CGE загварын хэрэглээ

- ✓ Төсвийн бодлого
- ✓ Олон улсын худалдаа
- ✓ Гадаадын хөрөнгө оруулалт
- ✓ Салбарын бодлого
- ✓ Байгалийн гамшиг
- ✓ Уур амьсгалын өөрчлөлт
- ✓ Том төслүүдийн нөлөө
- ✓ Гаднаас ирэх шилжих төлбөрийн нөлөө
- ✓ Гол нэрийн бүтээгдэхүүний дэлхийн зах зээлийн үнэ
- ✓ Бүтээмжийн өсөлт/бууралт
- ✓ Ковид-19

CGE загвар

- ✓ CGE загвар
  - ✓ Эдийн засгийн агентуудын оновчтой үйл хөдлөл дээр суурилсан
  - ✓ Салбар Хоорондын Тэнцэл, Нийгмийн Тооцоололын Матриц
  - ✓ Бодит загвар е бодит хувьсагчуудын хамаарал
    - ✓ Инфляц байхгүй – мөнгө орсон санхүүгийн загварууд байна
    - ✓ Харьцангуй үнэ гол үүрэг гүйцэтгэдэг
  - ✓ Ерөнхий тэнцвэр гэдэг нь бүх юм нэг нэгнээсээ хамаарна
  - ✓ Нэг улсын ба глобал загвар
  - ✓ Нээлттэй жижиг эдийн засгийн загварууд өргөн хэрэглэгддэг
  - ✓ Статик болон динамик
  - ✓ Микро симляцын загвартай уялдан өрхөд үзүүлэх нөлөөг харна

CGE загварт суурилсан Монголд хийгдсэн судалгааны ажлууд

- ✓ Фишер ба бусад (2010). Оюу Толгойн зэсийн уурхайн эдийн засагт үзүүлэх нөлөөлөл
  - ❖ GTAP дээр суурилсан глобал загвар, GEMPACK
  - ❖ 10 улсын глобал загвар
- ✓ Г.Рагчаасүрэн (2012). Жижиг нээлттэй эдийн засгийн CGE загвар:
  - ❖ Дээрх загварын тусгай хувилбар
  - ❖ Таван Толгой нүүрсний ордын нөлөө
  - ❖ Төсвийн Тогтвортой байдлын тухай хуулийн нөлөө

CGE загварт суурилсан Монголд хийгдсэн судалгааны ажлууд

- ✓ Рагчаасүрэн ба бусад (2016) – PEP төсөл
  - ❖ Зэсийн үнийн нөлөө
  - ❖ Нүүрсний зах зээлийн тэлэлт
- ✓ ERI-гийн MON-CGE загвар
  - ❖ Чингис бондын нөлөө
  - ❖ Занараас шатахуун гаргаж авах төслийн нөлөө
  - ❖ Нүүрснээс шатдаг хий гаргаж авах төслийн нөлөө
- ✓ Гэрэгэ Партнерс ба Хөдөлмөрийн Судалгааны Институтийн боловсруулсан Монголын эдийн засгийн ORANI загвар (статик болон динамик)

Одоо хийж байгаа ажил

- Дэлхийн банкны MANAGE (Mitigation, Adaptation and New Technologies Applied General Equilibrium) загвар дээр
  - Жижиг нээлттэй эдийн засгийн динамик загвар
  - Одоо үүр амьсгалын өөрчлөлтийн нөлөөг улс орон бүрээр тооцож байна – CCDR (Country Climate Development Research)
  - Zero-carbon болох хөтөлбөрүүд
  - Эдийн засгийн үйл ажиллагаа, газар ашиглалт, эко системд хоорондын хамаарал

CGE загварт суурилсан Монголд хийгдсэн судалгааны ажлууд

- Үндэсний Хөгжлийн Газарт нутагшуулсан SDGSIM (2018): Дэлхийн үнийн шок, ЗГ-ын орлого, зардлын шок, Салбарын бүтээмжийн шок, Гадаад шууд ХО-ын шок
- Рагчаасүрэн ба бусад (2019) – PEP төсөл:
  - Төсвийн хумих/тэлэх бодлогын нөлөө,
  - Шатахууны үнийн өсөлтийн нөлөө,
  - Нүүрсний салбарын гадаад шууд хөрөнгө оруулалтын нөлөө,
  - Түүхий эдийн үнийн шокын нөлөө,
  - Оюу толгойн далд уурхайн бүтээн байгуулалтын нөлөө

Анхаарал тавьсанд баярлалаа

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

БОДЛОГЫН ШИНЖИЛГЭЭ

"Ерөнхий тэнцвэрийн загвар"

I. НТМ 2019 он	II. БҮТЭЭМЖИЙН НӨЛӨӨ	III. АВЛИГЫН НӨЛӨӨ	IV. ХҮҮХДИЙН МӨНГӨНИЙ НӨЛӨӨ
✓ Нийт дэнс; ✓ Үйлдвэрлэлийн бүтэц; ✓ Эрэлтийн бүтэц; ✓ Агентуудын бүтэц;	✓ Нөхцөл байдал ✓ Урьдач нөхцөлүүд; ✓ Үр дүн;	✓ Нөхцөл байдал ✓ Урьдач нөхцөлүүд; ✓ Үр дүн;	✓ Нөхцөл байдал ✓ Урьдач нөхцөлүүд; ✓ Үр дүн;

2023 он

НИЙГМИЙН ТООЦООЛЛЫН МАТРИЦ, 2019 ОН

№	САЛБАР-19	№	БҮТЭЭГДЭХҮҮН-20	№	АГЕНТҮҮД-3
1	ХАА	1	ХАА	1	Өрх
2	Нүүрс	2	Нүүрс	2	Засгийн газар
3	Металлын хүдэр	3	Металлын хүдэр	3	Гадаад сектор
4	Бусад ашигт малтмал	4	Бусад ашигт малтмал		**ТАТВАРУУД-3**
5	Үйлдвэрлэл	5	Үйлдвэрлэл	1	Шууд татвар
6	Кокс	6	Кокс	2	Импортын тариф
7	Цахилгаан	7	Барилга	3	Бүтээгдэхүүний цэвэр татвар
8	Ус хангамж	8	Худалдаа		**ХӨЧИН ЗҮЙЛС-2**
9	Барилга	9	Зочид буудал	1	Хөдөлмөр
10	Худалдаа	10	Тээвэр	2	Капитал
11	Тээвэр	11	Шуудан		**ХАДГАЛАМЖ-ХӨРӨНГӨ ОРУУЛАЛТ-1**
12	Зочид буудал	12	Цахилгаан	1	Хадгаламж-Хөрөнгө оруулалт
13	Мэдээлэл, холбоо	13	Санхүү		**АЖИЛ, МЭРГЭЖИЛ-10**
14	Санхүү	14	Үл хөдлөх	1	Менежер
15	Үл хөдлөх	15	Түрээс	2	Мэргэжилтэн
16	Шинжлэх ухаан	16	Шинжлэх ухаан	3	Техникч болон туслах
17	Удирдлага	17	Туслах үйлчилгээ	4	Контор, үйлчилгээний ажилтан
18	Төрийн салбар	18	Төрийн салбар	5	Худалдаа, үйлчилгээний ажилтан
19	Бусад үйл ажиллагаа	19	Бохир ус	6	ХАА, ой, загас агнуурын ажилтан
		20	Бусад үйл ажиллагаа	7	Үйлдвэрлэл, барилга, гар урлал
				8	Машин механизмын операторч, угсрагч
				9	Энгийн ажил мэргэжил
				10	Зэвсэгт хүчний ажил мэргэжил

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

- 2019 оны НТМ-ыг хамгийн дэлгэрэнгүй байдлаар 32 салбар, 48 бүтээгдэхүүнтэй байгуулж, үүнээс GAMS код ашиглан **19 салбартай, 20 бүтээгдэхүүнтэй хялбар бүтцийг гарган авсан.**
- **Загварт оруулсан "НТМ"**
  - ✓ 19 салбар, 20 бүтээгдэхүүн;
  - ✓ 2 үйлдвэрлэлийн хүчин зүйлс /L,K/;
  - ✓ 3 төрлийн институт /h, g, row/;
  - ✓ 3 төрлийн татвартай /орлогын албан татвар, импортын татвар, бараа бүтээгдэхүүний татвар/;
  - ✓ Улсын болон хувийн секторын хадгаламж-хөрөнгө оруулалттай.

ТОО МЭДЭЭЛЭЛ

- Нөөцийн хүснэгт - ҮСХ
- Ашиглалтын хүснэгт - ҮСХ
- Төлбөрийн тэнцэл – Монголбанк, IMF
- Улсын төсөв - Сангийн яам
- Ам.долларын ханш - ҮСХ
- Татварын задаргаа - ҮСХ
- Өрхийн нийгэм эдийн засгийн судалгаа - ҮСХ
- Ажиллах хүчний судалгаа - ҮСХ

Нийгмийн тооцооллын матриц, 2019 он, тэрбум төгрөг

ҮЗҮҮЛЭЛТ		L	K	AG	AG	AG	AG	AG	AG	J	I	OTH	OTH	OTH
		LAB	CAP	H	GVT	TD	TM	TI	ROW	Sec	Com	INV	VSTK	TOT
L	LAB								817	10,018				10,835
K	CAP								158	23,657				23,815
AG	H	10,541	19,558		5,593				761					36,453
AG	GVT			1,991		5,649	790	3,224	236	150	0			12,040
AG	TD			5,649										5,649
AG	TM										790			790
AG	TI										3,224			3,224
AG	ROW	294	4,258	339	692						24,663			30,246
J	SEC										72,263			72,263
I	Com			21,668	4,960				22,407	38,438	7,064	10,589	2,879	108,005
OTH	INV			6,806	795				5,867					13,468
OTH	VSTK											2,879		2,879
OTH	TOT	10,835	23,815	36,453	12,040	5,649	790	3,224	30,246	72,263	108,005	13,468	2,879	319,667

ҮЙЛДВЭРЛЭЛИЙН БҮТЭЦ, 2019 ОН

САЛБАРУУД	ХӨДӨЛМӨР	КАПИТАЛ	НЭМҮҮ ӨРТӨГ	ХҮЧИН ЗҮЙЛСИЙН БАГТААМЖ	
				хөдөлмөр	капитал
ХАА	20.0	8.1	13.0	63.6	36.4
Нүүрс	2.5	23.6	14.9	7.0	93.0
Металлын хүдэр	7.5	15.7	12.3	25.2	74.8
Бусад ашигт малтмал	1.0	1.1	1.1	40.9	59.1
Үйлдвэрлэл	6.5	8.4	7.6	35.3	64.7
Кокс	0.4	0.2	0.3	66.3	33.7
Цахилгаан	2.4	1.5	1.9	52.5	47.5
Ус хангамж	0.9	0.2	0.5	73.7	26.3
Барилга	6.3	2.3	3.9	66.2	33.8
Худалдаа	13.4	9.1	10.9	50.9	49.1
Тээвэр	6.4	4.0	5.0	53.2	46.8
Зочид буудал	1.6	0.8	1.1	59.3	40.7
Мэдээлэл, холбоо	1.7	2.2	2.0	35.0	65.0
Санхүү	3.5	5.4	4.6	31.1	68.9
Үл хөдлөх	0.5	9.5	5.8	3.8	96.2
Шинжлэх ухаан	2.3	1.0	1.6	60.9	39.1
Удирдлага	1.1	0.4	0.7	66.1	33.9
Төрийн салбар	20.0	6.4	12.0	68.9	31.1
Бусад үйл ажиллагаа	2.0	0.3	1.0	83.2	16.8
Нийт	**100.0**	**100.0**	**100.0**	**41.3**	**58.7**

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

- ✓ Монгол Улсын ДНБ 37.8 их наяд төгрөг бөгөөд өрхийн хэрэглээ, засгийн газрын зардал, хөрөнгө оруулалт, экспорт болон импортын ДНБ-д эзлэх хувь **57%, 13%, 28%, 57% болон 65%** байна.
- ✓ Эдийн засагт капиталын багтаамж хөдөлмөрөөс өндөр байна /**Капитал 62.5%, хөдөлмөр 26.5%**/.
- ✓ Нийт хөдөлмөрийн **20 хувь** нь ХАА, **10.5 хувь** нь УУ, **17 хувь** нь боловсруулах аж үйлдвэр салбар, **52 хувь** нь үйлчилгээний салбарт ногдож байна.
- ✓ Капиталын орлогын **8 хувь** нь ХАА салбарт, **40.1 хувь** нь УУ салбарт, **12.5 хувь** нь боловсруулах аж үйлдвэрийн салбарт, **38.7 хувь** нь үйлчилгээний салбарт хуваарилагдаж байна.

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

ЭРЭЛТИЙН БҮТЭЦ, 2019 ОН

Эрэлтийн бүтэц 2019 он, хувиар

№	Бүтээгдэхүүн	Өрхийн хэрэглээ	Засгийн газрын хэрэглээ	Завсрын хэрэглээ	Маржин	Үндсэн хөрөнгийн нийт хуримтлал	Эрэлтийн хөрөнгийн өөрчлөлт
1	ХАА	24.1	-	59.6	-	4.8	11.5
2	Нүүрс	18.8	-	42.5	-	-	38.6
3	Металлын хүдэр	-	-	7.0	-	-	93.0
4	Бусад ашигт малтмал	1.0	-	212.8	-	-	(113.8)
5	Аж үйлдвэрийн бүт	36.0	-	43.0	-	15.7	5.4
6	Кокс	12.1	-	88.5	-	-	(0.6)
7	Барилга	0.1	0.0	31.0	-	68.9	-
8	Худалдаа	-	-	-	100.0	-	-
9	Зочид буудал	57.8	0.1	42.1	-	-	-
10	Тээвэр	22.1	0.1	74.3	3.6	-	-
11	Шуудан	6.2	-	93.8	-	-	-
12	Цахилгаан	16.5	-	83.5	-	-	-
13	Санхүү	30.4	-	69.6	-	-	-
14	Үл хөдлөх	73.4	-	26.6	-	-	-
15	Түрээс	1.4	-	49.2	-	49.4	-
16	Шинжлэх ухаан	18.5	3.7	77.5	-	0.3	-
17	Туслах үйлчилгээ	8.4	0.0	79.2	-	12.4	-
18	Төрийн салбар	28.3	68.6	3.0	-	-	-
19	Бохир ус	19.1	34.4	46.6	-	-	-
20	Бусад үйл ажиллагаа	54.6	19.1	26.3	-	-	-

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

Эцийн хэрэглээний бүтэц, 2019 он, хувиар

№	Бүтээгдэхүүн	Өрхийн хэрэглээ	Засгийн газрын хэрэглээ	Завсрын хэрэглээ	Маржин	Үндсэн хөрөнгийн нийт хуримтлал	Эрэлтийн хөрөнгийн өөрчлөлт
1	ХАА	7.3	-	10.1	-	2.9	26.0
2	Нүүрс	0.7	-	0.8	-	-	10.0
3	Металлын хүдэр	-	-	0.1	-	-	9.9
4	Бусад ашигт малтмал	0.0	-	0.3	-	-	(1.9)
5	Аж үйлдвэрийн бүт	50.6	-	34.1	-	45.1	57.1
6	Кокс	2.6	-	10.9	-	-	(1.0)
7	Барилга	0.0	0.0	5.8	-	47.1	-
8	Худалдаа	-	-	-	97.0	-	-
9	Зочид буудал	3.2	0.0	1.3	-	-	-
10	Тээвэр	4.7	0.1	9.0	3.0	-	-
11	Шуудан	0.0	-	0.1	-	-	-
12	Цахилгаан	1.5	-	4.2	-	-	-
13	Санхүү	4.3	-	5.5	-	-	-
14	Үл хөдлөх	9.6	-	2.0	-	-	-
15	Түрээс	0.0	-	0.5	-	1.9	-
16	Шинжлэх ухаан	3.8	3.4	9.1	-	0.1	-
17	Туслах үйлчилгээ	0.9	0.0	5.1	-	2.9	-
18	Төрийн салбар	8.7	92.4	0.5	-	-	-
19	Бохир ус	0.2	1.4	0.2	-	-	-
20	Бусад үйл ажиллагаа	1.8	2.7	0.5	-	-	-

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

Нийт эрэлтийг авч үзвэл ХАА салбарын нийт эрэлтийн **51 хувийг** завсрын хэрэглээ, **21 хувийг** өрхийн хэрэглээ, УУ салбарын дотоодын эрэлт **7 хувь**, боловсруулах аж үйлдвэрийн салбарын **43 хувийг** завсрын хэрэглээ, **26 хувийг** өрхийн хэрэглээ, **22 хувийг** хөрөнгө оруулалт бүрдүүлж байгаа бол үйлчилгээний салбарын дийлэнх хэсгийг бүюу **38 хувийг** завсрын хэрэглээ эзэлж байна.

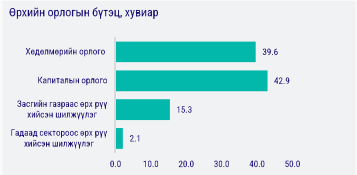
АГУУЛГА

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

АГЕНТУУДЫН БҮТЭЦ, 2019 ОН

ӨРХ

Өрхийн орлогын бүтэц, хувиар



Өрхийн зарлагын бүтэц, хувиар

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

ЗАСГИЙН ГАЗАР

Засгийн газрын орлогын бүтэц, хувиар

Засгийн газрын зарлагын бүтэц, хувиар

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

ГАДААД СЕКТОР

Гадаад секторын зарлагын бүтэц, хувиар

Гадаад секторын зарлагын бүтэц, хувиар

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

Өрхийн дансны бүтцээс харахад өрхийн орлогын **43 хувийг** капиталын орлого, **40 хувийг** хөдөлмөрийн орлого эзэлж байгаа бол зардлын **59 хувийг хэрэглээ, 19 хувийг** хадгаламж эзэлж байна.

Засгийн газрын орлогын **46.9 хувийг** шууд татвар, **26.8 хувийг** бүтээгдэхүүний цэвэр татвар, зарлагын хувьд өрх рүү хийж буй шилжүүлэг **46.5 хувь**, бараа бүтээгдэхүүний зардал **41.2 хувийг** эзэлж байна.

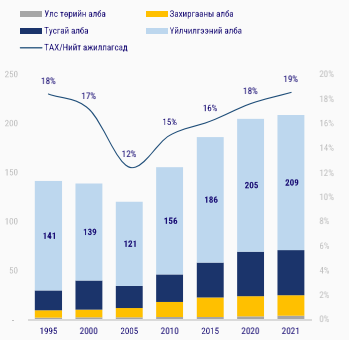
Нийт импортын **71 хувь** нь боловсруулах аж үйлдвэрийн салбар, **28 хувь** нь үйлчилгээний салбар хийж байгаа бол экспортын **71 хувийг** УУ салбар, **12 хувийг** боловсруулах аж үйлдвэрийн салбар, **12 хувийг** үйлчилгээний салбар эзэлж байна.

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

ТӨРИЙН БҮТЭЭМЖИЙН ӨНӨӨГИЙН НӨХЦӨЛ БАЙДАЛ

ТӨРИЙН БҮТЭЭМЖ

Төрийн албан хаагчийн тоо, мян.хүн



Эх үүсвэр: Үндэсний Статистикийн хороо

Сүүлийн 10 жилийн хугацаанд төрийн албан хаагчдын тоо **1.3 дахин нэмэгдэж**, 2021 оны байдлаар ажиллах хүчний 5 хүний 1 нь төсвөөс цалинжиж байна.

ШИНЭ СЭРГЭЛТИЙН БОДЛОГО

"E-Mongolia"-д нэвтрүүлсэн төрийн 57 байгууллагын 563 үйлчилгээг 1000-д хүргэнэ.

Орон зайн өгөгдлийн дэд бүтцэд суурилсан нээлттэй цахим системийг хөгжүүлж, хэрэглээнд нэвтрүүлнэ.

Газрын нэгдсэн системийг хэрэглээнд нэвтрүүлнэ.

Төрийн зарим чиг үүргийг хувийн хэвшил, мэргэжлийн холбоонд шилжүүлнэ.

Бизнес эрхлэгчдийг дэмжиж тусгай зөвшөөрөл, зөвшөөрлийн тоог 2 дахин цөөрүүлж, цахимаар олгох, сунгах боломжийг бүрдүүлнэ.

/хүчин төгөлдөр мөрдөгдөж буй хуулиар 300 гаруй зөвшөөрөл, тусгай зөвшөөрлийг олгохоор заасан ч бодит байдал дээр бизнес эрхлэх хугацаанд 900 гаруй тооны зөвшөөрөл гаргуулж байна./

ДБ: ЗАСАГЛАЛЫН ҮР АШИГ

Огноо	Үзүүлэлт байраар	Үзүүлэлт оноогоор	өсөлт, %
2022 он	137	34.6	
2023 он	128	38.9	12%
2024 он	119	43.3	11%
2025 он	110	47.6	10%
2026 он	100	52.4	10%
2027 он	90	57.2	9%
2028 он	80	62.2	9%
2029 он	70	66.8	7%
2030 он	60	71.9	8%

- Дэлхийн банкны засаглалын индекс 200 гаруй орон, 1996-2021 онуудад хийсэн, 6 үзүүлэлтээр тооцдог.
- **Засаглалын үр ашиг:** Монгол Улсын хувьд 2021 онд 137 дугаар байранд 34.62 оноотой жагсаж байгаа бол 2030 он гэхэд 71.9 оноотой 60 дугаар байранд жагсах зорилт тавьж байна. */Төрийн үйлчилгээний чанар, төрийн хүнд суртал, бодлогын хэрэгжилт, туушгай байдал/*

БОДЛОГЫН ҮНЭЛГЭЭНИЙ НӨХЦӨЛ

СУУРЬ ХУВИЛБАР	✓ 8 жил ✓ BGP – Тэнцвэрт өсөлтийн зам
БОДЛОГЫН ХУВИЛБАР	✓ Төрийн удирдлагын салбарын бүтээмжийн өсөлт
ТААМАГЛАЛ	✓ 2030 онд 71.9 оноотой 60 дугаар байранд жагсах

ҮР ДҮН: ТӨРИЙН БҮТЭЭМЖИЙН НӨЛӨӨ

Үзүүлэлт, хувиар	2023	2024	2025	2026	2027	2028	2029	2030
Нэрлэсэн ДНБ	0.00	0.30	0.57	0.81	1.04	0.65	0.91	1.11
Бодит ДНБ	0.00	0.55	1.03	1.45	1.86	1.13	1.60	1.95
Хэрэглээний үнийн индекс	-0.15	-0.29	-0.41	-0.53	-0.33	-0.47	-0.57	-0.60
Нийт хөрөнгө оруулалт	0.07	0.13	0.18	0.23	0.14	0.20	0.24	0.25
Экспорт	0.15	0.28	0.39	0.50	0.30	0.43	0.52	0.54
Импорт	0.10	0.19	0.27	0.35	0.21	0.30	0.36	0.38
Өрхийн орлого/хадгаламж	0.01	0.02	0.03	0.05	0.06	0.07	0.09	0.10
Өрхийн бодит хэрэглээ	0.16	0.31	0.44	0.58	0.39	0.54	0.66	0.71
Засгийн газрын орлого	0.06	0.12	0.17	0.22	0.16	0.21	0.26	0.28
Засгийн газрын хадгаламж	2.68	5.23	7.66	10.17	6.91	9.67	11.99	13.14
Нэрлэсэн цалин	-0.87	-1.58	-2.15	-2.65	-1.35	-1.99	-2.41	-2.42

ТӨРИЙН БҮТЭЭМЖ ӨССӨНӨӨР:

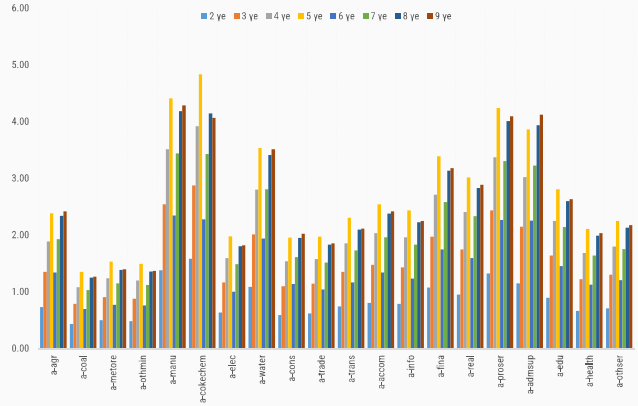
- ✓ ДНБ-ийг нэмэгдүүлнэ;
- ✓ Бүх салбарт үйлдвэрлэл өснө;
- ✓ Хөдөлмөр төрийн удирдлага салбараас бусад салбар луу шилжинэ;
- ✓ Цалин буурснаар өрхийн орлого буурна;
- ✓ Шууд татварын орлого буурснаар ЗГ-ын орлого буурна;
- ✓ Өрх, ЗГ-ын хадгаламж буурна, улмаар нийт хөрөнгө оруулалт буурна;
- ✓ Экспорт, импорт өснө;
- ✓ Ихэнх бүтээгдэхүүний үнэ буурна.

ТӨРИЙН БҮТЭЭМЖ НЭМЭГДСЭНЭЭР АЖИЛЛАГЧИД ТӨРИЙН САЛБАРААС БУСАД САЛБАР РУУ ШИЛЖИНЭ.

Төрийн салбарын ажиллагчид

Эх үүсвэр: Эдийн засаг, хөгжлийн яам

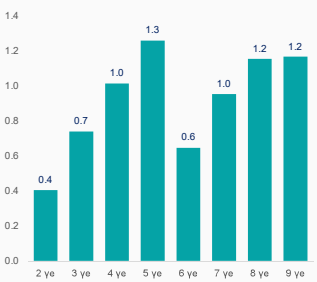
Салбаруудын ажиллагчид



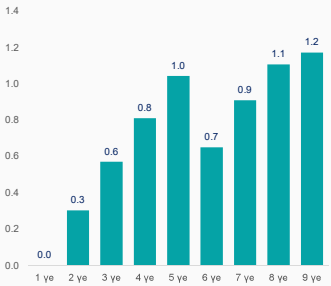
Эх үүсвэр: Эдийн засаг, хөгжлийн яам

ТӨРИЙН БҮТЭЭМЖ НЭМЭГДЭХ НЬ САЛБАРУУДЫН ҮЙЛДВЭРЛЭЛИЙГ НЭМЭГДҮҮЛЖ БАЙНА.

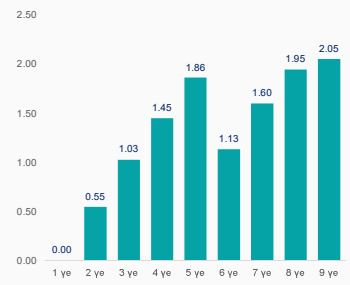
Төрийн салбарын үйлдвэрлэл



ДНБ-ий өсөлт



Бодит ДНБ-ий өсөлт



АГУУЛГА

1 НТМ 2019 он
- Нийт данс;
- Үйлдвэрлэлийн бүтэц;
- Эрэлтийн бүтэц;
- Агентуудын бүтэц;

2 БҮТЭЭМЖИЙН НӨЛӨӨ
- Нөхцөл байдал
- Урьдач нөхцөлүүд;
- Үр дүн;

3 АВЛИГЫН НӨЛӨӨ
- Нөхцөл байдал
- Урьдач нөхцөлүүд;
- Үр дүн;

4 ХҮҮХДИЙН МӨНГӨНИЙ НӨЛӨӨ
- Нөхцөл байдал
- Урьдач нөхцөлүүд;
- Үр дүн;

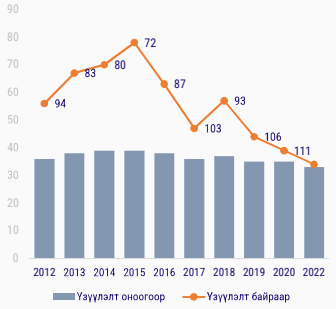
БОДЛОГЫН ҮНЭЛГЭЭНИЙ НӨХЦӨЛ

СУУРЬ ХУВИЛБАР	✓ 8 жил ✓ BGP – Тэнцвэрт өсөлтийн зам
БОДЛОГЫН ХУВИЛБАР	✓ Төсвийн хөрөнгө оруулалтын авлига буурах
ТААМАГЛАЛ	✓ Төсвийн хөрөнгө оруулалтын өртгийг нэмэгдүүлнэ (10 хувь). ✓ Хувийн сектор буюу өрхүүд авлигаас орлого олно. ✓ Өрхүүд авлигын нэмэлт орлогын тодорхой хэсгийг хэрэглээд (20 хувь) , үлдсэн хэсгийг гадаадад байршуулдаг (80 хувь).

АВЛИГЫН ӨНӨӨГИЙН НӨХЦӨЛ БАЙДАЛ

АВЛИГАЛ

Авлигын төсөөллийн индекс, мян.хүн



Эх үүсвэр: Транспаренси Интернэшнл

Монгол Улс 2020 онд авлигын индексээр **35 оноо** авч **111 дүгээр** байранд жагсжээ. Энэ нь 2019 оноос **зургаан байраар** ухарсан үзүүлэлт юм.

ШИНЭ СЭРГЭЛТИЙН БОДЛОГО

Авлига, албан тушаалын гэмт хэрэгт оногдуулах ялын бодлогыг чангатгах

Санхүүгийн хориг арга хэмжээ авах байгууллага /ФАТФ/-аас мөнгө угаах, терроризмыг санхүүжүүлэхтэй тэмцэх стратегийн дутагдалтай улсын жагсаалт /саарал, хар жагсаалт/-д орохгүй байх

Монгол Улсын зээлжих зэрэглэл одоогийн байгаа Мүүдис /B3, тогтвортой/, Фитч болон Эс энд Пи /B, тогтвортой/ түвшнээс буураагүй байх.

ДБ: ЗАСАГЛАЛЫН ҮР АШИГ

Огноо	Үзүүлэлт байраар	Үзүүлэлт оногоор	Өсөлт, %
2022 он	116	33	
2023 -2026 он	97	37	3%
2027-2030 он	66	45	5%

"Транспаренси Интернэшнл" байгуулга: Авлигын төсөөллийн индекс 180 улсын төрийн салбарын авлигын төсөөллийн хэмжээг 13 шинжээчийн байгууллагуудын үнэлгээ болон бизнесүүдийн удирдлагуудаас авсан асуумж дээр үндэслэн гаргадаг.

- *Авлигаас сэргийлэх үндэсний тогтолцоог бүрдүүлэх,*
- *Шүүхийн хараат бус байдлыг сайжруулах*
- *Үндэсний аюулгүй байдлын үзлийг шинээр тодорхойлох*
- *Хүний эрхийн ноцтой зөрчлийн гаралтийг бууруулах,*
- *Эмэгтэйчүүдийн оролцоог нэмэгдүүлэх*

ҮР ДҮН: АВЛИГЫГ БУУРУУЛАХ НӨЛӨӨ

Үзүүлэлт, хувиар	2023	2024	2025	2026	2027	2028	2029	2030
Нэрлэсэн ДНБ	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.06
Бодит ДНБ	0.01	0.02	0.05	0.09	0.15	0.20	0.27	0.34
Хэрэглээний үнийн индекс	-0.01	-0.02	-0.03	-0.05	-0.07	-0.10	-0.12	-0.15
Нийт хөрөнгө оруулалт	-0.03	-0.06	-0.08	-0.10	-0.10	-0.10	-0.09	-0.08
Экспорт	0.00	0.00	0.01	0.02	0.03	0.04	0.06	0.07
Импорт	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07
Өрхийн орлого/хадгаламж	-0.07	-0.14	-0.20	-0.26	-0.30	-0.33	-0.36	-0.39
Өрхийн бодит хэрэглээ	-0.07	-0.12	-0.17	-0.21	-0.22	-0.23	-0.24	-0.24
Засгийн газрын орлого	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05
Засгийн газрын хадгаламж	0.07	0.20	0.40	0.65	0.95	1.29	1.67	2.10

АВИЛГА БУУРСНААР:

- ДНБ-ийг нэмэгдүүлнэ;
- Бүх салбарт үйлдвэрлэл өснө;
- Экспорт, импорт өснө;
- Өрхийн орлого, хэрэглээ буурна.;
- Засгийн газрын орлого, хадгаламж өснө;
- Ихэнх бүтээгдэхүүний үнэ буурна;

АГУУЛГА

1 | НТМ 2019 он
- ✓ Нийт данс;
- ✓ Үйлдвэрлэлийн бүтэц;
- ✓ Эрэлтийн бүтэц;
- ✓ Агентуудын бүтэц;

2 | БҮТЭЭМЖИЙН НӨЛӨӨ
- ✓ Нөхцөл байдал
- ✓ Урьдач нөхцөлүүд;
- ✓ Үр дүн;

3 | АВЛИГЫН НӨЛӨӨ
- ✓ Нөхцөл байдал
- ✓ Урьдач нөхцөлүүд;
- ✓ Үр дүн;

4 | ХҮҮХДИЙН МӨНГӨНИЙ НӨЛӨӨ
- ✓ Нөхцөл байдал
- ✓ Урьдач нөхцөлүүд;
- ✓ Үр дүн;

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

ӨРХИЙГ ОРЛОГЫН ТҮВШНЭЭР 5 БҮЛЭГТ ХУВААНА. /ӨНЭЗС-ны задгай мэдээлэл/

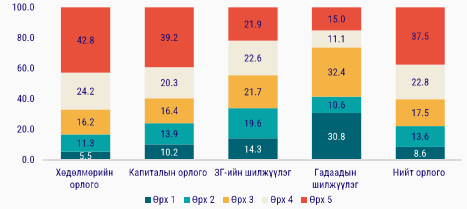
Хөдөлмөрийн орлого
- ✓ Цалин, хөлстэй ажиллагч

Капиталын орлого
- ✓ Мал аж ахуйн цэвэр орлого = Худалдсан мал – МАА эрхлэхтэй холбогдож гарсан зардал + Малын гаралтай бүтээгдэхүүн худалдсан орлого
- ✓ Газар тариалангийн цэвэр орлого = Худалдсан ГТ-ийн бүтээгдэхүүний орлого – ГТ-н эрхлэхтэй холбогдож гарсан зардал
- ✓ Хөдөө аж ахуй (хаа)-н бус үйлдвэрлэл, худалдааны цэвэр орлого
- ✓ Өөрийн аж ахуйгаас болон бусдаас хэрэглэсэн.
- ✓ Түрээсийн орлого, хүү болон ашиг

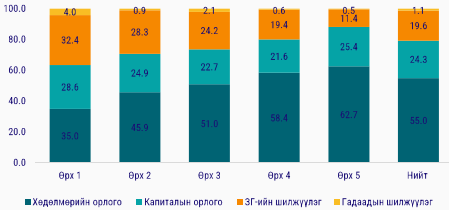
ЗГ-ийн шилжүүлгийн орлого
- ✓ Тэтгэвэр, тэтгэмжийн орлого

Гадаад шилжүүлгийн орлого

Нийт орлогод өрхүүдийн эзлэх хувь



Өрхийн орлогын бүтэц (хувь)



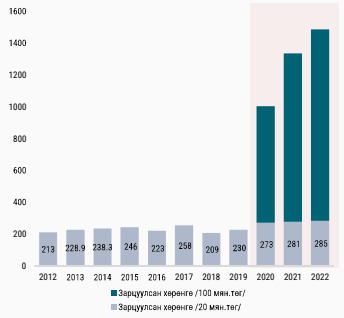
ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

ХҮҮХДИЙН МӨНГӨ 100 МЯНГАН ТӨГРӨГ БОЛЖ НЭМЭГДСЭНЭЭР ИРГЭДИЙН ХҮҮХДИЙН МӨНГӨ АВАГЧДЫН ТОО НЭМЭГДСЭН

- ✓ Монгол Улс “Хүүхдийн мөнгө” хөтөлбөрийг 1995 оноос эхлэн амьжиргааны түвшнээс доогуур орлоготой, зорилтот бүлэгт чиглүүлж хүүхдийн тэтгэмж олгож байсан.
- ✓ 2006 оноос 0-18 хүртэлх насны бүх хүүхдэд сар бүр **3.0 мянган төгрөг**
- ✓ 2007 оноос жилд нэг удаа **100.0 мянган төгрөг**
- ✓ 2009 оноос сар бүр **21.0 мянган төгрөг**
- ✓ 2012 оноос сар бүр **20.0 мянган төгрөг**
- ✓ 2020 оны 4 дүгээр сарын 01-ний өдрөөс эхлэн хүүхэд бүрд сар бүр **100.0 мянган төгрөг**
- ✓ 2023 оноос нийт хүүхдийн 91 хувьд **100 мянган төгрөг**

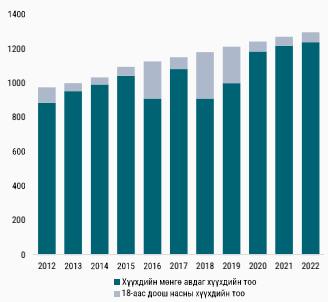
Эх үүсвэр: УСХ

Хүүхдийн мөнгөн тэтгэмжид зарцуулсан хөрөнгө (тэрбум төгрөг)



Эх үүсвэр: Сангийн яам

Хүүхдийн мөнгөн тэтгэмж авагчдын тоо (мянган хүн)



Эх үүсвэр: Сангийн яам

Хүүхдийн мөнгөн тэтгэмж улсын төсвийн **3 орчин хувийг** эзэлж байсан бол 100 мянган төгрөг болгож нэмэгдүүлснээр **13 орчим хувь** болж нэмэгдлээ

2019 онд 18-аас доош насны хүүхдүүдийн **82.5 хувь** хүүхдийн мөнгөн тэтгэмж авч байсан бол 2022 оны байдлаар **95 хувь** болж нэмэгдлээ.

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

БОДЛОГЫН ҮНЭЛГЭЭНИЙ НӨХЦӨЛ

СУУРЬ ХУВИЛБАР	✓ **1 жил** ✓ **BGP – Тэнцвэрт өсөлтийн зам**
БОДЛОГЫН ХУВИЛБАР	✓ **Хүүхдийн мөнгийг 20 мянгаас 100 мянган төгрөг болгон нэмэгдүүлсэн нөлөө**
ТААМАГЛАЛ	✓ **Засгийн газрын худалдан авалт тогтмол**

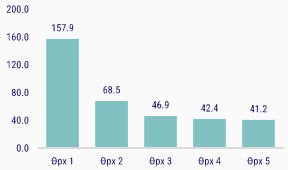
ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

ӨРХИЙН БОДИТ ОРЛОГЫГ НЭМЭГДҮҮЛСЭН БАЙНА.

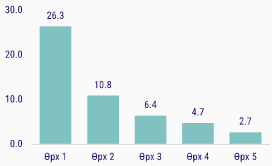
1.3 – 5 дахин ↑
их наяд төгрөг
Хүүхдийн мөнгөн тэтгэмж

5.2 – 64 хувь ↑
их наяд төгрөг
ЗГ-аас өрх рүү хийж буй шилжүүлэг

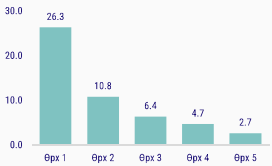
ЗГ-ААС ӨРХ РҮҮ ХИЙЖ БУЙ ШИЛЖҮҮЛЭГ



ӨРХИЙН ОРЛОГО – 7.1 хувь ↑



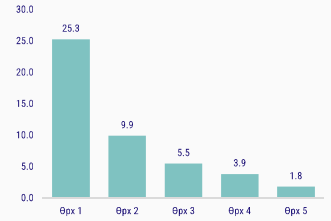
ӨРХИЙН ХЭРЭГЛЭЭ – 7.1 хувь ↑



ҮНЭ – 0.83 нэгж хувиар ↑

7.3 хувь – 0.5 нэгж хувиар ↑
Инфляцын жилийн дундаж түвшин, 2021 он
2018 оноос

ӨРХИЙН БОДИТ ХЭРЭГЛЭЭ 7.0 хувь ↑



МОНГОЛ УЛСЫН ЗАСГИЙН ГАЗАР

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

МОНГОЛ УЛСЫН ЗАСГИЙН ГАЗАР

САНГИЙН ЯАМ

САНГИЙН ЯАМНЫ “CGE” ЗАГВАРЫН ЦААШДЫН ХЭРЭГЛЭЭ

2023.03.23

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

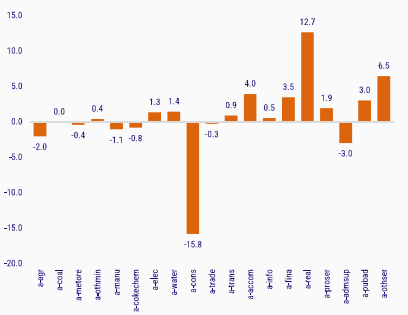
ХӨРӨНГӨ ОРУУЛАЛТЫН ЭДИЙН ЗАСАГТ ҮЗҮҮЛЭХ НӨЛӨӨ ӨНДӨР БАЙНА.

ХӨРӨНГӨ ОРУУЛАЛТ = ХАДГАЛАМЖ

10.6 хувь ↓
ХӨРӨНГӨ ОРУУЛАЛТ
=
4.4 хувь
ӨРХИЙН ХАДГАЛАМЖ
+
63.6 хувь
ЗГ-ЫН ХАДГАЛАМЖ
+
0.0 хувь
ГАДААД ХАДГАЛАМЖ

ҮЙЛДВЭРЛЭЛ – 0.7 хувь ↓

ХӨДӨЛМӨР ЭРХЛЭЛТ – 0.4 хувь ↓



БОДИТ ДНБ – 0.62 хувь ↓

АЖИЛГҮЙДЛИЙН ТҮВШИН – 0.34 нэгж хувь ↑

ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

САНГИЙН ЯАМНЫ САНХҮҮ, ТӨСВИЙН СУДАЛГААНЫ ГАЗРЫН ЧИГ ҮҮРЭГ

1. Санхүү, төсвийн тухайн үеийн болон ирээдүйн нөхцөл байдлыг **таамаглах, дүн шинжилгээ хийх**
   - Төрийн албан хаагчийн цалинг нэмэгдүүлэх;
   - Татварын хувь хэмжээг өөрчлөх;
   - Нүүрс, зэсийн экспортыг орлогын төсөөлөл гаргах.
2. Санхүү, төсвийн хэрэгжүүлсэн бодлогын арга хэмжээний **үр дүн, нөлөөг тодорхойлох**
   - Хүүхдийн мөнгөний нөлөөг тооцох:
     - *20,000-100,000 төгрөг болгох нэмэгдүүлэх үеийн нөлөө;*
     - *100,000 төгрөгийг нийт хүүхдийн 91%-д олгох үеийн нөлөө.*
3. Төсвийн төлөвлөлтөд цаашид авч хэрэгжүүлэх боломжтой **бодлогын арга хэмжээг санал болгох**
   - Сангийн тэлэх эсвэл хумих бодлого хэрэгжүүлбэл эдийн засагт үзүүлэх нөлөөг тооцох.

ТӨСВИЙН БОДЛОГОТОЙ УЯЛДУУЛАН CGE ЗАГВАРЫГ АШИГЛАХ НЬ

Төсвийн бодлого

1. ТАТВАРЫН БОДЛОГО
2. ЗАСГИЙН ГАЗРЫН ЗАРДАЛ
3. ТӨСВИЙН ХӨРӨНГӨ ОРУУЛАЛТ
4. ЭКСПОРТЫН ОРЛОГО

→

- ДНБ
- ИНФЛЯЦ
- АЖИЛГҮЙДЛИЙН ТҮВШИН
- ХӨРӨНГӨ ОРУУЛАЛТ

Макро эдийн засгийн голлох үзүүлэлтүүд

Бусад улс орнуудын төсвийн бодлогын нөлөөг үнэлдэг CGE загварууд:

АНУ:	Австрали:	БНХАУ:	КАНАД:	БРАЗИЛ:
Treasury Individual Income Tax Model (TIITM)	Monash Multi-Regional Forecasting Model (MMRF)	Chinese Academy of Social Sciences (CASS) Model	Global Trade Analysis Project (GTAP) Model	GEMPACK Model
Татварын бодлого	Сангийн бодлого	Сангийн бодлого	Худалдаа, татварын бодлого	Худалдаа, татварын бодлого

МОНГОЛ УЛСЫН ЗАСГИЙН ГАЗАР | ЭДИЙН ЗАСАГ, ХӨГЖЛИЙН ЯАМ

АНХААРАЛ ХАНДУУЛСАНД БАЯРЛАЛАА

Холбоо барих

Утас: + 976-51-263333
Факс: + 976-51-263333

И-мэйл: info@med.gov.mn
Website: med.gov.mn
Facebook: medgoMN

Хаяг:

Эдийн засаг, хөгжлийн яам
Улаанбаатар хот, Чингэлтэй дүүрэг, Нэгдсэн Үндэстний Гудамж 5/1
Засгийн газрын II байр

ҮНДЭСНИЙ СТАТИСТИКИЙН ХОРОО

ӨРХИЙН САРЫН ДУНДАЖ ОРЛОГО, ЗАРЛАГА ТООЦОХ АРГА ЗҮЙ

ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА

2023 он

СУДАЛГААНЫ ТҮҮХ

Өрхийн орлого, зарлагын судалгаа
1966 оноос эхлэн 2007 оны 7 сар хүртэл улирал бүр
ӨОЗС

Амьжиргааны түвшний түүвэр судалгаа
1995, 1998, 2002-2003 онуудад 3 удаа
АТТС

Өрхийн нийгэм, эдийн засгийн судалгаа
2007 оны 7 сараас эхлэн улирал бүр
ӨНЭЗС

- Үндэсний Статистикийн Хороо 1966 оноос эхлэн өрхийн орлого, зарлагын судалгааг явуулж ирсэн бөгөөд Өрхийн орлого, зарлагын судалгаа, Амьжиргааны түвшний түүвэр судалгааг нэгтгэн 2007 оны 7 дугаар сарын 1-нээс “Өрхийн нийгэм, эдийн засгийн судалгаа”-г явуулж байна.

АГУУЛГА

СУДАЛГААНЫ ТӨРӨЛ

Өрхийн нийгэм, эдийн засгийн судалгаа

Хураангуй
Үндсэн зорилго:
Орлого, зарлага, хэрэглээг тооцох
Явагдах он:
2013, 2015, 2017, 2019 .....
Түүврийн хэмжээ:
11232 өрх
/Улаанбаатарт-3600, аймгийн төвд-2640, хөдөөд-4992 өрх/

Дэлгэрэнгүй
Үндсэн зорилго:
Хүн амын амьжиргаа, ядуурлын үндсэн үзүүлэлтүүд, өрхийн орлого, зарлага, хэрэглээг тооцох
Явагдах он:
2014, 2016, 2018, 2020 .....
Түүврийн хэмжээ:
16488 өрх
/Улаанбаатарт-3600, аймгийн төвд-5400, хөдөөд-7488 өрх/

ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА

- Өрхийн ам бүлийн байдал
- Шилжилт хөдөлгөөн
- Боловсрол
- Эрүүл мэнд
- Хөдөлмөр эрхлэлт
- Бусад орлого
- ХАА-н үйлдвэрлэл, хэрэглээ
- ХАА-н бус үйлдвэрлэл, худалдаа, үйлчилгээ
- Хадгаламж, зээл
- Орон сууц, эрчим хүч
- Удаан эдэлгээтэй бараа, эд хогшил
- Хүнсний бус зардал, хэрэглээ
- Хүнсний зардал, хэрэглээ

СУДЛАГДАХ СЭДЭВ, ҮЗҮҮЛЭЛТҮҮД

- Судалгаанд Монгол Улсын хүн амыг улс, бүс, суурьшлын түвшинд төлөөлөх хэмжээний өрхийг түүвэрлэн авч, өрхийн гишүүдийн нас, хүйс, боловсрол, хөдөлмөр эрхлэлтийн байдал, өрхийн орлого, зарлага, хэрэглээтэй холбоотой үзүүлэлтүүдийг цуглуулан судалж байна.

ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА

СУДАЛГААНЫ АЧ ХОЛБОГДОЛ

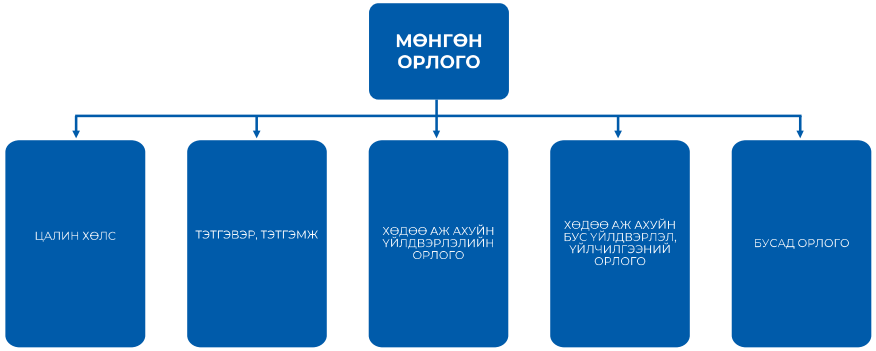
- Ядуурлын үндсэн үзүүлэлтүүдийг тогтмол давтамжтайгаар тооцох боломж бүрдсэн.
- Өрхийн орлого, зарлагыг тооцох, хэрэглээний үнийн индексэд ашигладаг сагс, түүний жинг шинэчлэх болон ДНБ-ийг эцсийн ашиглалтын аргаар тооцоход шаардлагатай мэдээллийг бий болгодог.
- Өрхийн амьжиргаа, ядуурлын чиглэлээрх дүн шинжилгээ хийх суурь мэдээллийг бүрдүүлдэг.

МЭДЭЭЛЭЛ ЦУГЛУУЛАЛТ

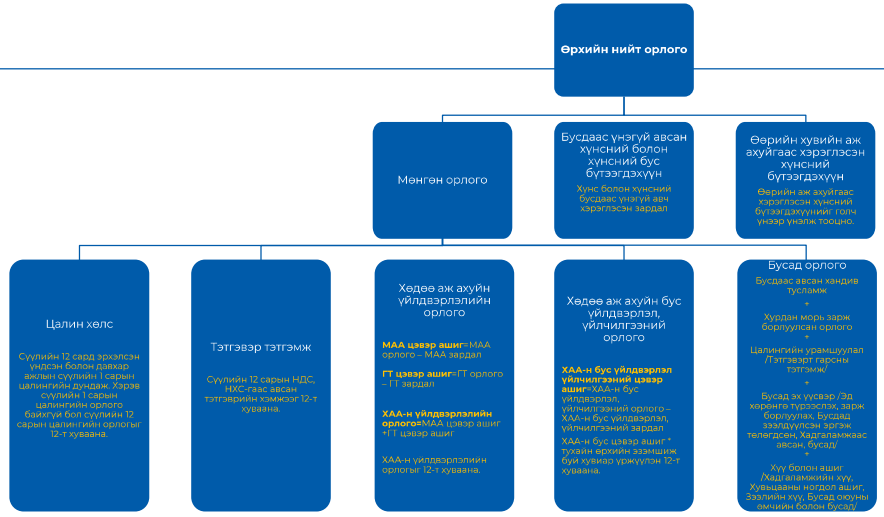
- Нийслэл, аймгийн статистикийн газар, хэлтсийн Өрхөд суурилсан судалгааны мэдээлэл цуглуулагч нар
- Судалгааны батлагдсан маягт, зааврын дагуу
- Үндэсний статистикийн хорооны судалгаа хариуцсан нэгжээс хүргүүлсэн түүврийн дагуу өрхөөс
- Сар бүр мэдээллийг цуглуулж Үндэсний статистикийн хорооны судалгааны серверт дамжуулна.

НИЙТ ОРЛОГО

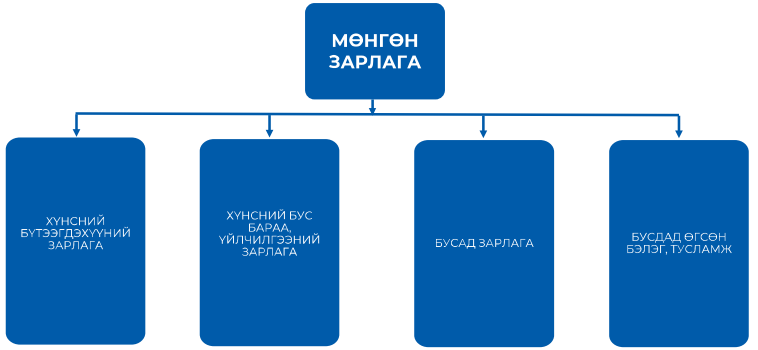
МӨНГӨН ОРЛОГО

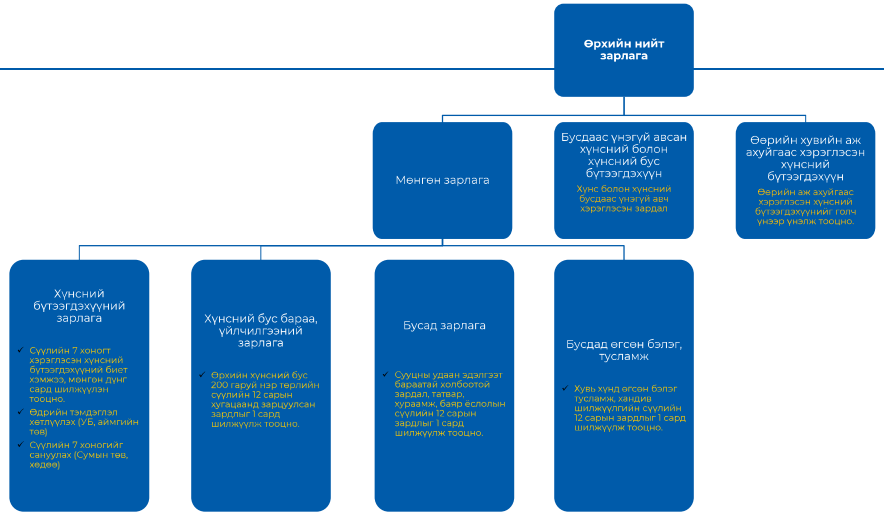


НИЙТ ОРЛОГО



МӨНГӨН ОРЛОГО





ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

Амьжиргааны түвшний үзүүлэлтийг сонгох:

Практик талаас

1. ОРЛОГО

- Нийт өрхийн 1/3-ийн орлого улирлын чанартай хөдөө аж ахуйн орлого байдаг.
- Барилга, зам гэх мэт бүтээн байгуулалтын салбарын ажил эрхлэлт улирлын чанартай байдаг.
- Өөрчлөлт хэлбэлзэл ихтэй.
- Орлогынхоо мэдээллийг нуудаг.

2. ХЭРЭГЛЭЭ

- Хэрэглээ нь орлогыг бодвол тогтвортой, өөрчлөлт багатай.
- Өрхүүд жилийн туршид хэрэглээгээ жигд хуваарилж тэгшитгэдэг.
- Өрхүүд орлогоосоо илүүгээр хэрэглээгээ мэдээлэх дуртай байдаг.

ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

Мөнгөн дүнгийн үзүүлэлт

Амьжиргааны түвшний үзүүлэлтийг сонгох нь:

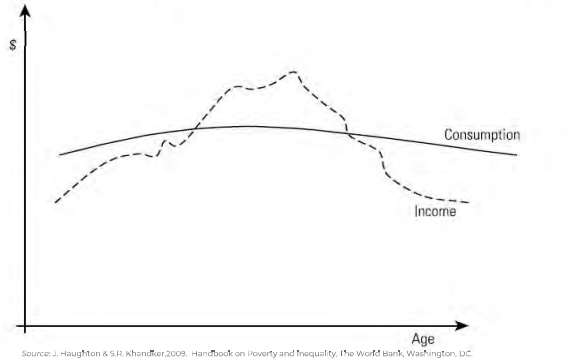
Хэрэглээ?
Орлого? } ***Аль нь вэ?***

Онол, практикийн асуудлын хүрээнд баримтлах зарчим, цуглуулагдах мэдээллийн боломжоос хамаарч сонголтыг хийсэн.

Бидний сонголт - “ХЭРЭГЛЭЭ”

ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

Figure 2.2 Lifecycle Hypothesis: Income and Consumption Profile over Time



Source: J. Haughton & S.R. Khandker,2009. Handbook on Poverty and Inequality, The World Bank, Washington, DC.

ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

Хэрэглээний бүрэлдэхүүн

1. Хүнсний хэрэглээ
2. Хүнсний бус хэрэглээ
3. Сууцны хэрэглээ
4. Удаан эдэлгээт барааны хэрэглээ
5. Түлш, эрчим хүчний хэрэглээ

Хэрэглээг бүрдүүлэхэд баримтлах үндсэн зарчмууд:

- Мэдээллийн боломжит эх үүсвэрүүдийг хамруулна.
- Зөвхөн хэрэглэсэн бараа, үйлчилгээг хамруулна.
- Хэрэглэсэн бараа, үйлчилгээг үнийн дүнгээр илэрхийлнэ.
- Худалдан авааг үйлчилгээсэн хүнсний зүйлийн нэр төрлүүдийн үнийн дүнг тодорхойлно.
- Хэрэглээг тодорхойлоход хамруулж байгаа хэрэглээ тус бүрийн хамралтын хугацаа ижил байна.

ЯДУУРЛЫН ШУГАМ

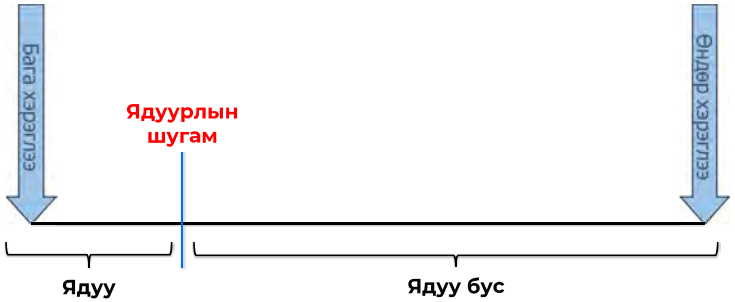
Монгол улс Дэлхийн банкны зөвлөмжийн дагуу ядуурлын тооцоог хийхдээ “Үндсэн хэрэгцээний зардлын арга” –аар тооцсон абсолют ядуурлын шугамыг хэрэглэж байна.

Ядуурлын шугам: Үндсэн хэрэгцээний зардлын арга

Хүний амьдралын **наад захын хэрэглээ** буюу хүний эрүүл, идэвхитэй амьдралыг хангахуйц илчлэгтэй хоол тэжээлийг худалдан авах болон хүнсний бус зайлшгүй хэрэглээнд шаардагдах зардлыг тооцох

ЯДУУРЛЫН ШУГАМ

Хэрэглээг тооцсоны дараа хүн амыг ядуу ба ядуу бус гэж ангилж, сонгогдсон үзүүлэлтүүдтэй харьцуулах боломжтой хэмжигдэхүүн хэрэгтэй.



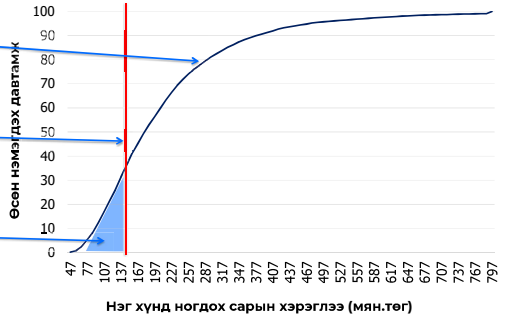
ЯДУУРЛЫГ ХЭРХЭН ХЭМЖДЭГ ВЭ?

Хэрэглээний тархалтын муруй

Хувь хүний амьжиргаа, аж байдлыг илэрхийлэх хэрэглээний үзүүлэлтээр хүн амын амьжиргааны түвшний тархалт

Ядуурлын шугам - Хувь хүний амьжиргааны түвшин уг шугамаас доош орвол түүнийг ядуу гэж тооцдог.

Ядуурлын үндсэн үзүүлэлтүүд - Хүн амын ядуурлын нэгдсэн статистик



ҮНДЭСНИЙ СТАТИСТИКИЙН ХОРОО

АНХААРАЛ ХАНДУУЛСАНД БАЯРЛАЛАА

WWW.NSO.MN WWW.1212.MN

ЦАЛИН ХӨЛС

✓ Хэрэв сүүлийн 1 сарын цалингийн орлого байхгүй бол сүүлийн 12 сарын цалингийн орлогыг 12-т хувааж авна.

БҮЛЭГ 4. ХӨДӨЛМӨР ЭРХЛЭЛТ

СҮҮЛИЙН 12 САРЫН ҮНДСЭН ХӨДӨЛМӨР ЭРХЛЭЛТ				
(4.34) [НЭР]-ын/ийн сүүлийн 12 сард эрхэлсэн үндсэн ажлын байгууллагын хариуцлагын хэлбэр юу вэ?	(4.35) [НЭР] сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?	(4.36) [НЭР] нь сүүлийн 12 сард үндсэн ажлаасаа хэдэн төгрөгийн цалин авсан бэ? *ЗӨВХӨН СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛНА. МӨН ТАТВАР, НИЙГМИЙН ДААТГАЛ, ЭРҮҮЛ МЭНДИЙН ДААТГАЛЫН ШИМТГЭЛИЙГ ХАССАН ДҮНГЭЭР БУЮУ ГАР ДЭЭР АВСАН ЦЭВЭР ЦАЛИНГ БҮРТГЭНЭ.* *МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.*		
Төрийн өмчит үйлдвэрийн газар 1 Орон нутгийн өмчит үйлдвэрийн газар 2 Төсөвт байгууллага 3 Төрийн бус байгууллага 4 Хувийн аж ахуйн нэгж байгууллага 5 Нөхөрлөл 6 Хоршоо 7 Улс төрийн нам 8 Бусад 9	Тийм 1 Үгүй 2 → (4.37)	Цалингийн дүн: Сүүлийн сард	Цалингийн дүн: Сүүлийн 12 сард	Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
		Төгрөг	Төгрөг	Төгрөг

СҮҮЛИЙН 12 САРЫН ҮНДСЭН АЖЛААС БУСАД БҮХ АЖЛЫН ОРЛОГО			
(4.49) [НЭР] **түр болон давхар эрхэлсэн бүх ажлаасаа** сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?	(4.50) [НЭР] нь сүүлийн 12 сард **түр болон давхар эрхэлсэн бүх ажлаасаа** нийт хэдэн төгрөгийн цалин авсан бэ? *СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛАХГҮЙ.* *МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.*		
Тийм 1 Үгүй 2 → Дараагийн хүн	Цалингийн дүн: Сүүлийн сард	Цалингийн дүн: Сүүлийн 12 сард	Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
	Төгрөг	Төгрөг	Төгрөг

ЦАЛИН ХӨЛС

✓ Сүүлийн 12 сард эрхэлсэн **үндсэн** болон **давхар** ажлын **сүүлийн 1 сарын цалингийн дундаж**.

БҮЛЭГ 4. ХӨДӨЛМӨР ЭРХЛЭЛТ

СҮҮЛИЙН 12 САРЫН ҮНДСЭН ХӨДӨЛМӨР ЭРХЛЭЛТ				
(4.34) [НЭР]-ын/ийн сүүлийн 12 сард эрхэлсэн үндсэн ажлын байгууллагын хариуцлагын хэлбэр юу вэ?	(4.35) [НЭР] сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?	(4.36) [НЭР] нь сүүлийн 12 сард үндсэн ажлаасаа хэдэн төгрөгийн цалин авсан бэ? *ЗӨВХӨН СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛНА. МӨН ТАТВАР, НИЙГМИЙН ДААТГАЛ, ЭРҮҮЛ МЭНДИЙН ДААТГАЛЫН ШИМТГЭЛИЙГ ХАССАН ДҮНГЭЭР БУЮУ ГАР ДЭЭР АВСАН ЦЭВЭР ЦАЛИНГ БҮРТГЭНЭ.* *МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.*		
Төрийн өмчит үйлдвэрийн газар 1 Орон нутгийн өмчит үйлдвэрийн газар 2 Төсөвт байгууллага 3 Төрийн бус байгууллага 4 Хувийн аж ахуйн нэгж байгууллага 5 Нөхөрлөл 6 Хоршоо 7 Улс төрийн нам 8 Бусад 9	Тийм 1 Үгүй 2 → (4.37)	Цалингийн дүн: Сүүлийн сард	Цалингийн дүн: Сүүлийн 12 сард	Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
		Төгрөг	Төгрөг	Төгрөг

СҮҮЛИЙН 12 САРЫН ҮНДСЭН АЖЛААС БУСАД БҮХ АЖЛЫН ОРЛОГО			
(4.49) [НЭР] **түр болон давхар эрхэлсэн бүх ажлаасаа** сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?	(4.50) [НЭР] нь сүүлийн 12 сард **түр болон давхар эрхэлсэн бүх ажлаасаа** нийт хэдэн төгрөгийн цалин авсан бэ? *СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛАХГҮЙ.* *МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.*		
Тийм 1 Үгүй 2 → Дараагийн хүн	Цалингийн дүн: Сүүлийн сард	Цалингийн дүн: Сүүлийн 12 сард	Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
	Төгрөг	Төгрөг	Төгрөг

ТЭТГЭВЭР, ТЭТГЭМЖ

✓ Сүүлийн 12 сарын НДС, НХС-гаас авсан тэтгэвэр, тэтгэмжийн хэмжээг 12-т хувааж, түүнээс дундаж тэтгэвэр, тэтгэмжийн хэмжээг авна.

НИЙГМИЙН ДААТГАЛЫН САН

[НЭР] сүүлийн 12 сард хэдий хэмжээний тэтгэвэр, тэтгэмж авсан бэ?

АВААГҮЙ БОЛ "0" ГЭЖ БИЧНЭ ҮҮ.

(5.07) Өндөр насны тэтгэвэр	(5.08) Хөгжлийн бэрхшээлтэй иргэний тэтгэвэр	(5.09) Тэжээгчээ алдсаны тэтгэвэр	(5.10) Хөдөлмөрийн чадвар түр алдсаны тэтгэмж	(5.11) Жирэмсний болон амаржсаны тэтгэмж	(5.12) Оршуулгын тэтгэмж	(5.13) Ажилгүйдлийн тэтгэмж	(5.14) Бусад нийгмийн даатгалын тэтгэвэр, тэтгэмж (сургалтын төлбөр, нөхөн сэргээх төлбөр, сувиллын зардал)
						Төгрөг	Төгрөг

НИЙГМИЙН ХАЛАМЖИЙН САН

[НЭР] сүүлийн 12 сард хэдий хэмжээний тэтгэвэр, тэтгэмж авсан бэ?

АВААГҮЙ БОЛ "0" ГЭЖ БИЧНЭ ҮҮ.

(5.16) Хөгжлийн бэрхшээлтэй иргэний тэтгэвэр	(5.17) Өндөр настны, тэжээгч нь нас барсан 18 хүртэлх насны хүүхдийн, өрх толгойлсон эх/эцгийн тэтгэвэр болон 16 насанд хүрсэн одой иргэний тэтгэвэр	(5.18) Жирэмсэн болон 0-3 хүртэлх насны хүүхэд асарсны тэтгэмж	(5.19) Асаргааны тэтгэмж (ахмад настан, хөгжлийн бэрхшээлтэй иргэнийг асарч байгаа иргэний болон хүнд нөхцөлд байгаа хүүхдийн асаргааны тэтгэмж)	(5.20) Хүнс тэжээлийн дэмжлэг үзүүлэх үйлчилгээ (хүнсний талон)	(5.21) Хүүхдийн мөнгө	(5.22) Ахмад настан, хөгжлийн бэрхшээлтэй иргэнд үзүүлэх амралт, рашаан сувиллын хөнгөлөлт	(5.23) 3 болон түүнээс дээш хүүхэдтэй өрх толгойлсон эх, эцэгт олгох тэтгэмж	(5.24) Эхийн алдар 1, 2 дугаар зэргийн одонгийн мөнгөн тусламж	(5.25) Бусад тэтгэмж, тусламж, хөнгөлөлт (насны хишиг, онцгой тохиолдлын болон амьжиргаа дэмжих бусад мөнгөн тэтгэмж, цаатан иргэнд олгох тэтгэмж, протез, ортопедийн болон түлшний хөнгөлөлт г.м)
Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг

ХАА-Н ҮЙЛДВЭРЛЭЛИЙН ОРЛОГО

1. МАА-н цэвэр ашиг = (МАА-н нийт орлого – МАА-н нийт зардал);
2. ГТ-гийн цэвэр ашиг = (ГТ-гийн нийт орлого – ГТ-гийн нийт зардал);
3. ХАА-н үйлдвэрлэлийн орлого = (МАА-н цэвэр ашиг + ГТ-гийн цэвэр ашиг);
4. ХАА-н үйлдвэрлэлийн орлого / 12

МАА-н орлого

МӨРИЙН ДУГААР	МАЛЫН ТӨРӨЛ	(6.02) Танайх одоо хадгалж [МАЛ]-тай байна уу? *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ* → *Даралгийн мал*			Сүүлийн 12 сард танайх хадгалж [МАЛ]..... *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ*		
		Бүгд	Үүнээс: Хээлтэгч	Төл	(6.03) Хүнсэндээ хэрэглэсэн	(6.04) Худалдсан *АМЬДААР БОЛОН НЯДАЛЖ ХУДАЛДСАНЫГ ОРУУЛНА.*	(6.05) Худалдсан малын нийт үнэ, төгрөгөөр
01	Үхэр						
02	Адуу						
03	Тэмээ						
04	Хонь						
05	Ямаа						
	ТУСЛАХ АЖ АХУЙ						
06	Бусад (тахиа, шувуу, гахай, зөгий, цаа буга)		x x x	x x x			
99	**Нийт**						

Мал худалдан борлуулсан нийт орлого

СҮҮЛИЙН 12 САРЫН БАЙДЛААР

МАА-н орлого

МӨРИЙН ДУГААР	БҮТЭЭГДЭХҮҮН		(6.08) Ашиг шимийг нь ашигласан малын тоо *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ* → *Даралгийн мөр*	(6.09) Нийт бүтээгдэхүүний хэмжээ	(6.10) Өрхийн хэрэгцээнд хэрэглэсэн хэмжээ	Худалдсан (6.11) Нийт хэмжээ	(6.12) Нийт үнэ, төгрөгөөр	Боловсруулж худалдсан (6.13) Нийт хэмжээ	(6.14) Нийт үнэ, төгрөгөөр
					БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ				
	НООС, ҮС, НООЛУУР, КГ								
01	Хонь	КГ							
02	Тэмээ	КГ							
03	Ямааны ноолуур	КГ							
04	Үхэр, адууны хөөвөр, хяслас	КГ							
	АРЬС, ШИР, ШИРХЭГЭЭ								
05	Хонь	ШИРХЭГ	XXXXX						
06	Ямаа	ШИРХЭГ	XXXXX						
07	Үхэр	ШИРХЭГ	XXXXX						
08	Адуу	ШИРХЭГ	XXXXX						
09	Тэмээ	ШИРХЭГ	XXXXX						
	СҮҮ, ЛИТРЭЭР								
10	Хонины	ЛИТР							
11	Ямааны	ЛИТР							
12	Үнээний	ЛИТР							
13	Айраг	ЛИТР							
14	Ингэний	ЛИТР							
	БУСАД БҮТЭЭГДЭХҮҮН								
15	Өндөг	ШИРХЭГ	XXXXX						
16	Зөгийн бал	КГ	XXXXX						
17	Бусад		XXXXX						

Малын ашиг шим, боловсруулж худалдсан бүтээгдэхүүний нийт орлого

ХАА-Н ҮЙЛДВЭРЛЭЛИЙН ОРЛОГО

2. ГТ-гийн цэвэр ашиг = (ГТ-гийн нийт орлого – ГТ-гийн нийт зардал)

МӨРИЙН ДУГААР	НЭР ТӨРӨЛ	(6.19) Сүүлийн 12 сард та [НЭР ТӨРӨЛ] үргэлж хураан авсан уу? Тийм 1 Үгүй 2 → *Даралгийн бүтээгдэхүүн*	(6.20) Сүүлийн 12 сард хураан авсан нийт [НЭР ТӨРӨЛ] ургацын хэмжээ, килограммаар	Үүнээс: (6.21) Өрхийн хэрэгцээнд хэрэглэсэн	(6.22) Малын тэжээлд зориулсан	(6.23) Худалдсан *БОЛОВСРУУЛАЛТ ХИЙЖ ХУДАЛДСАНЫГ ОРУУЛНА.* Хэмжээ, кг	Бүгд үнэ, төгрөгөөр
				БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ.			
01	Төмс						
02	Пуувын						
03	Манжин						
04	Байцай						
05	Хүрэн манжин						
06	Сонгино						
07	Сармис						
08	Улаан лооль						
09	Өргөст хэмх						
10	Жимс, жимсгэнэ						
11	Улаан буудай						
12	Хадлан			x x x x			
13	Бусад (арвай, овъёос, хөх тариа гэх мэт)						
99	**Нийт**	xxxxx					

МӨРИЙН ДУГААР	ЗАРДЛЫН НЭР ТӨРӨЛ	(6.24) Сүүлийн 12 сард хэдэн төгрөгийн зардал гарсан бэ? *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ*
01	Үр	
02	Бордоо	
03	Хортон шавьж, устгал	
04	Цаглин хөлс	
05	Тоног төхөөрөмж	
06	Салбаг хэрэгсэл	
07	Засвар, үйлчилгээ	
08	Түүхий эд, материал	
09	Шатахуун	
10	Татвар, даатгал, хураамж	
11	Тээвэр	
12	Түрээс	
13	Бусад (үүр, ус, цахилгаан, дулаан, халаалт, шуудан, холбоо гэх мэт)	
99	**Нийт зардал**	

Газар тариалангийн бүтээгдэхүүн худалдан борлуулсан нийт орлого

Газар тариалан эрхлэхтэй холбогдож гарсан нийт зардал

ХАА-Н ҮЙЛДВЭРЛЭЛИЙН ОРЛОГО

1. МАА-н цэвэр ашиг = (МАА-н нийт орлого – МАА-н нийт зардал)

МАА-н зардал

МӨРИЙН ДУГААР	МӨНГӨН ЗАРДАЛ: ЗАРДЛЫН НЭР ТӨРӨЛ	(6.06) Сүүлийн 12 сард мал аж ахуй эрхлэхтэй холбогдож гарсан зардал, төгрөгөөр *ЗАРДАЛ ГАРААГҮЙ БОЛ "0" ГЭЖ НӨХНӨ*
01	Малын тэжээл	
02	Малын эм, тариргын зардал	
03	Шатахуун	
04	Татвар, даатгал	
05	Цаглин хөлс	
06	Хашаа, хороо, тоног төхөөрөмж	
07	Малтай болох зорилгоор мал худалдан авсан	
08	Бусад (Засвар үйлчилгээ, үүр, ус, цахилгаан, дулаан, халаалт, түрээс гэх мэт)	
99	**Нийт зардал**	

Мал аж ахуй эрхлэхтэй холбогдож гарсан нийт зардал

ХАА-Н БУС ҮЙЛДВЭРЛЭЛ, ҮЙЛЧИЛГЭЭНИЙ ОРЛОГО

1. ХАА-н бус үйлдвэрлэл, үйлчилгээний цэвэр ашиг = (ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт орлого – ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт зардал);
2. ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого = ХАА-н бус үйлдвэрлэл, үйлчилгээний цэвэр ашиг * (өрхийн тухайн үйлдвэрлэл, үйлчилгээнээс эзэмшиж буй хувь / 100);
3. ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого / 12

	ҮЙЛДВЭРЛЭЛ, ХУДАЛДАА, ҮЙЛЧИЛГЭЭ ' 1
(7.03) Үйлдвэрлэл, худалдаа, үйлчилгээнийхээ нэрийг хэлнэ үү? *ЭДИЙН ЗАСГИЙН ҮЙЛ АЖИЛЛАГААНЫ АНГИЛЛЫН КОДЫГ БИЧНЭ.*	Код:
(7.04) Энэ үйлдвэрлэл, худалдаа, үйлчилгээний хэдэн хувийг танай өрхийн гишүүд эзэмшдэг вэ?	%

Өрхийн тухайн үйлдвэрлэл, үйлчилгээнээс эзэмшиж буй хувь

ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого

		Сарын тоо	
(7.08) Сүүлийн 12 сарын байдлаар энэ үйлдвэрлэл, худалдаа, үйлчилгээг хэдэн сар эрхэлсэн бэ?			
(7.09) Энэ үйлдвэрлэл, худалдаа, үйлчилгээний тухайн сарын борлуулалт хэдэн төгрөг байсан бэ?		Төгрөг	Сар
ЯРИЛЦЛАГА ХИЙЖ БУЙ САРААС ӨМНӨХ 12 САРЫН ХУГАЦААН ДАХЬ САР БҮРИЙН ҮНИЙН ДҮНГИЙН ТАЛААР АСУУЖ БИЧНЭ.	Ярилцлага авсан сараас 12 сарын өмнөх I		
	Ярилцлага авсан сараас 11 сарын өмнөх II		
	Ярилцлага авсан сараас 10 сарын өмнөх III		
	Ярилцлага авсан сараас 9 сарын өмнөх IV		
	Ярилцлага авсан сараас 8 сарын өмнөх V		
	Ярилцлага авсан сараас 7 сарын өмнөх VI		
	Ярилцлага авсан сараас 6 сарын өмнөх VII		
	Ярилцлага авсан сараас 5 сарын өмнөх VIII		
	Ярилцлага авсан сараас 4 сарын өмнөх IX		
	Ярилцлага авсан сараас 3 сарын өмнөх X		
	Ярилцлага авсан сараас 2 сарын өмнөх XI		
	Ярилцлага авсан сар/1 сарын өмнөх XII		
(7.10) Сүүлийн 12 сарын нийт борлуулалт = (I + II +III + ... XI + XII)			

ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт орлого

ХАА-Н БУС ҮЙЛДВЭРЛЭЛ, ҮЙЛЧИЛГЭЭНИЙ ОРЛОГО

ХАА-н бус үйлдвэрлэл, үйлчилгээний зардал

(7.07) Сүүлийн 12 сард хэдэн төгрөгийн мөнгөн зардал гарсан бэ?			
	01	Ажилчдад олгосон цалин	
	02	Борлуулахаар авсан бараа	
	03	Түүхий эд, материал	
	04	Шатахуун, шатах тослох материал	
	05	Уур, ус, цахилгаан эрчим хүч, дулаан халаалт	
	06	Тоног төхөөрөмж	
	07	Орон байрны түрээс	
	08	Сэлбэг, хэрэгсэл	
	09	Засвар үйлчилгээ	
	10	Татвар, хураамж, патент, лиценз, даатгал	
	11	Бусад зардал (тээврийн зардал, шуудан, холбоо, интернет, зээлийн	
	99	**Нийт зардал**	

ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт зардал

БУСАД ОРЛОГО

1. Бусад орлого = Бусдаас авсан бэлэг, тусламж, хандив + Хурдан морь зарж борлуулсан орлого + Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/ + Бусад эх үүсвэрийн орлого + Хүү болон ашгийн орлого
2. Бусад орлого / 12

Хурдан морь зарж борлуулсан орлого

МӨРИЙН ДУГААР	МАЛЫН ТӨРӨЛ	(6.02) Танайх одоо хэдэн [МАЛ]-тай байна вэ? *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ* → ***Дараагийн мал***			Сүүлийн 12 сард танайх хэдэн [МАЛ]........ *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ*		
		Бүгд	Үүнээс: Хээлтэгч	Үүнээс: Төл	(6.03) Хүнсэндээ хэрэглэсэн	(6.04) Худалдсан *АМЬДААР БОЛОН НЯДАЛЖ ХУДАЛДСАНЫГ ОРУУЛНА.*	(6.05) Худалдсан малын нийт үнэ, төгрөгөөр
01	Үхэр						
02	а. Адуу						
	б. Хурдан морь	x x x	x x x	x x x	x x x		
03	Тэмээ						
04	Хонь						
05	Ямаа						

Үндсэн болон давхар эрхэлсэн бүх ажлын урамшуулал /Тэтгэвэрт гарсны тэтгэмж/

Цалингийн дүн		Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
Сүүлийн сард	Сүүлийн 12 сард	
Төгрөг	Төгрөг	Төгрөг

БУСАД ОРЛОГО

1. Бусад орлого = Бусдаас авсан бэлэг, тусламж, хандив + Хурдан морь зарж борлуулсан орлого + Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/ + Бусад эх үүсвэрийн орлого + Хүү болон ашгийн орлого
2. Бусад орлого / 12

БҮЛЭГ 5. БУСАД ОРЛОГО — ХЭСЭГ В. **БУСДААС АВСАН БЭЛЭГ, ТУСЛАМЖ, ХАНДИВ**

(5.47) Сүүлийн 12 сард танай өрхийн гишүүд хувь хүн, хамаатан, найз нөхөд болон тусламжийн байгууллагаас мөнгөн болон мөнгөн бус хэлбэрээр бэлэг, тусламж, хандив авсан уу? *БОЛОВСРОЛЫН ЗОРИУЛАЛТААР /СУРГАЛТЫН ТӨЛБӨРӨӨС БУСАД ЗАРДАЛ/ АВСАН БЭЛЭГ, ТУСЛАМЖИЙГ ЭНД ОРУУЛАХ БӨГӨӨД БУЦААЖ ТӨЛӨХ МӨНГӨН БОЛОН МӨНГӨН БУС ТУСЛАМЖИЙГ ЭНД ОРУУЛАХГҮЙ.*

Тийм	1	
Үгүй	2 →	БҮЛЭГ 6

МӨРИЙН ДУГААР	(5.48) *БЭЛЭГ, ТУСЛАМЖ, ХАНДИВ АВСАН ХҮНИЙ ХУВИЙН ДУГААРЫГ БИЧНЭ ҮҮ.* *БЭЛЭГ, ТУСЛАМЖ, ХАНДИВ АВСАН ТОХИОЛДОЛ БҮРИЙГ САЛГАЖ БИЧНЭ.*	(5.49) Хэн, ямар байгууллага бэлэг, тусламж, хандив өгсөн бэ?	(5.50) Бэлэг, тусламж, хандивыг та юунд зарцуулсан бэ?	(5.51) Бэлэг, тусламж, хандив хаанаас ирсэн бэ?	(5.52) Та сүүлийн 12 сард ойролцоогоор хичнээн төгрөг авсан бэ?	(5.53) Энэ бэлэг, тусламж, хандив тогтмол хугацаанд ирдэг үү?	(5.54) Бэлэг, тусламж, хандивыг ямар байдлаар хүлээн авдаг вэ?
		Аж ахуй нэгж байгууллага 1 Төрийн бус байгууллага 2 Эцэг, эх, үр хүүхэд, төрөл садан 3 Бусад хүн (найзууд, хөршүүд) 4 Гадаадын болон олон улсын байгууллага, гадаадын иргэн 5 Бусад 6	Өрхийн хэрэглээ 1 Боловсрол 2 Эмчилгээ 3 Сууцтай болох 4 Баяр ёслол 5 Оршуулгын 6 Өрхийн үйлдвэрлэл, бизнес 7 Бусад 8	Дотоод: Нийслэл 1 Аймгийн төв 2 Сумын төв 3 Хөдөө 4 Гадаад 5		Тийм 7 хоног бүр 1 Сар бүр 2 Улирал бүр 3 Жил бүр 4 Үгүй 5	Бэлэн мөнгөөр 1 Дансаар 2 Мөнгөн гуйвуулгаар 3 Мөнгөн бус хэлбэрээр 4 Бусад 5
	Хувийн дугаар				Төгрөг		
01							
02							
03							

БУСАД ОРЛОГО

1. Бусад орлого = Бусдаас авсан бэлэг, тусламж, хандив + Хурдан морь зарж борлуулсан орлого + Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/ + Бусад эх үүсвэрийн орлого + Хүү болон ашгийн орлого
2. Бусад орлого / 12

БУСАД ЭХ ҮҮСВЭР				
[НЭР] сүүлийн 12 сард хэдий хэмжээний орлого олсон бэ? БАЙХГҮЙ БОЛ **"0"** ГЭЖ БИЧНЭ ҮҮ.				
Өөрийн эзэмшлийн хөрөнгийг түрээслсэн (сууц, машин, тоног төхөөрөмж, газар)	Үндсэн хөрөнгө борлуулсан	Бусдад зээлдүүлсэнээс эргэж төлөгдсөн	Хадгаламжаас авсан	Бусад эх үүсвэрийн орлого
Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг

ХҮҮ БОЛОН АШИГ			
[НЭР] сүүлийн 12 сард хэдий хэмжээний орлого олсон бэ? БАЙХГҮЙ БОЛ "0" ГЭЖ БИЧНЭ ҮҮ.			
Хадгаламжийн хүү	Хувьцааны ноогдол ашиг	Зээлийн хүү	Бусад (оюуны өмчийн болон бусад)
Төгрөг	Төгрөг	Төгрөг	Төгрөг

БУСДААС ҮНЭГҮЙ АВСАН ХҮНСНИЙ БОЛОН ХҮНСНИЙ БУС БҮТЭЭГДЭХҮҮН

Бусдаас үнэгүй авсан **хүнсний** болон **хүнсний бус бүтээгдэхүүнийг** мөнгөн бус хэлбэрээр авсан бол тухайн үеийн зах зээлийн үнээр /тухайн нутаг дэвсгэрийн голч үнэ/ үнэлэн мөнгөн дүнгээр илэрхийлж тодорхойлно.

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ ӨРӨЙН ӨДРИЙН ТЭМДЭГЛЭЛ ЭЭС

			ДАРААХ МӨДӨЛЛИЙГ ӨРӨЙН ӨДРИЙН ТЭМДЭГЛЭЛ ЭЭС 7 ХОНОГИЙН ХЭРЭГЛЭЭГ НӨГТГЭН МӨНӨӨ. ХЭРВЭЭ ӨРХ ТУХАЙН НЭР ТӨРЛИЙГ ХЭРЭГЛЭЭГИЙ БОЛ "0" ГЭЖ БИЧНЭ				
			ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР			
	Улаанбаатар, аймгийн төвийн		(13.01) 7 хоногийн хугацаанд хэдий хэмжээгээр [НЭР ТӨРӨЛ] хэрэглэсэн бэ? (13.01)=(13.02)+(13.04)+(13.05)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА
				(13.02) Худалдан авсанаас хэрэглэсэн	(13.03) Худалдан авсан нэгжийн үнэ	(13.04) Бусдаас үнэгүй авсанаас хэрэглэсэн	(13.05) Өөрийн аж ахуйгаас хэрэглэсэн
	НЭР ТӨРӨЛ	НЭГЖ	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	ТӨГРӨГ /[нэгж]/	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ
10100	УР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН						
10101	Талх (ш670гр)	ш			/ш/		
10102	Цагаан будаа	кг			/кг/		
10103	Гурил, дэд зэрэг	кг			/кг/		

Бусдаас үнэгүй авч хэрэглэсэн **хүнсний бүтээгдэхүүн *** 4.285714286 /сард шилжүүлнэ/

БУСДААС ҮНЭГҮЙ АВСАН ХҮНСНИЙ БОЛОН ХҮНСНИЙ БУС БҮТЭЭГДЭХҮҮН

Бусдаас үнэгүй авч хэрэглэсэн **хүнсний бус бүтээгдэхүүний** нийт мөнгөн дүн / 12

ХЭРВЭЭ ӨРХИЙН ГИШҮҮН БУС ХҮНД ӨГӨХӨӨР ХУДАЛДАН АВСАН БОЛ 22801-Т БИЧНЭ

НЭР ТӨРЛИЙН КОД	АСУУЛТ (12.01)-МЭЙ БУХ НЭР ТӨРЛӨӨР АСУУХ. СУУЛИЙН 12 САРЫН ДОТОР ХУДАЛДАН АВСАН ЭСЭХИЙГ ТОДОРХОЙЛЖ, ХУДАЛДАН АВСАН "ТИЙМ-1" ГЭЖ ХАРИУЛСАН БОЛ ЭӨВХӨН ТУХАЙН НЭР ТӨРЛИЙГ ТОДОТГОН АСУУЛТ (12.02-12.04)-ЫГ АСУУНА. (12.01) Танай өрхийн хэн нэгэн гишүүн дараах нэр төрлийн бүтээгдэхүүнийг өөртөө хэрэглэхээр сүүлийн 12 сарын дотор худалдан авсан уу? Мөн бусдаас үнэгүй авсан уу? Тийм 1 Үгүй 2 → Дараагийн нэр төрөл	ХУДАЛДАН АВАЛТ (12.02) Сүүлийн 1 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ-ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	ХУДАЛДАН АВАЛТ (12.03) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ -ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	БУСДААС ҮНЭГҮЙ АВСАН (12.04) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүдийн бусдаас үнэгүй авсан НЭР ТӨРӨЛ хэдэн төгрөг болох вэ?
20100	Бэлэн хувцас (эрэгтэй, эмэгтэй, хүүхэд)			
20101	Савхин болон илэн куртка, дээл			
20102	Нэхий болон үслэг дээл, шуба			
20103	Өвлийн пальто, куртка			
20104	Бусад куртка, пальто, цув, пельник			

БУСДААС ҮНЭГҮЙ АВСАН ХҮНСНИЙ БОЛОН ХҮНСНИЙ БУС БҮТЭЭГДЭХҮҮН

Сумын төв, хөдөөгийн

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ САНУУЛЖ АСУУНА.

	(14.01)-РАСУУЛТЫГ БУХ НЭР ТӨРЛӨӨР АСУУХ. "ТИЙМ" БОЛ ЭХНИЙ БАГАНД "1", "ҮГҮЙ" БОЛ ХОЁРДАХЬ БАГАНАД "2" ГЭЖ ТАВИАД, ЗӨВХӨН "1" ГЭЖ ХАРИУЛСАН ТОХИОЛДОЛД (14.02)-ООС (14.06) ХҮРТЭЛХ АСУУЛТЫГ АСУУНА. (14.01) Танай өрх сүүлийн 7 хоног [НЭР ТӨРӨЛ] хэрэглэсэн үү. Тийм 1 Үгүй 2 → Дараагийн нэр төрөл	СУУЛИЙН 7 ХОНОГИЙН ХЭРЭГЛЭЭ				
		ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР				
		(14.02) Сүүлийн 7 хоног [НЭР ТӨРӨЛ] хэдий хэмжээгээр хэрэглэсэн бэ? (14.02)=(14.03)+(14.04)+(14.05)+(14.06)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА	
			(14.03) Худалдан авсанаас хэрэглэсэн	(14.04) Худалдан авсан нэгжийн үнэ	(14.05) Бусдаас үнэгүй авсанаас хэрэглэсэн	(14.06) Өөрийн аж ахуйгаас хэрэглэсэн	
	НЭР ТӨРӨЛ НЭГЖ	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	ТӨГРӨГ /[нэгж]/	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	
10100	УР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН						
10101	Талх (ш670гр) ш			/ш/			
10102	Цагаан будаа кг			/кг/			
10103	Гурил, дэд зэрэг кг			/кг/			

Бусдаас үнэгүй авч хэрэглэсэн **хүнсний бүтээгдэхүүн *** 4.285714286 /сард шилжүүлнэ/

НЭР ТӨРЛИЙН КОД	АСУУЛТ (12.01)-МЭЙ БУХ НЭР ТӨРЛӨӨР АСУУХ. СУУЛИЙН 12 САРЫН ДОТОР ХУДАЛДАН АВСАН ЭСЭХИЙГ ТОДОРХОЙЛЖ, ХУДАЛДАН АВСАН "ТИЙМ-1" ГЭЖ ХАРИУЛСАН БОЛ ЭӨВХӨН ТУХАЙН НЭР ТӨРЛИЙГ ТОДОТГОН АСУУЛТ (12.02 - 12.04)-ЫГ АСУУНА. (12.01) Танай өрхийн хэн нэгэн гишүүн дараах нэр төрлийн бүтээгдэхүүнийг өөртөө хэрэглэхээр сүүлийн 12 сарын дотор худалдан авсан уу? Мөн бусдаас үнэгүй авсан уу? Тийм 1 Үгүй 2 → Дараагийн нэр төрөл	ХУДАЛДАН АВАЛТ (12.02) Сүүлийн 1 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ-ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	ХУДАЛДАН АВАЛТ (12.03) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ -ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	БУСДААС ҮНЭГҮЙ АВСАН (12.04) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүдийн **бусдаас** үнэгүй авсан НЭР ТӨРӨЛ хэдэн төгрөг болох вэ?
21801	Зоогийн газар, кафе, үүнтэй ижил зэрэглэлийн үйлчилгээний газар			
21802	Цайны газар, гуанз			

Өрхөөс гадуур хооллохдоо өрхийн гишүүдийн бусдаас үнэгүй авсан хоолны мөнгөн дүнг 12-т хуваааж, түүнээс дундаж хэмжээг авна.

ӨӨРИЙН ХУВИЙН АЖ АХУЙГААС ХЭРЭГЛЭСЭН ХҮНСНИЙ БҮТЭЭГДЭХҮҮН

Өөрийн хувийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүнийг тухайн үеийн зах зээлийн үнээр /тухайн нутаг дэвсгэрийн голч үнэ/ үнэлэн мөнгөн дүнгээр илэрхийлж тодорхойлно.

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ ӨРӨЙН ӨДРИЙН ТЭМДЭГЛЭЛ ЭЭС

			ДАРААХ МӨДӨЛЛИЙГ ӨРӨЙН ӨДРИЙН ТЭМДЭГЛЭЛ ЭЭС 7 ХОНОГИЙН ХЭРЭГЛЭЭГ НӨГТГЭН МӨНӨӨ. ХЭРВЭЭ ӨРХ ТУХАЙН НЭР ТӨРЛИЙГ ХЭРЭГЛЭЭГИЙ БОЛ "0" ГЭЖ БИЧНЭ				
			ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР			
			(13.01) 7 хоногийн хугацаанд хэдий хэмжээгээр [НЭР ТӨРӨЛ] хэрэглэсэн бэ? (13.01)=(13.02)+(13.04)+(13.05)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА
				(13.02) Худалдан авсанаас хэрэглэсэн	(13.03) Худалдан авсан нэгжийн үнэ	(13.04) Бусдаас үнэгүй авсанаас хэрэглэсэн	(13.05) Өөрийн аж ахуйгаас хэрэглэсэн
	НЭР ТӨРӨЛ	НЭГЖ	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	ТӨГРӨГ /[нэгж]/	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ
10100	УР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН						
10101	Талх (ш670гр)	ш			/ш/		
10102	Цагаан будаа	кг			/кг/		
10103	Гурил, дэд зэрэг	кг			/кг/		

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ САНУУЛЖ АСУУНА.

	(14.01)-РАСУУЛТЫГ БУХ НЭР ТӨРЛӨӨР АСУУХ. "ТИЙМ" БОЛ ЭХНИЙ БАГАНД "1", "ҮГҮЙ" БОЛ ХОЁРДАХЬ БАГАНАД "2" ГЭЖ ТАВИАД, ЗӨВХӨН "1" ГЭЖ ХАРИУЛСАН ТОХИОЛДОЛД (14.02)-ООС (14.06) ХҮРТЭЛХ АСУУЛТЫГ АСУУНА. (14.01) Танай өрх сүүлийн 7 хоног [НЭР ТӨРӨЛ] хэрэглэсэн үү. Тийм 1 Үгүй 2 → Дараагийн нэр төрөл	СУУЛИЙН 7 ХОНОГИЙН ХЭРЭГЛЭЭ				
		ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР				
		(14.02) Сүүлийн 7 хоног [НЭР ТӨРӨЛ] хэдий хэмжээгээр хэрэглэсэн бэ? (14.02)=(14.03)+(14.04)+(14.05)+(14.06)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА	
			(14.03) Худалдан авсанаас хэрэглэсэн	(14.04) Худалдан авсан нэгжийн үнэ	(14.05) Бусдаас үнэгүй авсанаас хэрэглэсэн	(14.06) Өөрийн аж ахуйгаас хэрэглэсэн	
	НЭР ТӨРӨЛ НЭГЖ	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	ТӨГРӨГ /[нэгж]/	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	
10100	УР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН						
10101	Талх (ш670гр) ш			/ш/			
10102	Цагаан будаа кг			/кг/			
10103	Гурил, дэд зэрэг кг			/кг/			

ҮНДЭСНИЙ
СТАТИСТИКИЙН
ХОРОО

АНХААРАЛ ХАНДУУЛСАНД БАЯРЛАЛАА

WWW.NSO.MN WWW.1212.MN

ҮНДЭСНИЙ СТАТИСТИКИЙН ХОРОО

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ, САЛБАР ХООРОНДЫН ТЭНЦЭЛ

БХАГ, ҮТХ, Б.БАЯРМАА

2023 оны 03 сарын 24

ҮНДЭСНИЙ СТАТИСТИКИЙН ХОРОО

АГУУЛГА

1. Нөөц, ашиглалтын хүснэгт
2. Салбар хоорондын тэнцэл
3. Хүндрэл бэрхшээл, тулгарч буй асуудал
4. Мэдээлэл тархаалт

СХТ, НАХ-ийг Монгол Улс байгуулсан туршлага

- СХТ-ийн УААА-н балансын системийн зарчмаар анх 1966 оноор байгуулсан
- СХТ-ийг 1970, 1975, 1983, 1987, 1993, 1997, 2000, 2005 онуудаар зохиогдсон

ҮТС-д 1990-ээд оноос үе шаттайгаар шилжиж эхэлсэн.

- НАХ–ийг 1997, 2000, 2005, 2010, 2015 онуудад – суурь НАХ байгуулсан
- Жилийн НАХ 2013 оноос эхлэн 2010 оны суурь НАХ-д үндэслэн байгуулсан (2010-2019)

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

I. ДОТООДЫН НИЙТ БҮТЭЭГДЭХҮҮН

Үйлдвэрлэл − ЗХ = ЭХ + ХНХ + экспорт − импорт

ДНБ (Ү) = ДНБ (Э)

Үйлдвэрлэл + импорт = ЗХ + ЭХ + ХНХ + экспорт

Нөөц = Ашиглалт

II. БАРАА, ҮЙЛЧИЛГЭЭНИЙ ДАНС

III. НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

Бараа, үйлчилгээний дансны хамгийн дэлгэрэнгүй хувилбарыг НАХ хэлбэрээр илэрхийлж болно

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

Арга зүй: “Нөөц, ашиглалтын хүснэгт, салбар хоорондын тэнцэл байгуулах аргачлал” (ҮСХ-ны даргын 2013 оны 151 тоот тушаал)

Давтамж:
- ✓ Суурь нөөц, ашиглалтын хүснэгт /5 жил тутам/
- ✓ Жилийн нөөц, ашиглалтын хүснэгт /жил бүр/

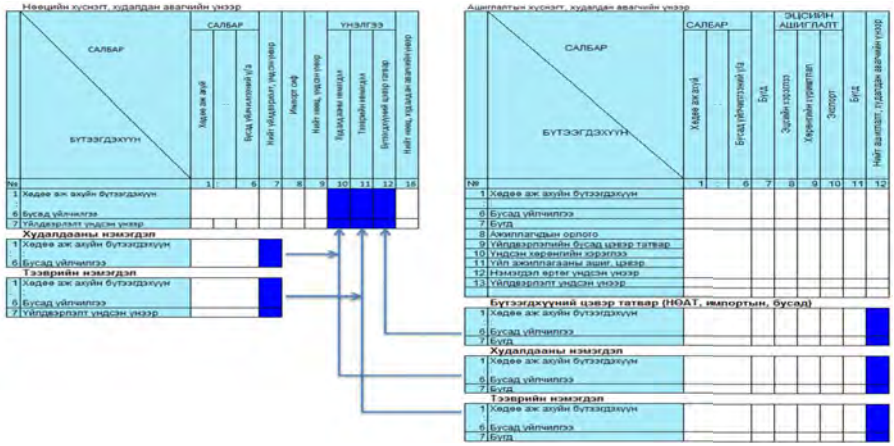
Ангилал:
- ✓ Эдийн засгийн үйл ажиллагааны салбарын ангилал (ISIC 4)
- ✓ Бүтээгдэхүүний нэгдсэн ангилал (CPC 2.1)
- ✓ Бүтээгдэхүүний эдийн засгийн ерөнхий ангилал (BEC 5)
- ✓ Бараат тодорхойлох, кодлох, уялдуулах систем (HS)
- ✓ Хувийн хэрэглээний зориулалттай бараа, үйлчилгээний ангилал (COICOP)
- ✓ Бараат тодорхойлох, кодлох, уялдуулах систем (HS)
- ✓ Санхүүгийн болон санхүүгийн бус хөрөнгийн ангилал, код

Хэмжээс:
- ✓ Нөөц болон ашиглалтын хүснэгт – [311 бүт. х 203 салбар], [173 бүт.х 130 салбар],
- ✓ Салбар хоорондын тэнцэл - [55 х 55 салбар], [53 х53 салбар]

Хэрэглээ:
- ✓ ДНБ-ийг шинэчлэх суурь мэдээлэл болно (жилийн ДНБ, улирлын ДНБ),
- ✓ НАХ-д үндэслэн СХТ-ийг хөрвүүлэн байгуулна

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

Нөөц, ашиглалтын хүснэгт - бүтэц



НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

НАХ-ийн хэрэглээ, ач холбогдол

Статистик ач холбогдолтой:
- Мэдээллийн олон тооны эх үүсвэрт харьцуулалт хийж, залруулах боломж
- ҮТ-ны өөр өөр үнэлгээний түвшинг өөртөө агуулсан
- ДНБ-ий 3 аргын тооцоо тэнцүү гарна
- Тэгш хэмт СХТ-ийг байгуулах суурь мэдээлэл нь болдог
- ДНБ-ийг зэрэгцүүлэх үнээр үнэлэх боломж

Судалгааны ач холбогдолтой
- Дагавар данс (өргөжүүлэх)
- Эдийн засгийн загварчлал, бүтцийн шинжилгээ, бүтээмжийн шинжилгээ

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

НАХ байгуулах дараалал

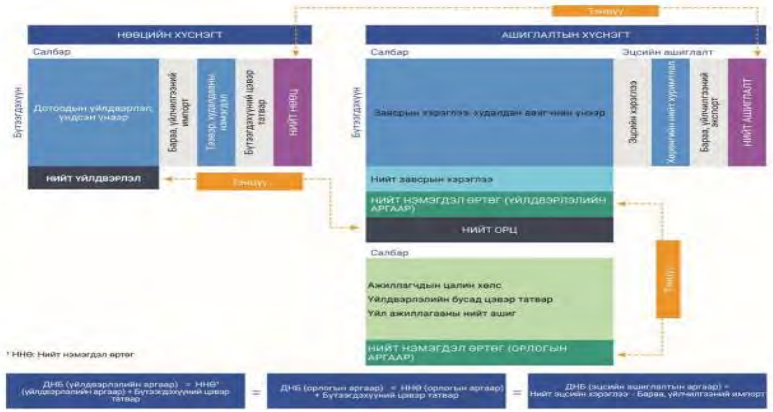
1. Нөөцийн хүснэгтийг үндсэн үнээр байгуулна (2 матриц). Үүнд:
- -Үйлдвэрлэлийн матриц, *бүтээгдэхүүн, салбараар*
- -Импортын матриц, *бүтээгдэхүүн, баганан вектороор*

2. Ашиглалтын хүснэгтийг худалдан авагчийн үнээр байгуулна (3 матриц). Үүнд:
- - ЗХ-ний матриц, *бүтээгдэхүүн, салбараар*
- - Эцсийн ашиглалтын баганан матриц, *бүтээгдэхүүн, эцсийн ашиглалтын үзүүлэлтүүдээр*
- - НӨ-ийн матриц, *нэмэгдэл өртгийн үзүүлэлтүүд, салбараар*

3. Ашиглалт талын үнэлгээний матрицуудыг байгуулна (3 матриц). Үүнд:
- - Худалдааны нэмэгдлийн матриц, *бүтээгдэхүүн, эцсийн ашиглалтын үзүүлэлтүүдээр*
- - Тээврийн нэмэгдлийн матриц, *бүтээгдэхүүн эцсийн ашиглалтын үзүүлэлтүүдээр*
- - Бүтээгдэхүүний цэвэр татварын матриц, *бүтээгдэхүүн, эцсийн ашиглалтын үзүүлэлтүүдээр*

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

НАХ-ийн хамрах хүрээ



НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

Монгол Улсын “Статистикийн тухай” хуулийн 7 дугаар зүйлийн 1 дэх хэсгийн заалт
б/ **“Салбар хоорондын тэнцэл, нөөц, ашиглалтын хүснэгтийг 5 жил тутам” байгуулна.**

- Малын ашиг шимийн гарцын судалгаа,
- ХАА-н бүтээгдэхүүний үйлдвэрлэгчийн үнийн судалгаа,
- ХАА-н үйлдвэрлэлийн орлого, зарлагын судалгаа

НӨӨЦ, АШИГЛАЛТЫН ХҮСНЭГТ

НАХ-ийн баланслалт

- Нөөцийн хүснэгтийг худалдан авагчийн үнээр байгуулна.
- Ашиглалтын хүснэгтийг үндсэн үнэд шилжүүлнэ.
- Импортын матрицыг байгуулна.
- Дотоодын ашиглалтын хүснэгтийг үндсэн үнээр байгуулна *(үндсэн үнээр тооцсон ашиглалтын хүснэгтээс импортын матрицыг хасна)*.
- Нөөцийн хүснэгтийг ашиглалтын хүснэгттэй баланслуулна *(үндсэн үнэ болон худалдан авагчийн үнээр)*.

Баланслалт:

- Бүтээгдэхүүний түвшинд
- Салбарын түвшинд

САЛБАР ХООРОНДЫН ТЭНЦЭЛ

НАХ-ЭЭС СХТ БАЙГУУЛАХ ЗАГВАРУУД:

САЛБАР ХООРОНДЫН ТЭНЦЭЛ

СХТ-ийн бүтэц

Салбар	Салбар			Эцсийн ашиглалт			Нийт ашиглалт
	Хөдөө аж ахуй	Үйлдвэр-лэл	Үйлчил-гээ	Эцсийн хэрэглээ	Нийт хөрөнгийн хуримтлал	Экс-порт	
Хөдөө аж ахуй Үйлдвэрлэл Үйлчилгээ	Завсрын хэрэглээ, салбар, салбараар			Эцсийн ашиглалт, салбараар, бүрэлдэхүүнээр			**Нийт ашиглалт, салбараар**
Импорт	Нийт импорт, салбараар						
Нэмэгдэл өртөг	Нэмэгдэл өртөг, бүрэлдэхүүнээр, салбараар						
Нөөц	**Нийт нөөц, салбараар**			**Нийт эцсийн ашиглалт, бүрэлдэхүүнээр**			

ХҮНДРЭЛ, БЭРХШЭЭЛ, АСУУДАЛ

- ✓ ААНБ-аас нэгжийн түвшинд зардал, хөрөнгийн дэлгэрэнгүй мэдээлэл авах
- ✓ НӨАТУС-ийн мэдээлэл боловсруулалт
- ✓ Шилэн дансны мэдээлэл боловсруулалт
- ✓ Суурь судалгааны үр дүн, шинэчилсэн тооцоо, судалгаа (ААНБТ, ХАА)
- ✓ Суурь НАХ, СХТ, жилийн НАХ, СХТ байгуулах хугацаа
- ✓ СХТ-д хоёрдогч үйл ажиллагааг салгаж тооцох
- ✓ Нөөц, ашиглалтын хүснэгтийг зэрэгцүүлэх үнээр байгуулах

САЛБАР ХООРОНДЫН ТЭНЦЭЛ

СХТ-ийн төрөл

1. Салбар хоорондын тэнцэл (Non-competitive import type IOT)

		Завсрын хэрэглээ, салбараар			Эцсийн хэрэглээ	Экспорт	Нийт гарц
		1	2	3			
салбар, дотоод	1	20	15	15	30	20	100
	2	15	65	40	60	70	250
	3	10	60	30	40	10	150
импорт		15	30	15	40		
Нэмэгдэл өртөг		40	80	50			
Нийт орц		100	250	150			

2. Салбар хоорондын тэнцэл, импортын өрсөлдөөнт төрлийн (Competitive import type IOT)

		Завсрын хэрэглээ, салбараар			Эцсийн хэрэглээ	Экспорт	Импорт	Нийт гарц
		1	2	3				
Салбар	1	30	20	20	40	20	-30	100
	2	20	80	50	80	70	-50	250
	3	10	70	30	50	10	-20	150
Нэмэгдэл өртөг		40	80	50				
Нийт орц		100	250	150				

МЭДЭЭЛЭЛ ТАРХААЛТ

СМНС (www.1212.mn)

Хүснэгт /байгуулна/:

- ✓ Нөөцийн хүснэгт (48x32), ашиглалтын хүснэгт (48x32), салбар хоорондын тэнцэл (2 төрлөөр, 20x20)

Тайлан, танилцуулга:

- ✓ Үндэсний тооцооны урсгал данс, нийгмийн тооцооны макро матриц, 2021
- ✓ Үндэсний тооцооны хуримтлалын данс, актив, пассивын данс, 2021
- ✓ Нөөц, ашиглалтын хүснэгт, 2019
- ✓ ДНБ-ий суурийг шинэчилсэн танилцуулга (суурь 2015 он)
- ✓ Нийгмийн тооцооны макро матриц, 2020
- ✓ Салбар хоорондын тэнцэл, ерөнхий ойлголт, хэрэглээ, шинжилгээ
- ✓ Хэрэглэгчдэд зориулсан статистикийн чанарын тайлан, 2021
- ✓ Бүс нутгийн ДНБ, үндсэн хөрөнгийн нийт хуримтлал, 2021
- ✓ ЖДҮ-ийн эдийн засагт оруулж буй хувь нэмэр, 2021
- ✓ Хөрөнгө оруулалт, 2021

ҮНДЭСНИЙ
СТАТИСТИКИЙН
ХОРОО

ӨРХИЙН САРЫН ДУНДАЖ ОРЛОГО, ЗАРЛАГА ТООЦОХ АРГА ЗҮЙ

ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА

2023 он

АГУУЛГА

1. ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА
2. ӨРХИЙН ОРЛОГЫН ҮЗҮҮЛЭЛТҮҮД
3. ӨРХИЙН ЗАРЛАГЫН ҮЗҮҮЛЭЛТҮҮД
4. ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

СУДАЛГААНЫ ТҮҮХ

Өрхийн орлого, зарлагын судалгаа
1966 оноос эхлэн 2007 оны 7 сар хүртэл улирал бүр

ӨОЗС

Амьжиргааны түвшний түүвэр судалгаа
1995, 1998, 2002-2003 онуудад 3 удаа

АТТС

Өрхийн нийгэм, эдийн засгийн судалгаа
2007 оны 7 сараас эхлэн улирал бүр

ӨНЭЗС

- Үндэсний Статистикийн Хороо 1966 оноос эхлэн өрхийн орлого, зарлагын судалгааг явуулж ирсэн бөгөөд Өрхийн орлого, зарлагын судалгаа, Амьжиргааны түвшний түүвэр судалгааг нэгтгэн 2007 оны 7 дугаар сарын 1-нээс “Өрхийн нийгэм, эдийн засгийн судалгаа”-г явуулж байна.

СУДАЛГААНЫ ТӨРӨЛ

Өрхийн нийгэм, эдийн засгийн судалгаа

Хураангуй

Үндсэн зорилго:

Орлого, зарлага, хэрэглээг тооцох

Явагдах он:

2013, 2015, 2017, 2019 .....

Түүврийн хэмжээ:

11232 өрх

/Улаанбаатарт-3600, аймгийн төвд-2640, хөдөөд-4992 өрх/

Дэлгэрэнгүй

Үндсэн зорилго:

Хүн амын амьжиргаа, ядуурлын үндсэн үзүүлэлтүүд, өрхийн орлого, зарлага, хэрэглээг тооцох

Явагдах он:

2014, 2016, 2018, 2020 .....

Түүврийн хэмжээ:

16488 өрх

/Улаанбаатарт-3600, аймгийн төвд-5400, хөдөөд-7488 өрх/

ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА

- Өрхийн ам бүлийн байдал
- Шилжилт хөдөлгөөн
- Боловсрол
- Эрүүл мэнд
- Хөдөлмөр эрхлэлт
- Бусад орлого
- ХАА-н үйлдвэрлэл, хэрэглээ
- ХАА-н бус үйлдвэрлэл, худалдаа, үйлчилгээ
- Хадгаламж, зээл
- Орон сууц, эрчим хүч
- Удаан эдэлгээтэй бараа, эд хогшил
- Хүнсний бус зардал, хэрэглээ
- Хүнсний зардал, хэрэглээ

СУДЛАГДАХ СЭДЭВ, ҮЗҮҮЛЭЛТҮҮД

- Судалгаанд Монгол Улсын хүн амыг улс, бүс, суурьшлын түвшинд төлөөлөх хэмжээний өрхийг түүвэрлэн авч, өрхийн гишүүдийн нас, хүйс, боловсрол, хөдөлмөр эрхлэлтийн байдал, өрхийн орлого, зарлага, хэрэглээтэй холбоотой үзүүлэлтүүдийг цуглуулан судалж байна.

МЭДЭЭЛЭЛ ЦУГЛУУЛАЛТ

- Нийслэл, аймгийн статистикийн газар, хэлтсийн Өрхөд суурилсан судалгааны мэдээлэл цуглуулагч нар
- Судалгааны батлагдсан маягт, зааврын дагуу
- Үндэсний статистикийн хорооны судалгаа хариуцсан нэгжээс хүргүүлсэн түүврийн дагуу өрхөөс
- Сар бүр мэдээллийг цуглуулж Үндэсний статистикийн хорооны судалгааны серверт дамжуулна.

ӨРХИЙН НИЙГЭМ, ЭДИЙН ЗАСГИЙН СУДАЛГАА

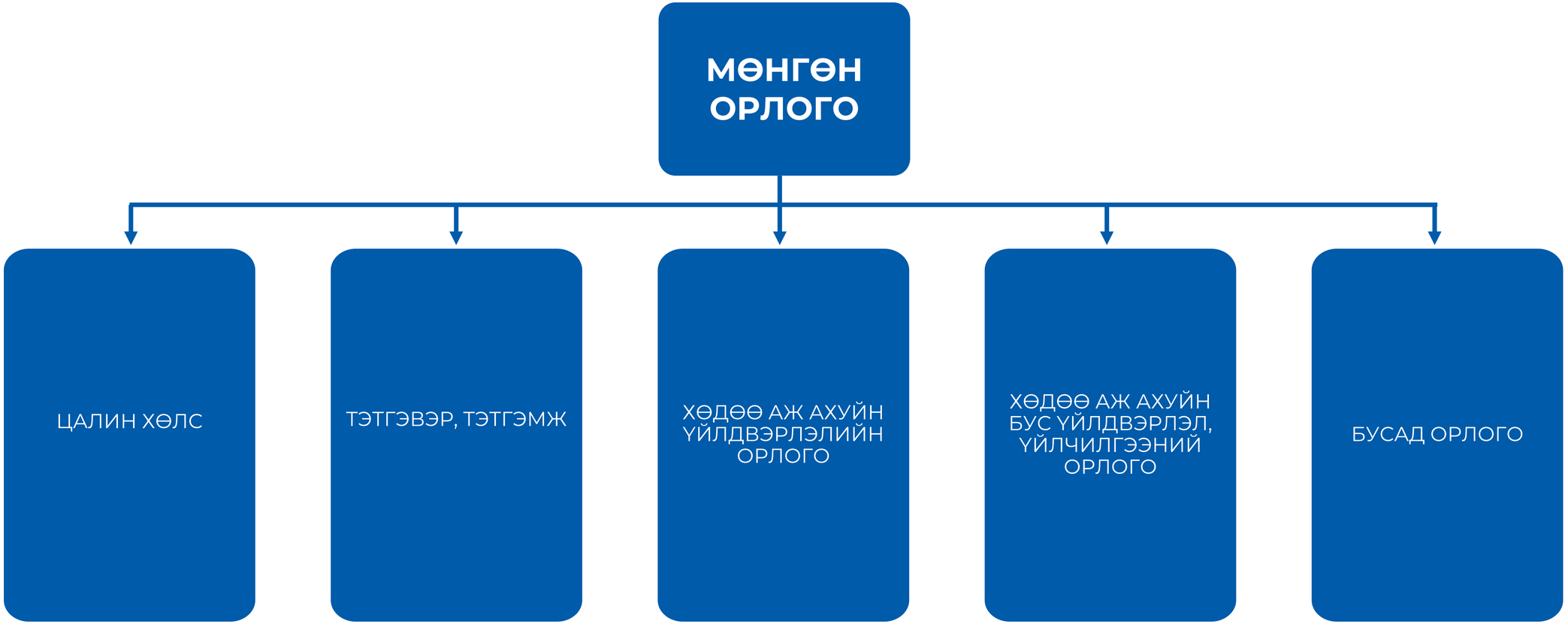
СУДАЛГААНЫ АЧ ХОЛБОГДОЛ

- Ядуурлын үндсэн үзүүлэлтүүдийг тогтмол давтамжтайгаар тооцох боломж бүрдсэн.
- Өрхийн орлого, зарлагыг тооцох, хэрэглээний үнийн индексэд ашигладаг сагс, түүний жинг шинэчлэх болон ДНБ-ийг эцсийн ашиглалтын аргаар тооцоход шаардлагатай мэдээллийг бий болгодог.
- Өрхийн амьжиргаа, ядуурлын чиглэлээрх дүн шинжилгээ хийх суурь мэдээллийг бүрдүүлдэг.

НИЙТ ОРЛОГО


ӨРХИЙН НИЙТ ОРЛОГО
Мөнгөн орлого
Бусдаас үнэгүй авсан хүнсний болон хүнсний бус бүтээгдэхүүн
Өөрийн хувийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүн

МӨНГӨН ОРЛОГО



Өрхийн нийт орлого

Мөнгөн орлого

Бусдаас үнэгүй авсан хүнсний болон хүнсний бус бүтээгдэхүүн

Хүнс болон хүнсний бусдаас үнэгүй авч хэрэглэсэн зардал

Өөрийн хувийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүн

Өөрийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүнийг голч үнээр үнэлж тооцно.

Цалин хөлс

Сүүлийн 12 сард эрхэлсэн үндсэн болон давхар ажлын сүүлийн 1 сарын цалингийн дундаж. Хэрэв сүүлийн 1 сарын цалингийн орлого байхгүй бол сүүлийн 12 сарын цалингийн орлогыг 12-т хуваана.

Тэтгэвэр тэтгэмж

Сүүлийн 12 сарын НДС, НХС-гаас авсан тэтгэврийн хэмжээг 12-т хуваана.

Хөдөө аж ахуйн үйлдвэрлэлийн орлого

МАА цэвэр ашиг=МАА орлого – МАА зардал

ГТ цэвэр ашиг=ГТ орлого – ГТ зардал

ХАА-н үйлдвэрлэлийн орлого=МАА цэвэр ашиг +ГТ цэвэр ашиг

ХАА-н үйлдвэрлэлийн орлогыг 12-т хуваана.

Хөдөө аж ахуйн бус үйлдвэрлэл, үйлчилгээний орлого

ХАА-н бус үйлдвэрлэл үйлчилгээний цэвэр ашиг=ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого – ХАА-н бус үйлдвэрлэл, үйлчилгээний зардал

ХАА-н бус цэвэр ашиг * тухайн өрхийн эзэмшиж буй хувиар үржүүлэн 12-т хуваана.

Бусад орлого

Бусдаас авсан хандив тусламж

+

Хурдан морь зарж борлуулсан орлого

+

Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/

+

Бусад эх үүсвэр /Эд хөрөнгө түрээслэх, зарж борлуулах, Бусдад зээлдүүлсэн эргэж төлөгдсөн, Хадгаламжаас авсан, бусад/

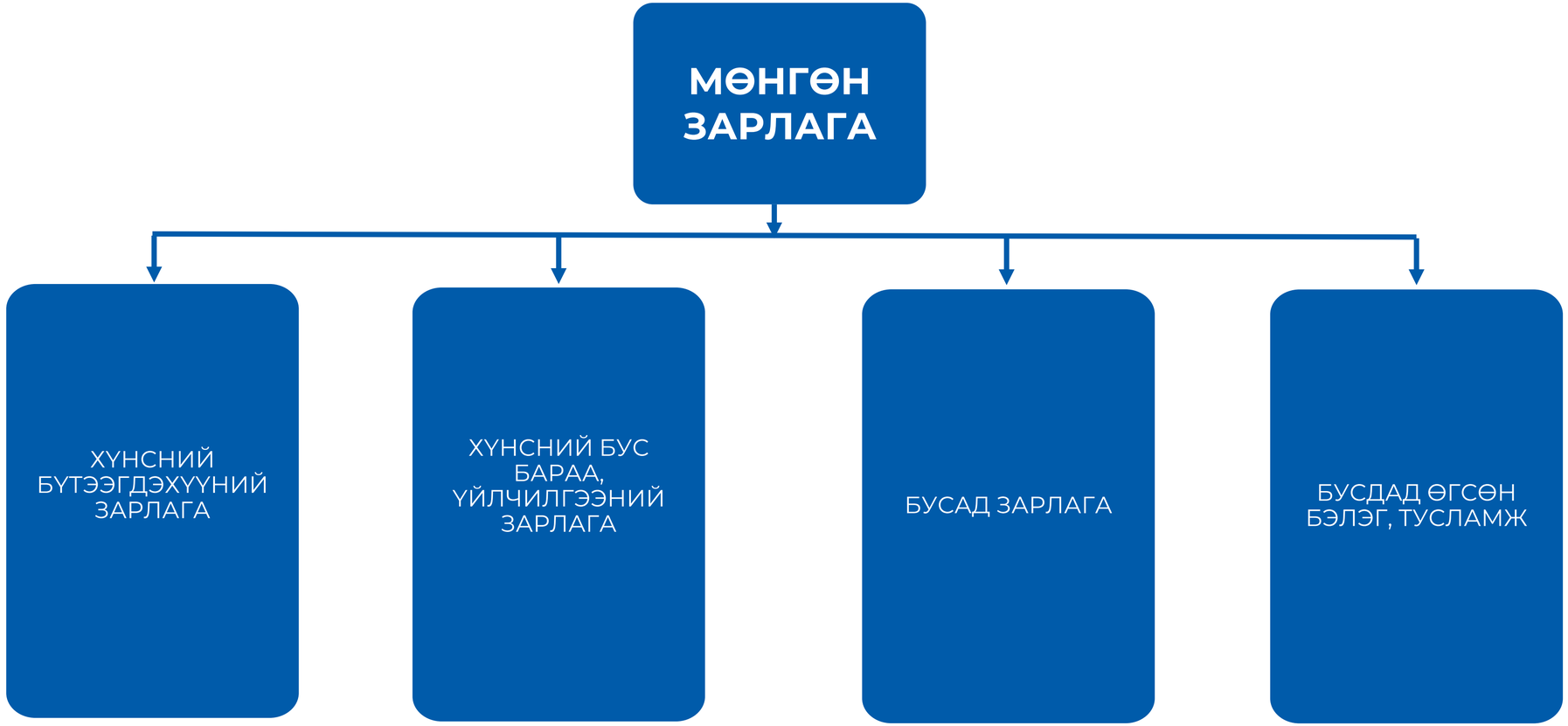
+

Хүү болон ашиг /Хадгаламжийн хүү, Хувьцааны ногдол ашиг, Зээлийн хүү, Бусад оюуны өмчийн болон бусад/

НИЙТ ОРЛОГО


ӨРХИЙН НИЙТ ЗАРЛАГА
Мөнгөн зарлага
Бусдаас үнэгүй авсан хүнсний болон хүнсний бус бүтээгдэхүүн
Өөрийн хувийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүн

МӨНГӨН ОРЛОГО



Өрхийн нийт зарлага

Мөнгөн зарлага

- Хүнсний бүтээгдэхүүний зарлага
  - ✓ Сүүлийн 7 хоногт хэрэглэсэн хүнсний бүтээгдэхүүний биет хэмжээ, мөнгөн дүнг сард шилжүүлэн тооцно.
  - ✓ Өдрийн тэмдэглэл хөтлүүлэх (УБ, аймгийн төв)
  - ✓ Сүүлийн 7 хоногийг сануулах (Сумын төв, хөдөө)
- Хүнсний бус бараа, үйлчилгээний зарлага
  - ✓ Өрхийн хүнсний бус 200 гаруй нэр төрлийн сүүлийн 12 сарын хугацаанд зарцуулсан зардлыг 1 сард шилжүүлж тооцно.
- Бусад зарлага
  - ✓ Сууцны удаан эдэлгээт бараатай холбоотой зардал, татвар, хураамж, баяр ёслолын сүүлийн 12 сарын зардлыг 1 сард шилжүүлж тооцно.
- Бусдад өгсөн бэлэг, тусламж
  - ✓ Хувь хүнд өгсөн бэлэг тусламж, хандив шилжүүлгийн сүүлийн 12 сарын зардлыг 1 сард шилжүүлж тооцно.

Бусдаас үнэгүй авсан хүнсний болон хүнсний бус бүтээгдэхүүн

Хүнс болон хүнсний бусдаас үнэгүй авч хэрэглэсэн зардал

Өөрийн хувийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүн

Өөрийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүнийг голч үнээр үнэлж тооцно.

ЯДУУРЛЫН ТООЦООНЫ АРГАЗҮЙ

Мөнгөн дүнгийн үзүүлэлт

Амьжиргааны түвшний үзүүлэлтийг сонгох нь:

Хэрэглээ?
Орлого?
} ***Аль нь вэ?***

Онол, практикийн асуудлын хүрээнд баримтлах зарчим, цуглуулагдах мэдээллийн боломжоос хамаарч сонголтыг хийсэн.

Бидний сонголт - “ХЭРЭГЛЭЭ”

ЯДУУРЛЫН ТООЦООНЫ АРГАЗҮЙ

Амьжиргааны түвшний үзүүлэлтийг сонгох:

Практик талаас

1. ОРЛОГО

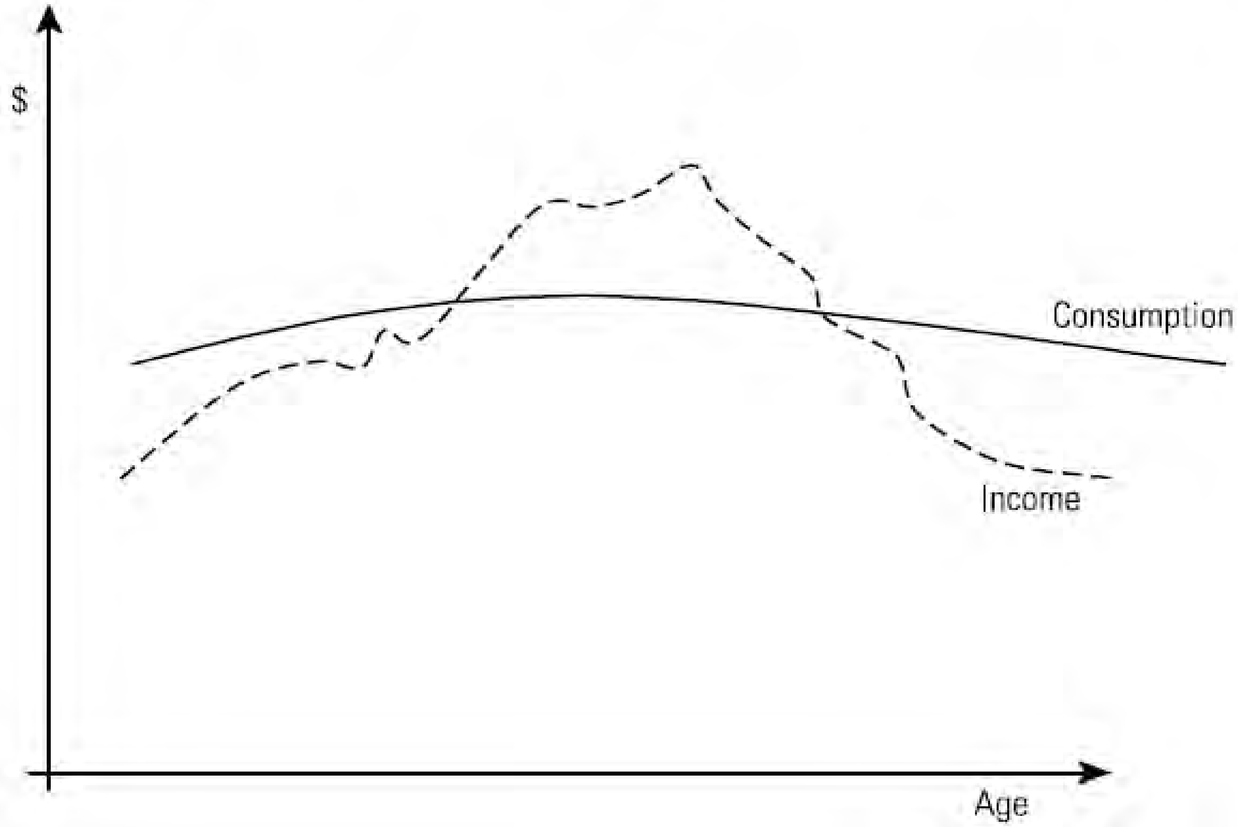
- Нийт өрхийн 1/3-ийн орлого улирлын чанартай хөдөө аж ахуйн орлого байдаг.
- Барилга, зам гэх мэт бүтээн байгуулалтын салбарын ажил эрхлэлт улирлын чанартай байдаг.
- Өөрчлөлт хэлбэлзэл ихтэй.
- Орлогынхоо мэдээллийг нуудаг.

2. ХЭРЭГЛЭЭ

- Хэрэглээ нь орлогыг бодвол тогтвортой, өөрчлөлт багатай.
- Өрхүүд жилийн туршид хэрэглээгээ жигд хуваарилж тэгшитгэдэг.
- Өрхүүд орлогоосоо илүүгээр хэрэглээгээ мэдээлэх дуртай байдаг.

ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

Figure 2.2 Lifecycle Hypothesis: Income and Consumption Profile over Time



Source: J. Haughton & S.R. Khandker,2009. Handbook on Poverty and Inequality, The World Bank, Washington, DC.

ЯДУУРЛЫН ТООЦООНЫ АРГА ЗҮЙ

Хэрэглээний бүрэлдэхүүн

1. Хүнсний хэрэглээ
2. Хүнсний бус хэрэглээ
3. Сууцны хэрэглээ
4. Удаан эдэлгээт барааны хэрэглээ
5. Түлш, эрчим хүчний хэрэглээ

Хэрэглээг бүрдүүлэхэд баримтлах үндсэн зарчмууд:

- Мэдээллийн боломжит эх үүсвэрүүдийг хамруулна.
- Зөвхөн хэрэглэсэн бараа, үйлчилгээг хамруулна.
- Хэрэглэсэн бараа, үйлчилгээг үнийн дүнгээр илэрхийлнэ.
- Худалдан авааагүй боловч хэрэглэсэн хүнсний зүйлийн нэр төрлүүдийн үнийн дүнг тодорхойлно.
- Хэрэглээг тодорхойлоход хамруулж байгаа хэрэглээ тус бүрийн хамралтын хугацаа ижил байна.

ЯДУУРЛЫН ШУГАМ

Хэрэглээг тооцсоны дараа хүн амыг ядуу ба ядуу бус гэж ангилж, сонгогдсон үзүүлэлтүүдтэй харьцуулах боломжтой хэмжигдэхүүн хэрэгтэй.

ЯДУУРЛЫН ШУГАМ

Монгол улс Дэлхийн банкны зөвлөмжийн дагуу ядуурлын тооцоог хийхдээ “Үндсэн хэрэгцээний зардлын арга” –аар тооцсон абсолют ядуурлын шугамыг хэрэглэж байна.

Ядуурлын шугам: Үндсэн хэрэгцээний зардлын арга

Хүний амьдралын **наад захын хэрэглээ** буюу хүний эрүүл, идэвхитэй амьдралыг хангахуйц илчлэгтэй хоол тэжээлийг худалдан авах болон хүнсний бус зайлшгүй хэрэглээнд шаардагдах зардлыг тооцох

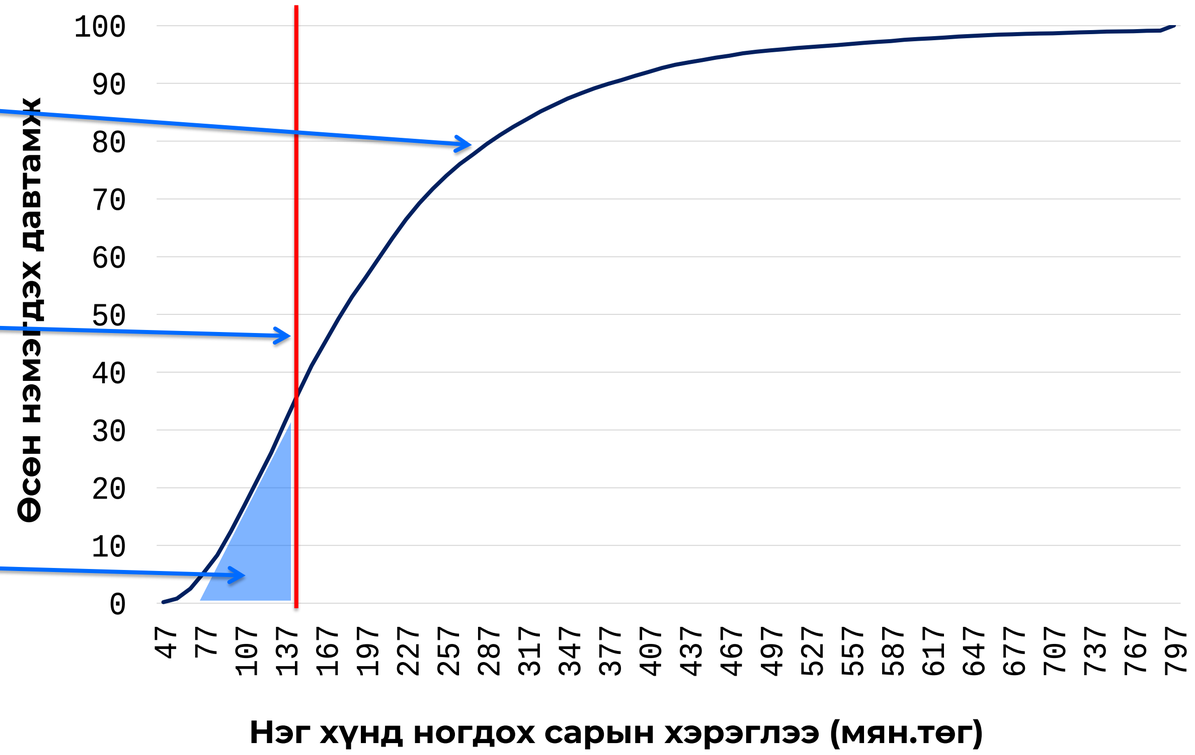
ЯДУУРЛЫГ ХЭРХЭН ХЭМЖДЭГ ВЭ?

Хувь хүний амьжиргаа, аж байдлыг илэрхийлэх хэрэглээний үзүүлэлтээр хүн амын амьжиргааны түвшний тархалт

Ядуурлын шугам - Хувь хүний амьжиргааны түвшин уг шугамаас доош орвол түүнийг ядуу гэж тооцдог.

Ядуурлын үндсэн үзүүлэлтүүд - Хүн амын ядуурлын нэгдсэн статистик

Хэрэглээний тархалтын муруй



ҮНДЭСНИЙ
СТАТИСТИКИЙН
ХОРОО

АНХААРАЛ ХАНДУУЛСАНД БАЯРЛАЛАА

ЦАЛИН ХӨЛС

✓ Сүүлийн 12 сард эрхэлсэн **үндсэн** болон **давхар** ажлын **сүүлийн 1 сарын цалингийн дундаж**.

БҮЛЭГ 4. ХӨДӨЛМӨР ЭРХЛЭЛТ

СҮҮЛИЙН 12 САРЫН ҮНДСЭН ХӨДӨЛМӨР ЭРХЛЭЛТ

(4.34) [НЭР]-ын/ийн сүүлийн 12 сард эрхэлсэн үндсэн ажлын байгууллагын хариуцлагын хэлбэр юу вэ?

Төрийн өмчит үйлдвэрийн газар	1
Орон нутгийн өмчит үйлдвэрийн газар	2
Тусөвт байгууллага	3
Төрийн бус байгууллага	4
Хувийн аж ахуйн нэгж байгууллага	5
Нөхөрлөл	6
Хоршоо	7
Улс төрийн нам	8
Бусад	9

(4.35) [НЭР] сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?

Тийм 1
Үгүй 2 → **(4.37)**

(4.36) [НЭР] нь сүүлийн 12 сард үндсэн ажлаасаа хэдэн төгрөгийн цалин авсан бэ?

ЗӨВХӨН СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛНА. МӨН ТАТВАР, НИЙГМИЙН ДААТГАЛ, ЭРҮҮЛ МЭНДИЙН ДААТГАЛЫН ШИМТГЭЛИЙГ ХАССАН ДҮНГЭЭР БУЮУ ГАР ДЭЭР АВСАН ЦЭВЭР ЦАЛИНГ БҮРТГЭНЭ.

МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.

Цалингийн дүн		Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
Сүүлийн сард	Сүүлийн 12 сард	
Төгрөг	Төгрөг	Төгрөг

СҮҮЛИЙН 12 САРЫН ҮНДСЭН АЖЛААС БУСАД БҮХ АЖЛЫН ОРЛОГО

(4.49) [НЭР] **түр болон давхар эрхэлсэн бүх ажлаасаа** сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?

Тийм 1
Үгүй 2 → **Дараагийн хүн**

(4.50) [НЭР] нь сүүлийн 12 сард **түр болон давхар эрхэлсэн бүх ажлаасаа** нийт хэдэн төгрөгийн цалин авсан бэ?

СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛАХГҮЙ.

МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.

Цалингийн дүн		Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
Сүүлийн сард	Сүүлийн 12 сард	
Төгрөг	Төгрөг	Төгрөг

ЦАЛИН ХӨЛС

✓ Хэрэв сүүлийн 1 сарын цалингийн орлого байхгүй бол сүүлийн 12 сарын цалингийн орлогыг 12-т хувааж авна.

БҮЛЭГ 4. ХӨДӨЛМӨР ЭРХЛЭЛТ

СҮҮЛИЙН 12 САРЫН ҮНДСЭН ХӨДӨЛМӨР ЭРХЛЭЛТ

(4.34) [НЭР]-ын/ийн сүүлийн 12 сард эрхэлсэн үндсэн ажлын байгууллагын хариуцлагын хэлбэр юу вэ?	(4.35) [НЭР] сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?	(4.36) [НЭР] нь сүүлийн 12 сард үндсэн ажлаасаа хэдэн төгрөгийн цалин авсан бэ?
		ЗӨВХӨН СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛНА. МӨН ТАТВАР, НИЙГМИЙН ДААТГАЛ, ЭРҮҮЛ МЭНДИЙН ДААТГАЛЫН ШИМТГЭЛИЙГ ХАССАН ДҮНГЭЭР БУЮУ ГАР ДЭЭР АВСАН ЦЭВЭР ЦАЛИНГ БҮРТГЭНЭ.
Төрийн өмчит үйлдвэрийн газар 1		
Орон нутгийн өмчит үйлдвэрийн газар 2		
Төсөвт байгууллага 3		*МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.*
Төрийн бус байгууллага 4		
Хувийн аж ахуйн нэгж байгууллага 5		
Нөхөрлөл 6		
Хоршоо 7	Тийм 1	**Цалингийн дүн**
Улс төрийн нам 8	Үгүй 2 → **(4.37)**	Сүүлийн сард: Төгрөг; Сүүлийн 12 сард: Төгрөг
Бусад 9		

Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
Төгрөг

СҮҮЛИЙН 12 САРЫН ҮНДСЭН АЖЛААС БУСАД БҮХ АЖЛЫН ОРЛОГО

(4.49) [НЭР] **түр болон давхар эрхэлсэн бүх ажлаасаа** сүүлийн 12 сард ажиллаад мөнгөн ба мөнгөн бус хэлбэрээр цалин хөлс авсан уу?	(4.50) [НЭР] нь сүүлийн 12 сард **түр болон давхар эрхэлсэн бүх ажлаасаа** нийт хэдэн төгрөгийн цалин авсан бэ?
	СҮҮЛИЙН 12 САРД ҮНДСЭН АЖЛААСАА АВСАН ЦАЛИН, ТЭТГЭМЖИЙГ ОРУУЛАХГҮЙ.
	МӨНГӨН БУС ХЭЛБЭРЭЭР АВСАН ЗҮЙЛИЙГ ТУХАЙН ҮЕИЙН ЗАХ ЗЭЭЛИЙН ҮНЭЭР ҮНЭЛЖ БЭЛЭН МӨНГӨӨР АВСАН ЦАЛИН ДЭЭР НЭМЖ ТООЦНО.
Тийм 1	**Цалингийн дүн**
Үгүй 2 → **Дараагийн хүн**	Сүүлийн сард: Төгрөг; Сүүлийн 12 сард: Төгрөг

Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
Төгрөг

ТЭТГЭВЭР, ТЭТГЭМЖ

- ✓ Сүүлийн 12 сарын НДС, НХС-гаас авсан тэтгэвэр, тэтгэмжийн хэмжээг 12-т хуваах, түүнээс дундаж тэтгэвэр, тэтгэмжийн хэмжээг авна.

НИЙГМИЙН ДААТГАЛЫН САН

[НЭР] сүүлийн 12 сард хэдий хэмжээний тэтгэвэр, тэтгэмж авсан бэ?

*АВААГҮЙ БОЛ **"0"** ГЭЖ БИЧНЭ ҮҮ.*

(5.07) Өндөр насны тэтгэвэр	(5.08) Хөгжлийн бэрхшээлтэй иргэний тэтгэвэр	(5.09) Тэжээгчээ алдсаны тэтгэвэр	(5.10) Хөдөлмөрийн чадвар түр алдсаны тэтгэмж	(5.11) Жирэмсний болон амаржсаны тэтгэмж	(5.12) Оршуулгын тэтгэмж	(5.13) Ажилгүйдлийн тэтгэмж	(5.14) Бусад нийгмийн даатгалын тэтгэвэр, тэтгэмж (сургалтын төлбөр, нөхөн сэргээх төлбөр, сувиллын зардал)
Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг

НИЙГМИЙН ХАЛАМЖИЙН САН

[НЭР] сүүлийн 12 сард хэдий хэмжээний тэтгэвэр, тэтгэмж авсан бэ?

*АВААГҮЙ БОЛ **"0"** ГЭЖ БИЧНЭ ҮҮ.*

(5.16) Хөгжлийн бэрхшээлтэй иргэний тэтгэвэр	(5.17) Өндөр настны, тэжээгч нь нас барсан 18 хүртэлх насны хүүхдийн, өрх толгойлсон эх/эцгийн тэтгэвэр болон 16 насанд хүрсэн одой иргэний тэтгэвэр	(5.18) Жирэмсэн болон 0-3 хүртэлх насны хүүхэд асарсны тэтгэмж	(5.19) Асаргааны тэтгэмж (ахмад настан, хөгжлийн бэрхшээлтэй иргэнийг асарч байгаа иргэний болон хүнд нөхцөлд байгаа хүүхдийн асаргааны тэтгэмж)	(5.20) Хүнс тэжээлийн дэмжлэг үзүүлэх үйлчилгээ (хүнсний талон)	(5.21) Хүүхдийн мөнгө	(5.22) Ахмад настан, хөгжлийн бэрхшээлтэй иргэнд үзүүлэх амралт, рашаан сувиллын хөнгөлөлт	(5.23) 3 болон түүнээс дээш хүүхэдтэй өрх толгойлсон эх, эцэгт олгох тэтгэмж	(5.24) Эхийн алдар 1, 2 дугаар зэргийн одонгийн мөнгөн тусламж	(5.25) Бусад тэтгэмж, тусламж, хөнгөлөлт (насны хишиг, онцгой тохиолдлын болон амьжиргааг дэмжих бусад мөнгөн тэтгэмж, цаатан иргэнд олгох тэтгэмж, протез, ортопедийн болон түлшний хөнгөлөлт г.м)
Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг

ХАА-Н ҮЙЛДВЭРЛЭЛИЙН ОРЛОГО

1. МАА-н цэвэр ашиг = (МАА-н нийт орлого – МАА-н нийт зардал);
2. ГТ-гийн цэвэр ашиг = (ГТ-гийн нийт орлого – ГТ-гийн нийт зардал);
3. ХАА-н үйлдвэрлэлийн орлого = (МАА-н цэвэр ашиг + ГТ-гийн цэвэр ашиг);
4. ХАА-н үйлдвэрлэлийн орлого / 12

МАА-н орлого

МӨРИЙН ДУГААР	МАЛЫН ТӨРӨЛ	(6.02) Танайх одоо хэдэн [МАЛ]-тай байна вэ? *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ* → ***Дараагийн мал***			Сүүлийн 12 сард танайх хэдэн [МАЛ]..... *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ*		
		Бүгд	Үүнээс: Хөлтэгч	Үүнээс: Төл	(6.03) Хүнсэндээ хэрэглэсэн	(6.04) Худалдсан *АМЬДААР БОЛОН НЯДАЛЖ ХУДАЛДСАНЫГ ОРУУЛНА.*	(6.05) Худалдсан малын нийт үнэ, төгрөгөөр
01	Үхэр						
02	Адуу						
03	Тэмээ						
04	Хонь						
05	Ямаа						
	ТУСЛАХ АЖ АХУЙ						
06	Бусад (тахиа, шувуу, гахай, зөгий, цаа буга)		x x x	x x x			
99	**Нийт**						

Мал худалдан борлуулсан нийт орлого

СҮҮЛИЙН 12 САРЫН БАЙДЛААР

МАА-н орлого

МӨРИЙН ДУГААР	БҮТЭЭГДЭХҮҮН		(6.08) Ашиг шимийг нь ашигласан малын тоо *БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ* → **Дараагийн мөр**	(6.09) Нийт бүтээгдэхүүний хэмжээ	(6.10) Өрхийн хэрэгцээнд хэрэглэсэн хэмжээ	Худалдсан (6.11) Нийт хэмжээ	Худалдсан (6.12) Нийт үнэ, төгрөгөөр	Боловсруулж худалдсан (6.13) Нийт хэмжээ	Боловсруулж худалдсан (6.14) Нийт үнэ, төгрөгөөр
	НООС, ҮС, НООЛУУР, КГ								
01	Хонь	КГ							
02	Тэмээ	КГ							
03	Ямааны ноолуур	КГ							
04	Үхэр, адууны хөөвөр, хялгас	КГ							
	АРЬС, ШИР, ШИРХЭГЭЭР								
05	Хонь	ШИРХЭГ	XXXXX						
06	Ямаа	ШИРХЭГ	XXXXX						
07	Үхэр	ШИРХЭГ	XXXXX						
08	Адуу	ШИРХЭГ	XXXXX						
09	Тэмээ	ШИРХЭГ	XXXXX						
	СҮҮ, ЛИТРЭЭР*								
10	Хонины	ЛИТР							
11	Ямааны	ЛИТР							
12	Үнээний	ЛИТР							
13	Айраг	ЛИТР							
14	Ингэний	ЛИТР							
	БУСАД БҮТЭЭГДЭХҮҮН								
15	Өндөг	ШИРХЭГ	XXXXX						
16	Зөгийн бал	КГ	XXXXX						
17	Бусад		XXXXX						

Малын ашиг шим, боловсруулж худалдсан бүтээгдэхүүний нийт орлого

ХАА-Н ҮЙЛДВЭРЛЭЛИЙН ОРЛОГО

1. МАА-н цэвэр ашиг = (МАА-н нийт орлого **–** МАА-н нийт зардал)

МАА-н зардал

МӨРИЙН ДУГААР	МӨНГӨН ЗАРДАЛ	
	ЗАРДЛЫН НЭР ТӨРӨЛ	(6.06) Сүүлийн 12 сард мал аж ахуй эрхлэхтэй холбогдож гарсан зардал, төгрөгөөр *ЗАРДАЛ ГАРААГҮЙ БОЛ **"0"** ГЭЖ НӨХНӨ*
01	Малын тэжээл	
02	Малын эм, тарилгын зардал	
03	Шатахуун	
04	Татвар, даатгал	
05	Цалин хөлс	
06	Хашаа, хороо, тоног төхөөрөмж	
07	Малтай болох зорилгоор мал худалдан авсан	
08	Бусад (Засвар үйлчилгээ, уур, ус, цахилгаан, дулаан, халаалт, түрээс гэх мэт)	
99	**Нийт зардал**	

Мал аж ахуй эрхлэхтэй холбогдож гарсан нийт зардал

ХАА-Н ҮЙЛДВЭРЛЭЛИЙН ОРЛОГО

2. ГТ-гийн цэвэр ашиг = (ГТ-гийн нийт орлого – ГТ-гийн нийт зардал)

ГАЗАР ТАРИАЛАНГИЙН ҮЙЛДВЭРЛЭЛ							
МӨРИЙН ДУГААР	НЭР ТӨРӨЛ	(6.19) Сүүлийн 12 сард та [НЭР ТӨРӨЛ] ургац хураан авсан уу? Тийм 1 Үгүй 2 → Дараагийн бүтээгдэхүүн	(6.20) Сүүлийн 12 сард хураан авсан нийт [НЭР ТӨРӨЛ] ургацын хэмжээ, килограммаар	Үүнээс: (6.21) Өрхийн хэрэгцээнд хэрэглэсэн	(6.22) Малын тэжээлд зориулсан	(6.23) Худалдсан БОЛОВСРУУЛАЛТ ХИЙЖ ХУДАЛДСАНЫГ ОРУУЛНА. Хэмжээ, кг	Бүгд үнэ, төгрөгөөр
				БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ.			
01	Төмс						
02	Лууван						
03	Манжин						
04	Байцай						
05	Хүрэн манжин						
06	Сонгино						
07	Сармис						
08	Улаан лооль						
09	Өргөст хэмх						
10	Жимс, жимсгэнэ						
11	Улаан буудай						
12	Хадлан			x x x x			
13	Бусад (арвай, овъёос, хөх тариа гэх мэт)						
99	**Нийт**	xxxxx					

МӨНГӨН ЗАРДАЛ		
МӨРИЙН ДУГААР	ЗАРДЛЫН НЭР ТӨРӨЛ	(6.24) Сүүлийн 12 сард хэдэн төгрөгийн зардал гарсан бэ? БАЙХГҮЙ БОЛ "0" ГЭЖ НӨХНӨ
01	Үр	
02	Бордоо	
03	Хортон шавьж устгал	
04	Цалин хөлс	
05	Тоног төхөөрөмж	
06	Сэлбэг хэрэгсэл	
07	Засвар, үйлчилгээ	
08	Түүхий эд, материал	
09	Шатахуун	
10	Татвар, даатгал, хураамж	
11	Тээвэр	
12	Түрээс	
13	Бусад (уур, ус, цахилгаан, дулаан, халаалт, шуудан, холбоо гэх мэт)	
99	**Нийт зардал**	

Газар тариалангийн бүтээгдэхүүн худалдан борлуулсан нийт орлого

Газар тариалан эрхлэхтэй холбогдож гарсан нийт зардал

ХАА-Н БУС ҮЙЛДВЭРЛЭЛ, ҮЙЛЧИЛГЭЭНИЙ ОРЛОГО

1. ХАА-н бус үйлдвэрлэл, үйлчилгээний цэвэр ашиг **=** (ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт орлого **–** ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт зардал);
2. ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого **=** ХАА-н бус үйлдвэрлэл, үйлчилгээний цэвэр ашиг ***** (өрхийн тухайн үйлдвэрлэл, үйлчилгээнээс эзэмшиж буй хувь / 100);
3. ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого / 12

	ҮЙЛДВЭРЛЭЛ, ХУДАЛДАА, ҮЙЛЧИЛГЭЭ [1] 1
(7.03) Үйлдвэрлэл, худалдаа, үйлчилгээнийхээ нэрийг хэлнэ үү? *ЭДИЙН ЗАСГИЙН ҮЙЛ АЖИЛЛАГААНЫ АНГИЛЛЫН КОДЫГ БИЧНЭ.*	Код:
(7.04) Энэ үйлдвэрлэл, худалдаа, үйлчилгээний хэдэн хувийг танай өрхийн гишүүд эзэмшдэг вэ?	%

Өрхийн тухайн үйлдвэрлэл, үйлчилгээнээс эзэмшиж буй хувь

ХАА-н бус үйлдвэрлэл, үйлчилгээний орлого

		Сарын тоо	
(7.08) Сүүлийн 12 сарын байдлаар энэ үйлдвэрлэл, худалдаа, үйлчилгээг хэдэн сар эрхэлсэн бэ?			
(7.09) Энэ үйлдвэрлэл, худалдаа, үйлчилгээний тухайн сарын борлуулалт хэдэн төгрөг байсан бэ?		Төгрөг	Сар
ЯРИЛЦЛАГА ХИЙЖ БУЙ САРААС ӨМНӨХ 12 САРЫН ХУГАЦААН ДАХЬ САР БҮРИЙН ҮНИЙН ДҮНГИЙН ТАЛААР АСУУЖ БИЧНЭ.	Ярилцлага авсан сараас 12 сарын өмнөх I		
	Ярилцлага авсан сараас 11 сарын өмнөх II		
	Ярилцлага авсан сараас 10 сарын өмнөх III		
	Ярилцлага авсан сараас 9 сарын өмнөх IV		
	Ярилцлага авсан сараас 8 сарын өмнөх V		
	Ярилцлага авсан сараас 7 сарын өмнөх VI		
	Ярилцлага авсан сараас 6 сарын өмнөх VII		
	Ярилцлага авсан сараас 5 сарын өмнөх VIII		
	Ярилцлага авсан сараас 4 сарын өмнөх IX		
	Ярилцлага авсан сараас 3 сарын өмнөх X		
	Ярилцлага авсан сараас 2 сарын өмнөх XI		
	Ярилцлага авсан сар/1 сарын өмнөх XII		
(7.10) Сүүлийн 12 сарын нийт борлуулалт = (I + II +III + ... XI + XII)			

ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт орлого

ХАА-Н БУС ҮЙЛДВЭРЛЭЛ, ҮЙЛЧИЛГЭЭНИЙ ОРЛОГО

ХАА-н бус үйлдвэрлэл, үйлчилгээний зардал

(7.07) Сүүлийн 12 сард хэдэн төгрөгийн мөнгөн зардал гарсан бэ?			
	01	Ажилчдад олгосон цалин	
	02	Борлуулахаар авсан бараа	
	03	Түүхий эд, материал	
	04	Шатахуун, шатах тослох материал	
	05	Уур, ус, цахилгаан эрчим хүч, дулаан халаалт	
	06	Тоног төхөөрөмж	
	07	Орон байрны түрээс	
	08	Сэлбэг, хэрэгсэл	
	09	Засвар үйлчилгээ	
	10	Татвар, хураамж, патент, лиценз, даатгал	
	11	Бусад зардал (тээврийн зардал, шуудан, холбоо, интернет, зээлийн	
	99	**Нийт зардал**	

ХАА-н бус үйлдвэрлэл, үйлчилгээний нийт зардал

БУСАД ОРЛОГО

1. Бусад орлого = Бусдаас авсан бэлэг, тусламж, хандив + Хурдан морь зарж борлуулсан орлого + Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/ + Бусад эх үүсвэрийн орлого + Хүү болон ашгийн орлого
2. Бусад орлого / 12

БҮЛЭГ 5. БУСАД ОРЛОГО

ХЭСЭГ В. БУСДААС АВСАН БЭЛЭГ, ТУСЛАМЖ, ХАНДИВ

(5.47) Сүүлийн 12 сард танай өрхийн гишүүд хувь хүн, хамаатан, найз нөхөд болон тусламжийн байгууллагаас мөнгөн болон мөнгөн бус хэлбэрээр бэлэг, тусламж, хандив авсан уу? *БОЛОВСРОЛЫН ЗОРИУЛАЛТААР /СУРГАЛТЫН ТӨЛБӨРӨӨС БУСАД ЗАРДАЛ/ АВСАН БЭЛЭГ, ТУСЛАМЖИЙГ ЭНД ОРУУЛАХ БӨГӨӨД БУЦААЖ ТӨЛӨХ МӨНГӨН БОЛОН МӨНГӨН БУС ТУСЛАМЖИЙГ ЭНД ОРУУЛАХГҮЙ.*

Тийм 1 ☐
Үгүй 2 → **БҮЛЭГ 6**

МӨРИЙН ДУГААР	(5.48) *БЭЛЭГ, ТУСЛАМЖ, ХАНДИВ АВСАН ХҮНИЙ ХУВИЙН ДУГААРЫГ БИЧНЭ ҮҮ.* *БЭЛЭГ, ТУСЛАМЖ, ХАНДИВ АВСАН ТОХИОЛДОЛ БҮРИЙГ САЛГАЖ БИЧНЭ.*	(5.49) Хэн, ямар байгууллага бэлэг, тусламж, хандив өгсөн бэ?	(5.50) Бэлэг, тусламж, хандивыг та юунд зарцуулсан бэ?	(5.51) Бэлэг, тусламж, хандив хаанаас ирсэн бэ?	(5.52) Та сүүлийн 12 сард ойролцоогоор хичнээн төгрөг авсан бэ?	(5.53) Энэ бэлэг, тусламж, хандив тогтмол хугацаанд ирдэг үү?	(5.54) Бэлэг, тусламж, хандивыг ямар байдлаар хүлээн авдаг вэ?
			Өрхийн хэрэглээ 1				
			Боловсрол 2				
		Аж ахуй нэгж байгууллага 1	Эмчилгээ 3				Бэлэн мөнгөөр 1
		Төрийн бус байгууллага 2	Сууцтай болох 4	Дотоод:		Тийм	Дансаар 2
		Эцэг, эх, үр хүүхэд, төрөл садан 3	Баяр ёслол 5	Нийслэл 1		7 хоног бүр 1	Мөнгөн гуйвуулгаар 3
		Бусад хүн (найзууд, хөршүүд) 4	Оршуулгын 6	Аймгийн төв 2		Сар бүр 2	
		Гадаадын болон олон улсын байгууллага, гадаадын иргэн 5	Өрхийн үйлдвэрлэл, бизнес 7	Сумын төв 3		Улирал бүр 3	Мөнгөн бус хэлбэрээр 4
				Хөдөө 4		Жил бүр 4	
		Бусад 6	Бусад 8	Гадаад 5		Үгүй 5	Бусад 5
	Хувийн дугаар				Төгрөг		
01							
02							
03							

БУСАД ОРЛОГО

1. Бусад орлого **=** Бусдаас авсан бэлэг, тусламж, хандив **+** Хурдан морь зарж борлуулсан орлого **+** Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/ **+** Бусад эх үүсвэрийн орлого **+** Хүү болон ашгийн орлого
2. Бусад орлого / 12

Хурдан морь зарж борлуулсан орлого

МӨРИЙН ДУГААР	МАЛЫН ТӨРӨЛ	(6.02) Танайх одоо хэдэн [МАЛ]-тай байна вэ? *БАЙХГҮЙ БОЛ **"0"** ГЭЖ НӨХНӨ* → ***Дараагийн мал***			Сүүлийн 12 сард танайх хэдэн [МАЛ]..... *БАЙХГҮЙ БОЛ **"0"** ГЭЖ НӨХНӨ*		
		Бүгд	Үүнээс: Хөөлтэгч	Үүнээс: Төл	(6.03) Хүнсэндээ хэрэглэсэн	(6.04) Худалдсан *АМЬДААР БОЛОН НЯДАЛЖ ХУДАЛДСАНЫГ ОРУУЛНА.*	(6.05) Худалдсан малын нийт үнэ, төгрөгөөр
01	Үхэр						
02	а. Адуу						
	б. Хурдан морь	x x x	x x x	x x x	x x x		
03	Тэмээ						
04	Хонь						
05	Ямаа						

Үндсэн болон давхар эрхэлсэн бүх ажлын урамшуулал /Тэтгэвэрт гарсны тэтгэмж/

Цалингийн дүн		Сүүлийн 12 сард авсан урамшуулал, тэтгэмж, нөхөн олговорууд
Сүүлийн сард	Сүүлийн 12 сард	
Төгрөг	Төгрөг	Төгрөг

БУСАД ОРЛОГО

1. Бусад орлого = Бусдаас авсан бэлэг, тусламж, хандив + Хурдан морь зарж борлуулсан орлого + Цалингийн урамшуулал /Тэтгэвэрт гарсны тэтгэмж/ + Бусад эх үүсвэрийн орлого + Хүү болон ашгийн орлого
2. Бусад орлого / 12

БУСАД ЭХ ҮҮСВЭР				
[НЭР] сүүлийн 12 сард хэдий хэмжээний орлого олсон бэ? БАЙХГҮЙ БОЛ **"0"** ГЭЖ БИЧНЭ ҮҮ.				
Өөрийн эзэмшлийн хөрөнгийг түрээсэлсэн (сууц, машин, тоног төхөөрөмж, газар)	Үндсэн хөрөнгө борлуулсан	Бусдад зээлдүүлсэнээс эргэж төлөгдсөн	Хадгаламжаас авсан	Бусад эх үүсвэрийн орлого
Төгрөг	Төгрөг	Төгрөг	Төгрөг	Төгрөг

ХҮҮ БОЛОН АШИГ			
[НЭР] сүүлийн 12 сард хэдий хэмжээний орлого олсон бэ? БАЙХГҮЙ БОЛ "0" ГЭЖ БИЧНЭ ҮҮ.			
Хадгаламжийн хүү	Хувьцааны ноогдол ашиг	Зээлийн хүү	Бусад (оюуны өмчийн болон бусад)
Төгрөг	Төгрөг	Төгрөг	Төгрөг

БУСДААС ҮНЭГҮЙ АВСАН ХҮНСНИЙ БОЛОН ХҮНСНИЙ БУС БҮТЭЭГДЭХҮҮН

Бусдаас үнэгүй авсан **хүнсний** болон **хүнсний бус бүтээгдэхүүнийг** мөнгөн бус хэлбэрээр авсан бол тухайн үеийн зах зээлийн үнээр /тухайн нутаг дэвсгэрийн голч үнэ/ үнэлэн мөнгөн дүнгээр илэрхийлж тодорхойлно.

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ ӨРХИЙН ӨДРИЙН ТЭМДЭГЛЭЛЭЭС

	Улаанбаатар, аймгийн төвийн		*ДАРААХ МЭДЭЭЛЛИЙГ ӨРХИЙН ӨДРИЙН ТЭМДЭГЛЭЛЭЭС 7 ХОНОГИЙН ХЭРЭГЛЭЭГ НЭГТГЭН НӨХНӨ. ХЭРВЭЭ ӨРХ ТУХАЙН НЭР ТӨРЛИЙГ ХЭРЭГЛЭЭГҮЙ БОЛ "0" ГЭЖ БИЧНЭ*				
			ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР			
			(13.01) 7 хоногийн хугацаанд хэдий хэмжээгээр [НЭР ТӨРӨЛ] хэрэглэсэн бэ? (13.01)=(13.02)+(13.04)+(13.05)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА
				(13.02) Худалдан авсанаас хэрэглэсэн	(13.03) Худалдан авсан нэгжийн үнэ	(13.04) Бусдаас үнэгүй авсанаас хэрэглэсэн	(13.05) Өөрийн аж ахуйгаас хэрэглэсэн
	НЭР ТӨРӨЛ	НЭГЖ	ТОО ХЭМЖЭЭ	ТОО ХЭМЖЭЭ	ТӨГРӨГ / [нэгж]	ТОО ХЭМЖЭЭ	ТОО ХЭМЖЭЭ
10100	**ҮР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН**						
10101	Талх (ш=670гр)	ш			/ ш		
10102	Цагаан будаа	кг			/ кг		
10103	Гурил, дээд зэрэг	кг			/ кг		

Бусдаас үнэгүй авч хэрэглэсэн **хүнсний бүтээгдэхүүн *** 4.285714286 /сард шилжүүлнэ/

БУСДААС ҮНЭГҮЙ АВСАН ХҮНСНИЙ БОЛОН ХҮНСНИЙ БУС БҮТЭЭГДЭХҮҮН

Сумын төв, хөдөөгийн

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ САНУУЛЖ АСУУНА.

	(14.01)-Р АСУУЛТЫГ БҮХ НЭР ТӨРЛӨӨР АСУУЖ, "ТИЙМ" БОЛ ЭХНИЙ БАГАНАД "1", "ҮГҮЙ" БОЛ ХОЁРДАХЬ БАГАНАД "2" ГЭЖ ТАВИАД, ЗӨВХӨН "1" ГЭЖ ХАРИУЛСАН ТОХИОЛДОЛД (14.02)-ООС (14.06) ХҮРТЭЛХ АСУУЛТЫГ АСУУНА. (14.01) Танай өрх сүүлийн 7 хоногт [НЭР ТӨРӨЛ] хэрэглэсэн үү. Тийм 1 Үгүй 2 → **Дараагийн нэр төрөл**			**СҮҮЛИЙН 7 ХОНОГИЙН ХЭРЭГЛЭЭ**				
				ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР			
				(14.02) Сүүлийн 7 хоногт [НЭР ТӨРӨЛ] хэдий хэмжээгээр хэрэглэсэн бэ? (14.02)=(14.03)+(14.05)+(14.06)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА
					(14.03) Худалдан авсанаас хэрэглэсэн	(14.04) Худалдан авсан нэгжийн үнэ	(14.05) Бусдаас үнэгүй авсанаас хэрэглэсэн	(14.06) Өөрийн аж ахуйгаас хэрэглэсэн
	НЭР ТӨРӨЛ	НЭГЖ		ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ	ТӨГРӨГ / [нэгж]	ТОО ХЭМЖ ЭЭ	ТОО ХЭМЖ ЭЭ
10100	**ҮР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН**							
10101	Талх (ш=670гр)	ш				/ ш		
10102	Цагаан будаа	кг				/ кг		
10103	Гурил, дээд зэрэг	кг				/ кг		

Бусдаас үнэгүй авч хэрэглэсэн **хүнсний бүтээгдэхүүн *** 4.285714286 /сард шилжүүлнэ/

НЭР ТӨРЛИЙН КОД	*АСУУЛТ (12.01)-ИЙГ БҮХ НЭР ТӨРЛӨӨР АСУУЖ, СҮҮЛИЙН 12 САРЫН ДОТОР ХУДАЛДАН АВСАН ЭСЭХИЙГ ТОДОРХОЙЛЖ, ХУДАЛДАН АВСАН "ТИЙМ-1" ГЭЖ ХАРИУЛСАН БОЛ ЗӨВХӨН ТУХАЙН НЭР ТӨРЛИЙГ ТОДОТГОН АСУУЛТ (12.02 -12.04)-ЫГ АСУУНА.* (12.01) Танай өрхийн хэн нэгэн гишүүн дараах нэр төрлийн бүтээгдэхүүнийг өөртөө хэрэглэхээр сүүлийн 12 сарын дотор худалдан авсан уу? Мөн бусдаас үнэгүй авсан уу? Тийм 1 Үгүй 2 → **Дараагийн нэр төрөл**	**ХУДАЛДАН АВАЛТ**		**БУСДААС ҮНЭГҮЙ АВСАН**
		(12.02) Сүүлийн 1 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ-ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	(12.03) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ -ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	(12.04) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүдийн **бусдаас** үнэгүй авсан НЭР ТӨРӨЛ хэдэн төгрөг болох вэ?
21801	Зоогийн газар, кафе, үүнтэй ижил зэрэглэлийн үйлчилгээний газар			
21802	Цайны газар, гуанз			

Өрхөөс гадуур хооллохдоо өрхийн гишүүдийн бусдаас үнэгүй авсан хоолны мөнгөн дүнг 12-т хувааж, түүнээс дундаж хэмжээг авна.

БУСДААС ҮНЭГҮЙ АВСАН ХҮНСНИЙ БОЛОН ХҮНСНИЙ БУС БҮТЭЭГДЭХҮҮН

Бусдаас үнэгүй авч хэрэглэсэн **хүнсний бус бүтээгдэхүүний** нийт мөнгөн дүн / 12

ХЭРВЭЭ ӨРХИЙН ГИШҮҮН БУС ХҮНД ӨГӨХӨӨР ХУДАЛДАН АВСАН БОЛ 22801-Т БИЧНЭ.

НЭР ТӨРЛИЙН КОД	*АСУУЛТ (12.01)-ИЙГ БҮХ НЭР ТӨРЛӨӨР АСУУЖ, СҮҮЛИЙН 12 САРЫН ДОТОР ХУДАЛДАН АВСАН ЭСЭХИЙГ ТОДОРХОЙЛЖ, ХУДАЛДАН АВСАН "ТИЙМ-1" ГЭЖ ХАРИУЛСАН БОЛ ЗӨВХӨН ТУХАЙН НЭР ТӨРЛИЙГ ТОДОТГОН АСУУЛТ (12.02 -12.04)-ЫГ АСУУНА.* (12.01) Танай өрхийн хэн нэгэн гишүүн дараах нэр төрлийн бүтээгдэхүүнийг өөртөө хэрэглэхээр сүүлийн 12 сарын дотор худалдан авсан уу? Мөн бусдаас үнэгүй авсан уу? Тийм 1 Үгүй 2 → **Дараагийн нэр төрөл**		**ХУДАЛДАН АВАЛТ**		**БУСДААС ҮНЭГҮЙ АВСАН**
			(12.02) Сүүлийн 1 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ-ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	(12.03) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүд НЭР ТӨРӨЛ -ийг худалдан авахад хичнээн төгрөг зарцуулсан бэ?	(12.04) Сүүлийн 12 сарын хугацаанд танай өрхийн гишүүдийн **бусдаас** үнэгүй авсан НЭР ТӨРӨЛ хэдэн төгрөг болох вэ?
20100	**Бэлэн хувцас (эрэгтэй, эмэгтэй, хүүхэд)**				
20101	Савхин болон илгэн куртка, дээл				
20102	Нэхий болон үслэг дээл, шуба				
20103	Өвлийн пальто, куртка				
20104	Бусад куртка, пальто, цув, пельник				

ӨӨРИЙН ХУВИЙН АЖ АХУЙГААС ХЭРЭГЛЭСЭН ХҮНСНИЙ БҮТЭЭГДЭХҮҮН

Өөрийн хувийн аж ахуйгаас хэрэглэсэн хүнсний бүтээгдэхүүнийг тухайн үеийн зах зээлийн үнээр /тухайн нутаг дэвсгэрийн голч үнэ/ үнэлэн мөнгөн дүнгээр илэрхийлж тодорхойлно.

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ ӨРХИЙН ӨДРИЙН ТЭМДЭГЛЭЛЭЭС

			ДАРААХ МЭДЭЭЛЛИЙГ ӨРХИЙН ӨДРИЙН ТЭМДЭГЛЭЛЭЭС 7 ХОНОГИЙН ХЭРЭГЛЭЭГ НЭГТГЭН НӨХНӨ. ХЭРВЭЭ ӨРХ ТУХАЙН НЭР ТӨРЛИЙГ ХЭРЭГЛЭЭГҮЙ БОЛ "0" ГЭЖ БИЧНЭ				
			ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР			
			(13.01)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА
			7 хоногийн хугацаанд хэдий хэмжээгээр [НЭР ТӨРӨЛ] хэрэглэсэн бэ? (13.01)=(13.02)+(13.04)+(13.05)	(13.02) Худалдан авсанаас хэрэглэсэн	(13.03) Худалдан авсан нэгжийн үнэ	(13.04) Бусдаас үнэгүй авсанаас хэрэглэсэн	(13.05) Өөрийн аж ахуйгаас хэрэглэсэн
	НЭР ТӨРӨЛ	НЭГЖ	ТОО ХЭМЖЭЭ	ТОО ХЭМЖЭЭ	ТӨГРӨГ / [нэгж]	ТОО ХЭМЖЭЭ	ТОО ХЭМЖЭЭ
10100	**ҮР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН**						
10101	Талх (ш=670гр)	ш			/ ш		
10102	Цагаан будаа	кг			/ кг		
10103	Гурил, дээд зэрэг	кг			/ кг		

ХҮНСНИЙ ЗҮЙЛИЙН ХЭРЭГЛЭЭГ САНУУЛЖ АСУУНА.

	(14.01)-Р АСУУЛТЫГ БҮХ НЭР ТӨРЛӨӨР АСУУЖ, "ТИЙМ" БОЛ ЭХНИЙ БАГАНАД "1", "ҮГҮЙ" БОЛ ХОЁР ДАХЬ БАГАНАД "2" ГЭЖ ТАВИАД, ЗӨВХӨН "1" ГЭЖ ХАРИУЛСАН ТОХИОЛДОЛД (14.02)-ООС (14.06) ХҮРТЭЛХ АСУУЛТЫГ АСУУНА.			**СҮҮЛИЙН 7 ХОНОГИЙН ХЭРЭГЛЭЭ**				
				ДҮН	ХЭРЭГЛЭЭ, БҮТЭЭГДЭХҮҮНИЙ ЭХ ҮҮСВЭРЭЭР			
	(14.01) Танай өрх сүүлийн 7 хоногт [НЭР ТӨРӨЛ] хэрэглэсэн үү. Тийм 1 Үгүй 2 → **Дараагийн нэр төрөл**			(14.02) Сүүлийн 7 хоногт [НЭР ТӨРӨЛ] хэдий хэмжээгээр хэрэглэсэн бэ? (14.02)=(14.03)+(14.05)+(14.06)	ХУДАЛДАН АВАЛТ		БУСДААС ҮНЭГҮЙ	ӨАА
					(14.03) Худалдан авсанаас хэрэглэсэн	(14.04) Худалдан авсан нэгжийн үнэ	(14.05) Бусдаас үнэгүй авсанаас хэрэглэсэн	(14.06) Өөрийн аж ахуйгаас хэрэглэсэн
	НЭР ТӨРӨЛ	НЭГЖ		ТОО ХЭМЖЭЭ	ТОО ХЭМЖЭЭ	ТӨГРӨГ / [нэгж]	ТОО ХЭМЖЭЭ	ТОО ХЭМЖЭЭ
10100	**ҮР ТАРИА, ГУРИЛ, ГУРИЛАН БҮТЭЭГДЭХҮҮН**							
10101	Талх (ш=670гр)	ш				/ ш		
10102	Цагаан будаа	кг				/ кг		
10103	Гурил, дээд зэрэг	кг				/ кг		

ҮНДЭСНИЙ
СТАТИСТИКИЙН
ХОРОО

АНХААРАЛ ХАНДУУЛСАНД БАЯРЛАЛАА

ҮНДЭСНИЙ СТАТИСТИКИЙН ХОРОО

АЖИЛЛАХ ХҮЧНИЙ СУДАЛГАА

ҮСХ, Нийгмийн статистикийн газрын
ахлах статистикч Э.Гантуяа

УЛААНБААТАР ХОТ

АГУУЛГА

1. Судалгааны зохион байгуулалт
2. Ангилал, аргачлал
3. Түүвэр
4. Мэдээллийн бааз
5. Тооцож байгаа гол үзүүлэлт
6. Тооцоолол

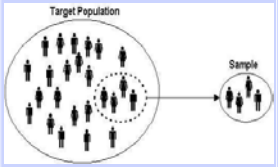
СУДАЛГААНЫ ЗОРИЛГО

ЗОРИЛГО

- Хөдөлмөрийн статистикийн суурь мэдээллийг өргөжүүлэн баяжуулах
- Хөдөлмөр эрхлэлтийн хэв шинжийг бүрэн хамруулсан дүн шинжилгээ хийх
- Хөдөлмөр эрхлэлтийг нэмэгдүүлэх, ажилгүйдэл, ядуурлыг бууруулахад чиглэгдсэн Засгийн газрын бодлого, хөтөлбөр боловсруулах, тэдгээрийг хэрэгжүүлэх үйл ажиллагаанд хяналт, шинжилгээ хийх, үнэлэлт дүгнэлт өгөх

Монгол Улсын “Статистикийн тухай” хуулийн 7 дугаар зүйлийн 1 дэх хэсгийн ё-д: Хүн амын ажил эрхлэлтийн түүвэр судалгааг улирал тутам явуулах

МЭДЭЭЛЛИЙН ЭХ ҮҮСВЭР

Тооллого	Түүвэр судалгаа	Захиргааны статистик мэдээ
Хүн ам орон сууцны тооллого  	• **Ажиллах хүчний судалгаа** • Цалин хөлсний бүтцийн туршилтын судалгаа -2010 • Ажил эрхлэлтийн зардлын туршилтын судалгаа- 2013 	1.Ажил хайгч иргэд, бүртгэлтэй ажилгүй иргэдийн сарын мэдээ - Сараар, ХНХЯ 2. Төрийн албан хаагчдын жилийн мэдээ -Жилээр, ТАЗ 3. Хөдөлмөрийн хамтын маргааны жилийн мэдээ - Жилээр,ХНХЯ 4. Үйлдвэрлэлийн осол хурц хордлогын улирлын мэдээ - Улирлаар, МХЕГ 5. Хөдөлмөрийн гэрээгээр ажиллаж байгаа гадаадын иргэд болон гадаад зуучлагдсан ажиллах хүчний улирлын мэдээ - Улирлаар, ХНХЯ

1. СУДАЛГААНЫ ЗОХИОН БАЙГУУЛАЛТ

ХӨДӨЛМӨРИЙН СТАТИСТИКИЙН ҮНДСЭН ҮЗҮҮЛЭЛТИЙН ЭХ ҮҮСВЭР

2009 он хүртэл: Хүн амын ажил эрхлэлтийн жилийн тайлан

2009 оноос: "Ажиллах хүчний судалгаа

2. АРГАЧЛАЛ, АНГИЛАЛ

ОУХС-ын 19, 20-р бага хурлын тогтоолыг
- Бүрэн хэрэгжүүлсэн 21 улс – Монгол Улс
- Стандартын хэрэгжил 15 улс байна.

2019 Монгол Улс аргачлалаа шинэчилсэн

2018 ОУХС-ын 20-р бага хурлын **Хөдөлмөрийн харилцааны статистикийн тухай тогтоол**

2013 ХСОУ-ын 19-р бага хурлаар батлагдсан **"Ажил, хөдөлмөр эрхлэлт болон хөдөлмөрийн дутуу ашиглалт"-ын талаарх тогтоол**

1. СУДАЛГААНЫ ЗОХИОН БАЙГУУЛАЛТ

2. АРГАЧЛАЛ, АНГИЛАЛ

Аргачлал

ҮСХ-ны дарга, Хөдөлмөр нийгмийн хамгааллын сайдын 2019 оны А/09, А/08 тоот хамтарсан тушаалаар батлагдсан "Хөдөлмөр эрхлэлтийн статистикийн үзүүлэлтийг тооцох аргачлал"

Бодит цалингийн индексийг тооцох аргачлал

Ажил эрхлэлтийн зардлын индексийг тооцох аргачлал

Хөдөлмөрийн хамтын маргааны аргачлал

Ангилал

Монгол Улсын Засаг захиргаа, нутаг дэвсгэрийн нэгжийн код

Үндэсний ажил, мэргэжлийн ангилал (YAMAT-08)

Эдийн засгийн үйл ажиллагааны салбарын ангилал (ЭЗБТҮАСА-4.0)

Боловсролын олон улсын стандарт ангилал (ISCED-97)

Ажил эрхлэлтийн зардлын үндэсний ангилал

2. АРГАЧЛАЛ, АНГИЛАЛ

Ажил гэж ...

✓ Бүтээгдэхүүн, үйлчилгээ бий болгох/бүтээхэд оролцсон хүний биеийн болон оюуны хүчний бүхий л үйл ажиллагаа

Хөдөлмөр эрхлэлт гэж ...

✓ Цалин хөлс, орлого олох зорилгоор бүтээгдэхүүн, үйлчилгээ бий болгох/бүтээх хүний үйл ажиллагаа

2. АРГАЧЛАЛ, АНГИЛАЛ

Хөдөлмөрийн насны хүн амын бүтэц

2. АРГАЧЛАЛ, АНГИЛАЛ

2. АРГАЧЛАЛ, АНГИЛАЛ

- НАСНЫ ХЯЗГААРГҮЙ
- 3 ШАЛГУУРЫГ ЗЭРЭГ ХАНГАХ

Ажилгүй хүн:

a) Тухайн хугацаанд ажилгүй байсан болон
b) ажил хийхэд бэлэн болон
c) ажил идэвхтэй хайж байгаа хүн.

Сүүлийн 2 шалгуурын аль нэгийг нь хангасан тохиолдолд БОЛОМЖИТ АЖИЛЛАХ ХҮЧ болно

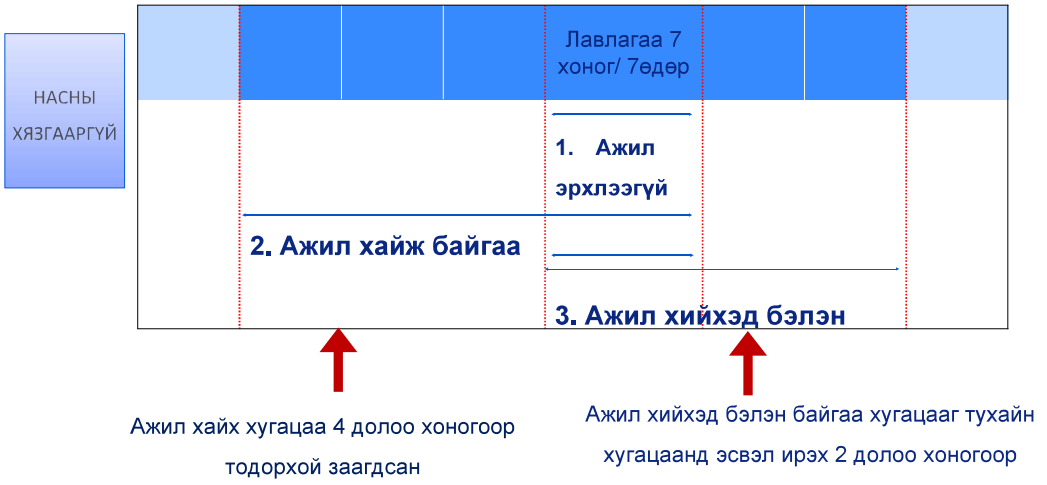
Бүртгэлтэй ажилгүй иргэн

Ажил хайсан

-Хөдөлмөр эрхлэлтийн байгууллага, биржд бүртгүүлсэн

- Ажил олгогчдод өргөдөл өгсөн
- Цахим хуудас, хэвлэл мэдээллийн хэрэгслээр
-Найз нөхөд ба хамаатнууд
-Хувийн бизнесээ эхлүүлэх

2. АРГАЧЛАЛ, АНГИЛАЛ



2. АРГАЧЛАЛ, АНГИЛАЛ

Ажилгүйдлийн түвшин:

$$\text{ХДАТ}_1 = \frac{\text{Ажилгүй хүний тоо}}{\text{Ажиллах хүч}} * 100\%$$

тайлбар: өргөтгөсөн ажиллах хүч = АХ + БАХ

Цаг хугацаанаас хамаарсан бүрэн бус хөдөлмөр эрхлэлт болон ажилгүйдлийн нэгдсэн түвшин:

$$\text{ХДАТ}_2 = \frac{\text{Ажилгүй хүний тоо} + \text{ЦХХББХЭ}}{\text{Ажиллах хүч}} * 100\%$$

Ажилгүй хүн болон боломжит ажиллах хүчний нэгдсэн түвшин:

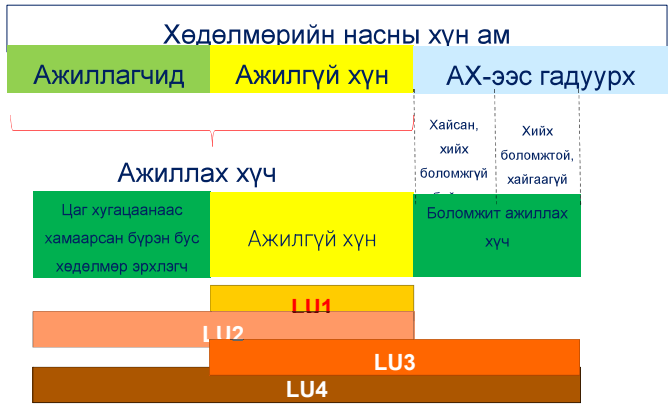
$$\text{ХДАТ}_3 = \frac{\text{Ажилгүй хүний тоо} + \text{боломжит ажиллах хүч}}{\text{Өргөтсөн ажиллах хүч}} * 100\%$$

Хөдөлмөрийн дутуу ашиглалтын нийлмэл түвшин:

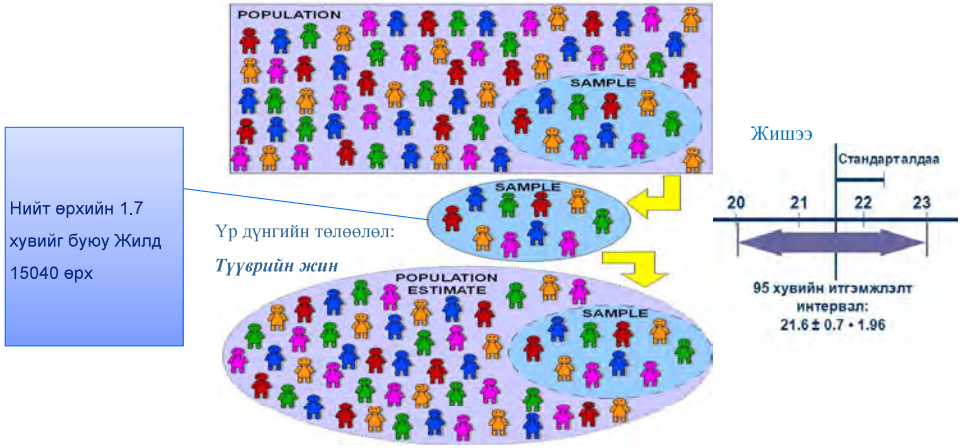
$$\text{ХДАТ}_4 = \frac{\text{Ажилгүй хүн} + \text{ЦХХББХЭ} + \text{БАХах хүч}}{\text{Өргөтгөсөн ажиллах хүч}} * 100\%$$

2. АРГАЧЛАЛ, АНГИЛАЛ

Хөдөлмөрийн дутуу ашиглалт



3. ТҮҮВЭР



Судалгааны түүврийн дизайн

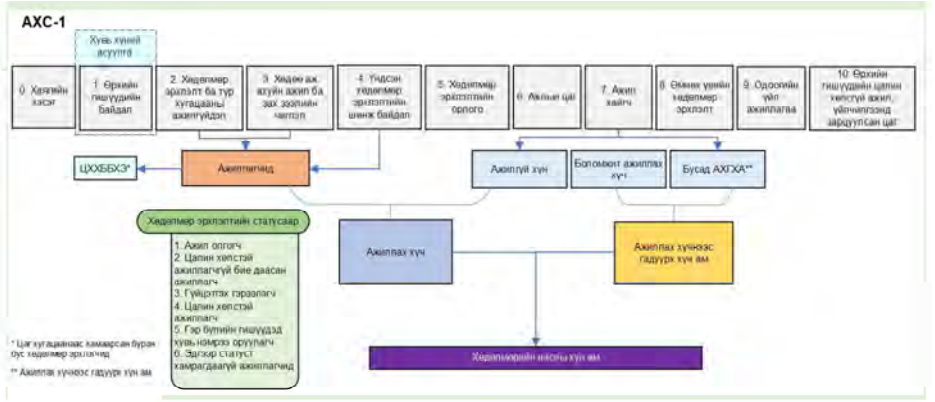
Түүврийн ротаци хуваарилалт:

Улирлаар ТАШН-д ротаци хийхдээ 25 хувийг нь шинээр сонгож, 75 хувийг нь өмнөх улирлынхыг хэвээр үлдээх зарчмаар судалгаа зохион байгуулагддаг.

ТАШН болон ТХШН-ийн тоо, улирлаар

I улирал /ТАШН-ын 25%/	II улирал /ТАШН-ын 25%/	IIII улирал /ТАШН-ын 25%/	IV улирал /ТАШН-ын 25%/
94 PSU – 940 HH			
94 PSU – 940 HH	94 PSU – 940 HH		
94 PSU – 940 HH	94 PSU – 940 HH	94 PSU – 940 HH	
94 PSU – 940 HH	94 PSU – 940 HH	94 PSU – 940 HH	94 PSU – 940 HH
	94 PSU – 940 HH	94 PSU – 940 HH	94 PSU – 940 HH
		94 PSU – 940 HH	94 PSU – 940 HH
			94 PSU – 940 HH

АХС-ны ерөнхий зураглал



Түүврийн ротаци хуваарилалт:

№	Аймаг	Нийт	I улиралд	II улиралд		III улиралд		IV улиралд		хамрагдах давтамжаар			
				шинэ	давтан	шинэ	давтан	шинэ	давтан	1 удаа	2 удаа	3 удаа	4 удаа
1	Архангай	480	120	30	90	30	90	30	90	60	60	60	30
2	Баян-Өлгий	480	120	30	90	30	90	30	90	60	60	60	30
3	Баянхонгор	480	120	30	90	30	90	30	90	60	60	60	30
4	Булган	480	120	30	90	30	90	30	90	60	60	60	30
5	Говь-Алтай	480	120	30	90	30	90	30	90	60	60	60	30
6	Дорноговь	640	160	40	120	40	120	40	120	80	80	80	40
7	Дорнод	640	160	40	120	40	120	40	120	80	80	80	40
8	Дундговь	480	120	30	90	30	90	30	90	60	60	60	30
9	Завхан	480	120	30	90	30	90	30	90	60	60	60	30
10	Өвөрхангай	480	120	30	90	30	90	30	90	60	60	60	30
11	Өмнөговь	640	160	40	120	40	120	40	120	80	80	80	40
12	Сүхбаатар	640	160	40	120	40	120	40	120	80	80	80	40
13	Сэлэнгэ	480	120	30	90	30	90	30	90	60	60	60	30
14	Төв	480	120	30	90	30	90	30	90	60	60	60	30
15	Увс	480	120	30	90	30	90	30	90	60	60	60	30
16	Ховд	480	120	30	90	30	90	30	90	60	60	60	30
17	Хөвсгөл	640	160	40	120	40	120	40	120	80	80	80	40
18	Хэнтий	480	120	30	90	30	90	30	90	60	60	60	30
19	Дархан-Уул	640	160	40	120	40	120	40	120	80	80	80	40
21	Орхон	640	160	40	120	40	120	40	120	80	80	80	40
22	Говьсүмбэр	320	80	20	60	20	60	20	60	40	40	40	20
23	Улаанбаатар	4000	1000	250	750	250	750	250	750	500	500	500	250
	Нийт	15040	3760	940	2820	940	2820	940	2820	1880	1880	1880	940

ТОГТВОРТОЙ ХӨГЖЛИЙН ЗОРИЛТ 2030-Н ҮЗҮҮЛЭЛТ:

1. Удирдах албан тушаалд ажиллагчдад эмэгтэйчүүдийн эзлэх хувь (**ТХЗ 5.5.2**), 2009-2021 оноор

2. Хөдөө аж ахуйн бус салбарын нийт ажиллагсдад албан бус ажил эрхлэгчдийн эзлэх хувь (**ТХЗ 8.3.1**), 2019-2021 оноор

3. Ажиллагчдын цагийн дундаж хөлс, төгрөгөөр, хүйсээр (**ТХЗ 8.5.1**), 2009-2021 оноор

4. Ажилгүйдлийн түвшин (хувиар), хүйс, насны бүлэг, хөгжлийн бэрхшээлтэй иргэдээр (**ТХЗ 8.5.2**), 2009-2021 оноор

5. Хөдөлмөр эрхлээгүй болон боловсрол, сургалтад хамрагдаагүй 15-24 насны залуучуудын тухайн насны хүн амд эзлэх хувь (**ТХЗ 8.6.1**), 2009-2021 оноор

6. Нийт ажиллагчдаас боловсруулах салбарт ажиллагчдын эзлэх хувь (**ТХЗ 9.2.2**), 1985-2021 оноор, 21 салбарын ангиллаар

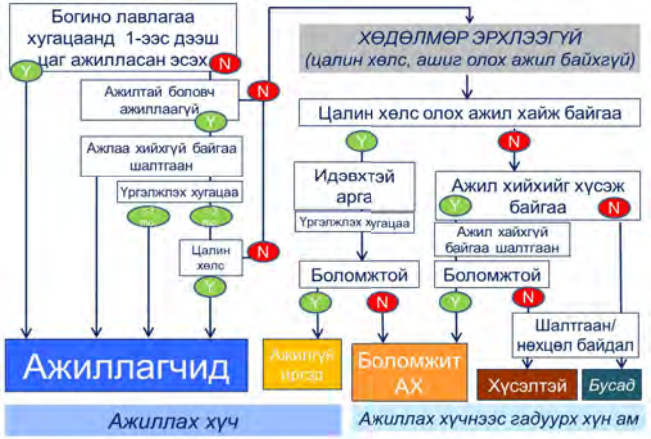
5. ҮР ДҮН

ОУХБ-аас тодорхойлсон Хөдөлмөрийн зах зээлийн түлхүүр **17** үзүүлэлт, тэдгээрийг Монгол Улс тооцдог эсэх

Үзүүлэлт	Тооцдог эсэх	Эх үүсвэр
1. Ажиллах хүчний оролцооны түвшин	+	АХС
2. Хөдөлмөр эрхлэлтийн түвшин	+	
3. Хөдөлмөр эрхлэлтийн статус	+	
4. Хөдөлмөр эрхлэлт, салбараар	+	
5. Хөдөлмөр эрхлэлт, ажил мэргэжлийн ангиллаар	+	
6. Бүрэн бус цагаар ажиллагчид	+	
7. Ажлын цаг	+	
8. Албан бус сектор дахь хөдөлмөр эрхлэлт	+	
9. Нийт ажилгүй иргэд	+	
10. Залуучуудын ажилгүйдэл	+	
11. Урт хугацааны ажилгүйдэл	+	
12. Цаг хугацаанаар хэмжигдэх бүрэн бус хөдөлмөр эрхлэлт	+	
13. Эдийн засгийн идэвхгүй хүн ам	+	
14. Боловсролын түвшин ба бичиг үсэг тайлагдаагүй байдал	+	
16. Цалин болон нөхөн олговрын зардал	+	ААНБ-ын үйлдвэрлэлийн мэдээ
17. Хөдөлмөрийн бүтээмж	+	АХС, АҮ-1
18. Ядуурал, орлогын хуваарилалт, **ажилтай ядуучууд**	+	ӨНЭЗС

6. ТООЦООЛОЛ

Тооцооллын схем



5. ҮР ДҮН

ОУХБ-ын гишүүн орнууд тогтмол цуглуулж, нэгтгэн боловсруулж, хэвлэн нийтэлт байх хөдөлмөрийн статистикийн үндсэн үзүүлэлт

Үзүүлэлт	Эх үүсвэр
1. Хөдөлмөрийн насны хүн ам	АХС
2. Ажиллах хүч	
3. Ажиллагчид	
4. Албан бус хөдөлмөр эрхлэлт	
5. Цаг хугацаанаас хамаарсан бүрэн бус хөдөлмөр эрхлэлт	
6. Цалин хөлстэй ажиллагчид	
7. Төрийн албан хаагчид	ТАЗ
8. Ажилгүй иргэд	АХС
9. Шантарсан ажил хайгчид болон сураагүй, ажилгүй байгаа залуучууд	
10. Ажлын цаг	
11. Цалин	НДЕГ+АХС
12. Хөдөлмөрийн зардал	-
13. Үйлдвэрлэлийн эвлэл, хөдөлмөрийн харьцаа	МҮЭХ
14. Үйлдвэрлэлийн осол	МХЕГ
15. Ажил хаялт, ажил түр хаалт	ХНХЯ
16. Ажилтай ядуучууд	ӨНЭЗС
17. Орлогын хувиарлал	ДНБ+АХС

Үзүүлэлт тус бүр нь 3-12 төрлийн хүснэгт болон ангиллаар задарч гардаг

6. ТООЦООЛОЛ

B04-06-д хариулагч аль аль нь тийм байж болох тул үндсэн үйл ажиллагааг асуух. Олон ажил, албан үүргийг гүйцэтгэж байгаа тохиолдолд ажлын цагийн талаарх олон улсын статистикийн стандартаар тодорхойлсны дагуу **хамгийн олон цагаар тогтмол** ажилладаг ажил, албан үүргийг **үндсэн ажил** гэж үзнэ.

(Нэр)- нь сүүлийн 7 хоногт наад зах нь 1 цаг ямар нэг **цалин хөлс, төлбөртэй ажил** эрхэлсэн үү?	(Нэр)- нь сүүлийн 7 хоногт наад зах нь 1 цаг **орлого олох зорилгоор** ямар нэг төрлийн хувийн бизнес, өрхийн болон хөдөө аж ахуйн үйл ажиллагаа эрхэлсэн үү?	(Нэр)- нь сүүлийн 7 хоногт өрхийн гишүүний бизнес эсвэл цалин хөлстэй ажилд нь тусалсан уу?	(Нэр)- тан сүүлийн 7 хоногт бүцаж хийхээр хүлээгдэж байгаа цалинтай ажил эсвэл бизнесийн үйл ажиллагаа байсан уу?	(Нэр)- нь сүүлийн 7 хоногт өрхийн/ гэр бүлийн бизнест туслаагүй ч эдгээрийг ер нь тогтмол хийдэг үү?
Сүүлийн 7 хоногийн үйл ажиллагаа			Ер нь тогтмол хийдэг эсэх	
Тийм - 1 => E01 Үгүй - 2	Тийм - 1 => D01a Үгүй - 2	Тийм - 1 => D01a Үгүй - 2	Тийм - 1 => C03 Үгүй - 2	Тийм- 1 Үгүй - 2 => D01b
B04	B05	B06	C01	C02

Асуулт B04: Зөвхөн цалинтай ажиллагчдын хувьд;
Асуулт B05: Зөвхөн хувиараа хөдөлмөр эрхлэгч, нөхөрлөл, хоршооллын гишүүд
Асуулт B06: Өрхийнхөө бусад цалинтай ажиллагчдад эсвэл хувийн бизнес эрхэлж буй гишүүдэд туслагч

Малчдын хувьд цалинтай малчин бол B04; малчин өрхийн, өрхийн төрүүлэгч болон малтай/мал бүхий өрхийн малчин B5, малчин өрхийн бусад гишүүд бол малтай/мал бүхий өрхийн бусад тулах буй гишүүд B06

6. ТООЦООЛОЛ

(Нэр)- нь яагаад сүүлийн 7 хоногт ажилгүй байсан бэ? *Доорх кодыг ашиглана уу.* **Хэрэв код 1- 4=> D01a 11 => D01b**	Ажиллаагүй хугацаанаас эхлэн (Нэр)/та 3 сарын дотор өмнө нь хийж байсан ажил/бизнесээ үргэлжлүүлэн хийх үү? **Тийм - 1 => D01a Үгүй - 2**	Эсвэл 3 сарын дараа өмнө нь хийж байсан ажил/бизнесээ дахин хийж эхлэх үү? Тийм - 1 Үгүй - 2 Мэдэхгүй - 3	(Нэр)- нь ажлаа хийгээгүй хугацаандаа ажлаасаа ямар нэг төрлийн орлого авч байсан уу? **Тийм - 1 => E01 Үгүй - 2 => D01b**
C03	**C04**	**C05**	**C06**

(Нэр)- нь дараах дурдагдсан ажлыг хийсэн үү? *Доорх кодыг ашиглана уу.* **Хэрэв код 2 => D03 1, 3, 4=> D02 5 => E01**	(Нэр)- нь сүүлийн 7 хоногт мал, тэжээвэр амьтан, газар тариалан, загас, ой, ан агнуур зэрэг ямар нэгэн аж ахуй эрхэлсэн үү? *Доорх кодыг ашиглана уу.* **Хэрэв код 2 => D03 5 => H01a буюу Бүлэг VII**
D01a	**D01b**

Ажилгүй байсан шалтгаан (C03-р багана)	Ажлын шинж байдлаас хамаарч ээлжийн ажил болон уян хатан цагаар ажилладаг - 1, Амралттай байсан - 2, Өвчин, осол гэмтэлд өртсөн - 3, Жирэмсний болон амаржсаны эсвэл эцэг болоны амралттай - 4, Эмийн чөлөөтэй - 5, Боловсрол, сургалтын чөлөөтэй - 6, Бусад хувийн амралттай (гэр бүлдээ анхаарах зэрэг) - 7, Түр зуур ажил хаялт, үйлдвэрлэгчдэд үзүүлэх хөнгөлөлт, ажлын зогсолт ирсэн - 8, Цаг агаар муу, байгалийн гамшигтай - 9, Хөдөлмөрийн маргаан үүссэн - 10, Улирлын чанартай ажил хийдэг - 11, Бусад - 12

ХАА үйл ажиллагааны төрөл (D01a-р багана)	Газар тариалан эрхлэх, жимс жимсгэнэ, хүнсний ногоо тариалах - 1, мал, тэжээвэр амьтан маллах, өсгөх - 2, Загас агнуур, эсвэл загасны аж ахуй, үржүүлэг - 3, Ойн аж ахуй, мод бэлтгэл - 4, Өөр төрлийн үйл ажиллагаа эсвэл бизнес эрхлэх - 5
ХАА үйл ажиллагааны төрөл (D01b-р багана)	Газар тариалан эрхлэх, жимс жимсгэнэ, хүнсний ногоо тариалах - 1, мал, тэжээвэр амьтан маллах, өсгөх - 2, Загас агнуур, эсвэл загасны аж ахуй, үржүүлэг - 3, Ойн аж ахуй, мод бэлтгэл - 4, Эдгээрийн аль нь ч биш - 5

6. ТООЦООЛОЛ

(Нэр)- нь сүүлийн 30 хоногт цалин хөлстэй ажил хайх ямар нэгэн оролдлого хийсэн үү?	(Нэр)- нь сүүлийн 30 хоногт ямар нэгэн бизнес эрхлэхийг оролдсон уу?	Хэрэв ямар нэгэн ажил/бизнес эрхлэх боломжтой болбол хийхийг хүсэж байна уу?	Хэрэв сүүлийн 7 хоногт ямар нэгэн ажил, бизнес эрхлэх боломж гарсан бол ажиллаж чадахаар байсан уу?	(Нэр)- нь ирэх 14 хоногт ажил хийхэд бэлэн үү?
Тийм - 1=> H04 Үгүй- 2	**Тийм - 1=> H04 Үгүй - 2**	**Тийм - 1 Үгүй - 2 => H13**	**Тийм - 1 => H13 Үгүй - 2**	**Тийм - 1 => H13 Үгүй - 2**
H01a	**H01b**	**H08**	**H10**	**H11**

6. ТООЦООЛОЛ

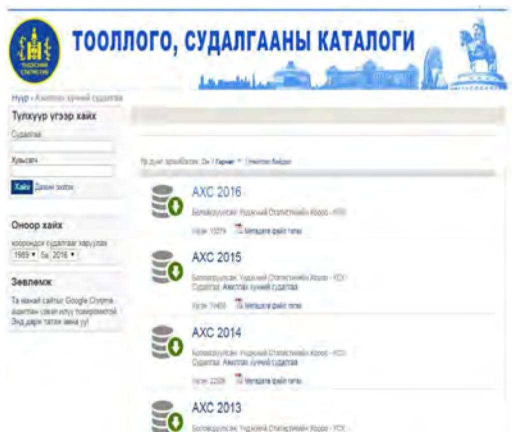
Малчдын хөдөлмөр эрхлэлтийг тодорхойлох нэмэлт шалгуурын асуултууд

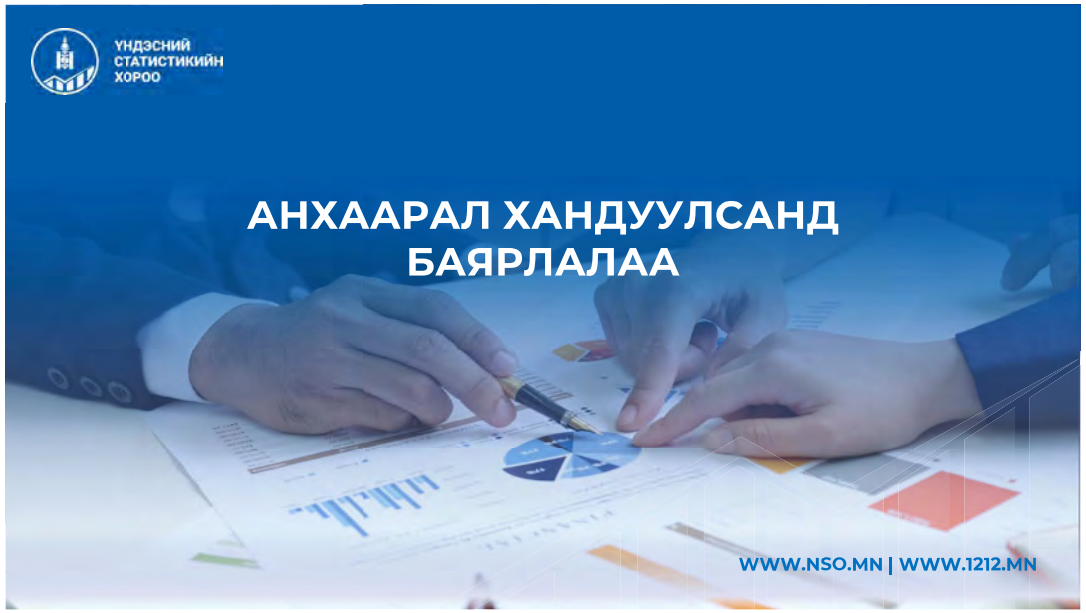
(Нэр)- нь бүтээгдэхүүнээ ямар зорилгоор үйлдвэрлэдэг бэ? *Доорх кодыг ашиглана уу.* **Хэрэв код 1 - 2 => E01 3 - 4 => D08**	(Нэр)- нь ихэвчлэн зах зээлд борлуулах зорилготойгоор мал, тэжээвэр амьтан өсгөж байгаа юу? **Тийм -1 => E01 Үгүй-2**	Танай өрх мал, тэжээвэр амьтнаас бий болсон бүтээгдэхүүнээ ихэвчлэн зах зээлд борлуулах зорилгоор үйлдвэрлэдэг үү? Жишээлбэл: мах , сүү, ноолуур, арьс шир ...гэх зэрэг **Тийм-1 => E01 Үгүй-2**	Танай өрх мал, тэжээвэр амьтан болон түүнээс бий болсон бүтээгдэхүүнийхээ зарим хэсгийг зарим тохиолдолд зарж, борлуулдаг уу? **Тийм -1 Үгүй -2 => D08**	Танай өрх мал, тэжээвэр амьтан болон түүнээс бий болсон бүтээгдэхүүнийхээ зарим хэсгийг зардаг бол ямар хугацааны давтамжтайгаар зарж, борлуулдаг вэ? *Доорх кодыг ашиглана уу.*	Танай өрх мал, тэжээвэр амьтнаас бий болсон бүтээгдэхүүнийхээ ойролцоогоор хэчнээнийг нь борлуулсан бэ? *Доорх кодыг ашиглана уу.* **Хэрэв код 1 => E01**	Сүүлийн нэг жилд мал, тэжээвэр амьтнаас олсон орлого нь тухайн хугацаанд танай өрхийн орлогын хэдэн хувийг эзэлсэн бэ? *Доорх кодыг ашиглана уу.* **Хэрэв код 1 => E01**	(Нэр)- та энэ ажлыг эрхлэхэд хэн нэгэн таныг хөлсөлсөн үү? **Тийм-1 => E01 Үгүй-2 => H01a**
D02	**D03**	**D04**	**D05**	**D06**	**D07**	**D07a**	**D08**

Бүтээгдэхүүн үйлдвэрлэлийн зорилго (D02-р багана)	Зөвхөн зах зээлд борлуулах - 1, Ихэвчлэн зах зээлд борлуулах - 2, Ихэвчлэн өрхийн хэрэгцээнд - 3, Зөвхөн өрхийн хэрэгцээнд - 4

Хэчнээн их худалдаалдаг (D07-р багана)	Талаас илүүг нь - 1, Талаас багыг нь - 2, Хэлж мэдэхгүй байна - 3
МАА-с олдог орлого (D07a-р багана)	Өрхийн орлогын талаас илүүг нь - 1, Өрхийн орлогын талаас багыг нь - 2, Хэлж мэдэхгүй байна - 3

НЭЭЛТТЭЙ БАЙДАЛ

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ХОРОО
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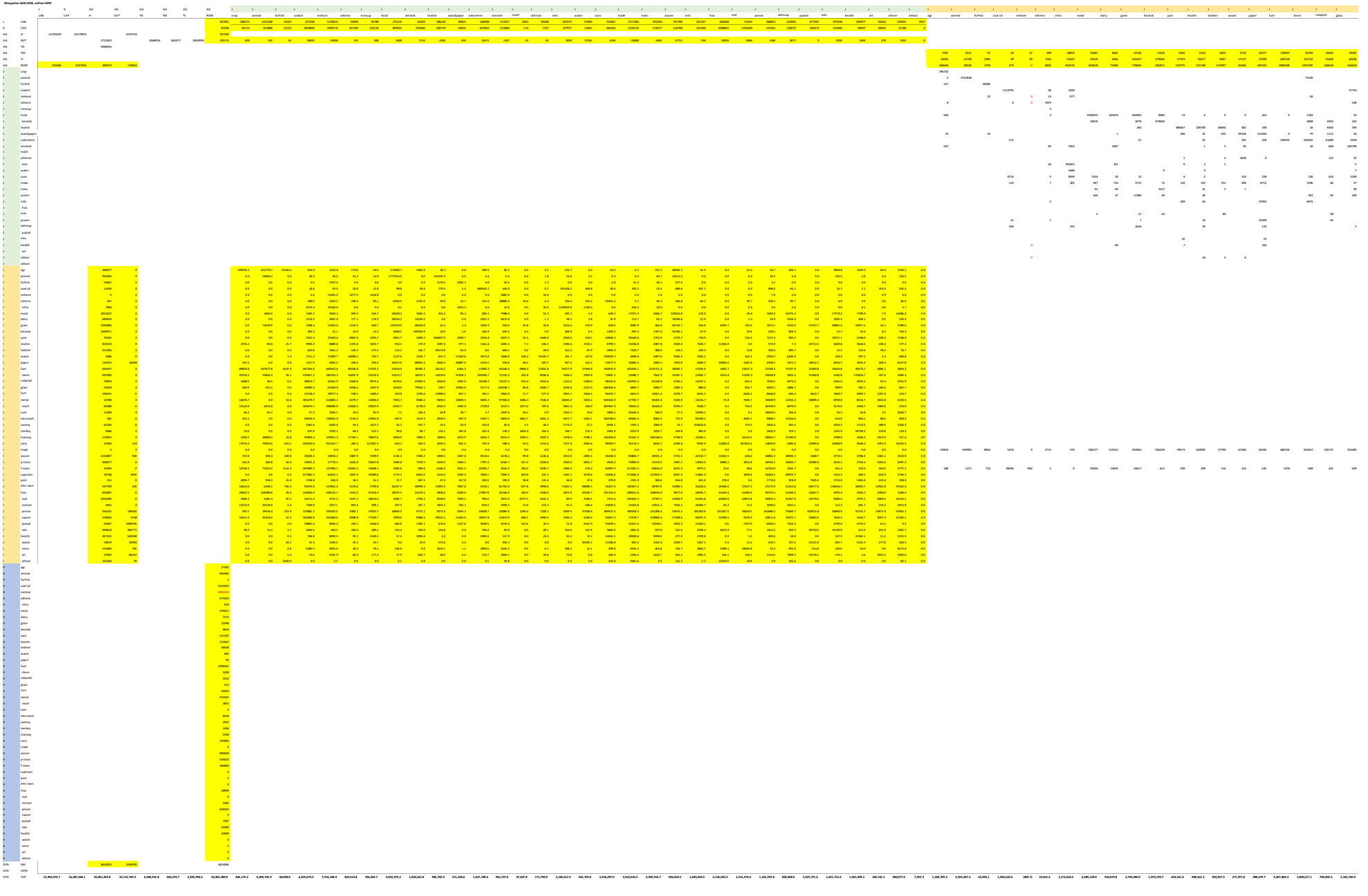
ANNEX-2 Products for CGE Modeling

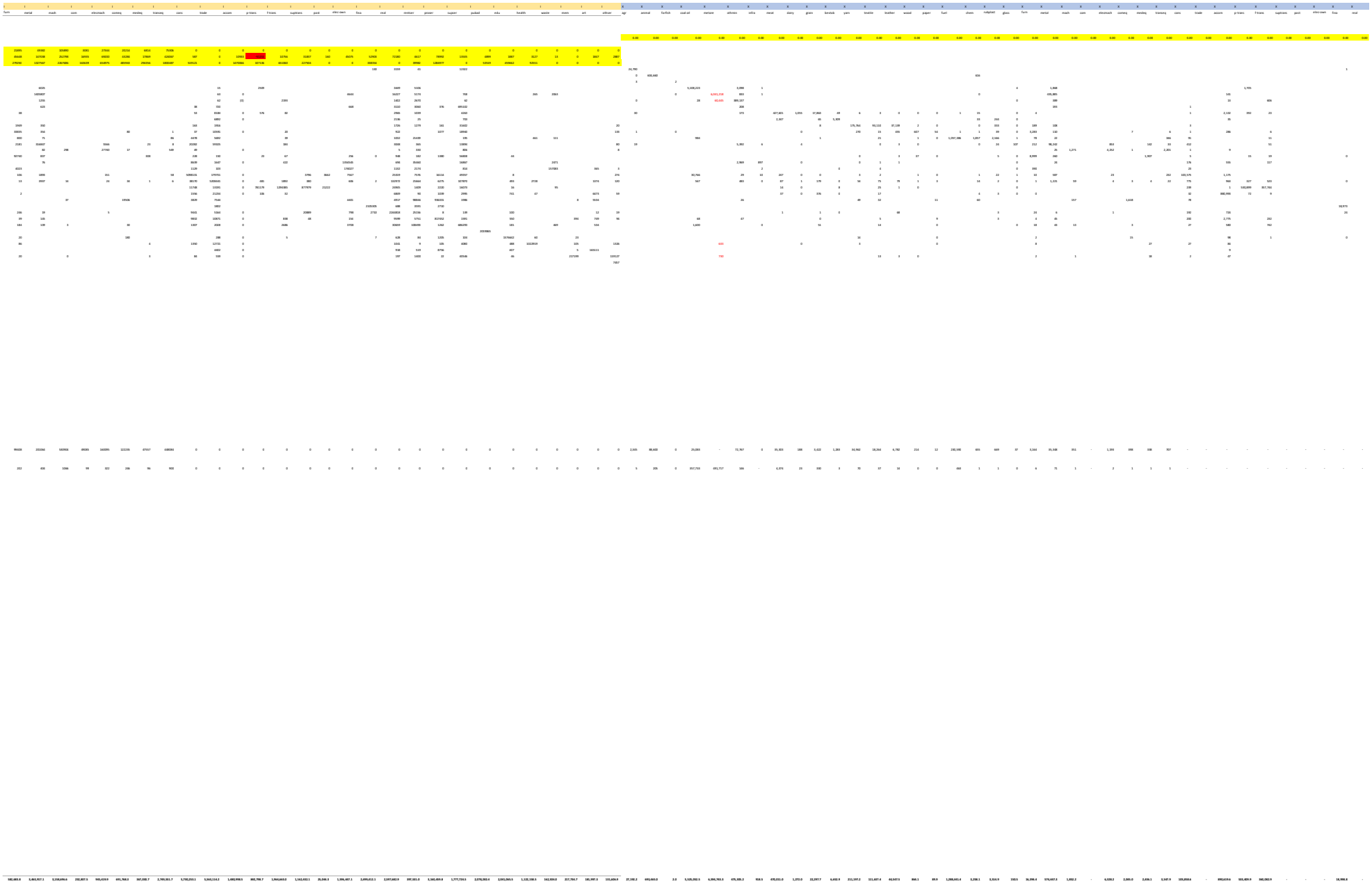
Macro SAM 2018

		L	K	AG	AG	AG	AG	AG	AG	J	I	OTH	OTH	OTH
		LAB	CAP	H	GVT	TD	TM	TI	ROW	Sec	Com	INV	VSTK	TOT
L	LAB								447,921	8,394,072				8,841,993
K	CAP								81,558	20,358,292				20,439,850
AG	H	8,567,547	17,332,051		3,134,187				767,239					29,801,024
AG	GVT			1,711,812		4,568,916	682,477	2,835,996	233,172	140,387	-			10,172,760
AG	TD			4,568,916										4,568,916
AG	TM										682,477			682,477
AG	TI										2,835,996			2,835,996
AG	ROW	274,446	3,107,799	269,373	720,491						20,751,914			25,124,022
J	SEC										60,944,538			60,944,538
I	Com			17,598,908	3,782,113				18,951,604	32,051,787	6,566,168	9,533,060	3,297,452	91,781,093
OTH	INV			5,652,015	2,535,970				4,642,527					12,830,512
OTH	VSTK											3,297,452		3,297,452
OTH	TOT	8,841,993	20,439,850	29,801,024	10,172,760	4,568,916	682,477	2,835,996	25,124,022	60,944,538	91,781,093	12,830,512	3,297,452	

Micro SAM 2018



Micro SAM 2018



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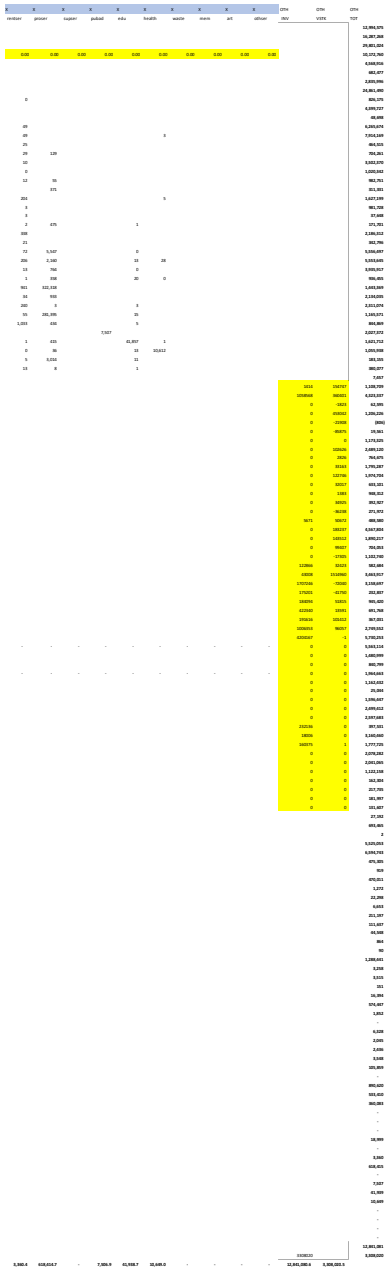


CGE Modeling Manual

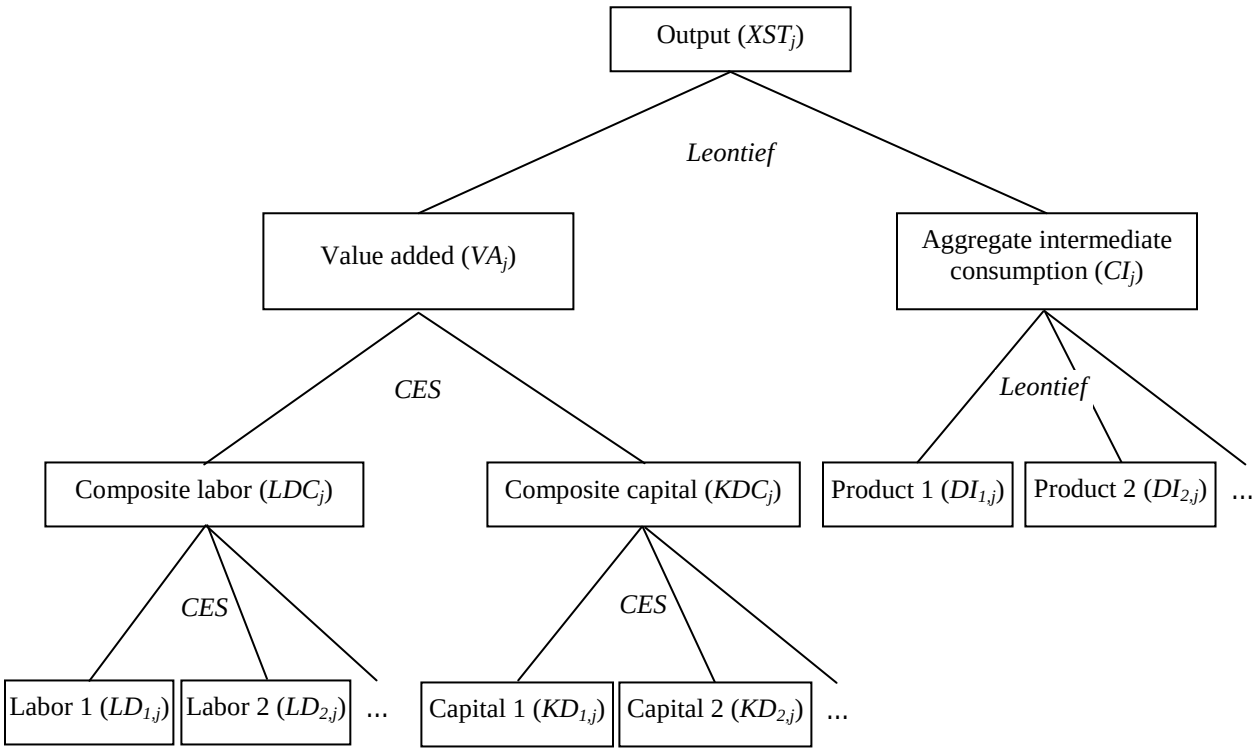
Based on

1. PRODUCTION

The set of productive activities is represented by indices $j, jj \in J = \{J_1,...,J_j,...\}$.

Firms are assumed to operate in a perfectly competitive environment. So each industry's representative firm maximizes profits subject to its production technology, while it considers the prices of goods and services and factors as given (price-taking behavior). Chart 1 describes the nested structure of production.

Chart 1: Nested structure of production



Such nested structures are common in CGE models. It is usually expected that the elasticity of substitution is greater at lower levels of the hierarchy. There are other possible specifications, and, in the end, it is up to the modeler to decide which combination of specifications best fits the situation.

At the top level (equations 1 and 2), the sectoral output of each productive activity *j* combines value added and total intermediate consumption in fixed shares. In other words, the two aggregate inputs are considered to be strictly complementary, without any possibility of substitution, following a Leontief production function.

1. $VA_j = v_j XST_j$
2. $CI_j = io_j XST_j$

where

CI_j : Total intermediate consumption of industry *j*

VA_j : Value added of industry *j*

XST_j : Total aggregate output of industry *j*

io_j : Coefficient (Leontief – intermediate consumption)

v_j : Coefficient (Leontief – value added)

At the second level, each industry's value added consists of composite labor and composite capital, following a constant elasticity of substitution (CES) specification.

3. $$VA_j = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}$$

where

KDC_j : Industry *j* demand for composite capital

LDC_j : Industry *j* demand for composite labor

B_j^{VA} : Scale parameter (CES – value added)

β_j^{VA} : Share parameter (CES – value added)

ρ_j^{VA} : Elasticity parameter (CES – value added) ; $-1 < \rho_j^{VA} < \infty$

Profit maximization (or cost minimization) by the firms leads them to employ labor and capital to the point where the value marginal product of each is equal to its price (the wage rate and the rental rate of capital respectively). With a CES production function, such behavior is described by the demand for labor relative to capital of equation 4 (Appendix C1).

4. $$LDC_j = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}} \frac{RC_j}{WC_j}\right]^{\sigma_j^{VA}} KDC_j$$

where

RC_j : Rental rate of industry *j* composite capital

WC_j : Wage rate of industry *j* composite labor

σ_j^{VA} : Elasticity of transformation (CES – value added) ; $0 < \sigma_j^{VA} < \infty$

In accordance with the algebra of CES aggregator functions, $\rho_j^{VA} = \frac{1-\sigma_j^{VA}}{\sigma_j^{VA}}$ (Appendix C1).

At the bottom level on the value added side, the various categories of labor, indexed as $l \in L = \{L_1,...,L_l,...\}$, are combined following a constant elasticity of substitution (CES) technology (equation 5), which reflects the imperfect substitutability between different types of labor. The firm chooses its labor composition so as to minimize its labor cost given the relative wage rates. Labor demand of each type derives from the first-order conditions of cost minimization by the representative firm, subject to the CES technology (equation 6) (Appendix C2). Likewise, composite capital is a CES combination of the different categories of capital, indexed as $k \in K = \{K_1,...,K_k,...\}$. As in the case of labor, it is assumed that different categories of capital (land, buildings, machinery and equipment, etc.) are imperfect substitutes (equation 7). The demand for each type of capital results from cost minimization (equation 8).

5. $$LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

6. $$LD_{l,j} = \left[\frac{\beta_{l,j}^{LD}\ WC_j}{WTI_{l,j}}\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j$$

7. $$KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD}\ KD_{k,j}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$$

8. $$KD_{k,j} = \left[\frac{\beta_{k,j}^{KD}\ RC_j}{RTI_{k,j}}\right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j$$

where

$KD_{k,j}$: Demand for type *k* capital by industry *j*

$LD_{l,j}$: Demand for type *l* labor by industry *j*

$RTI_{k,j}$: Rental rate paid by industry *j* for type *k* capital, including capital taxes

$WTI_{l,j}$: Wage rate paid by industry *j* for type *l* labor, including payroll taxes

B_j^{KD} : Scale parameter (CES – composite capital)

B_j^{LD} : Scale parameter (CES – composite labor)

$\beta_{k,j}^{KD}$: Share parameter (CES – composite capital)

$\beta_{l,j}^{LD}$: Share parameter (CES – composite labor)

ρ_j^{KD} : Elasticity parameter (CES – composite capital); $-1 < \rho_j^{KD} < \infty$

ρ_j^{LD} : Elasticity parameter (CES – composite labor); $-1 < \rho_j^{LD} < \infty$

σ_j^{KD} : Elasticity of substitution (CES – composite capital); $0 < \sigma_j^{KD} < \infty$

σ_j^{LD} : Elasticity of substitution (CES – composite labor); $0 < \sigma_j^{LD} < \infty$

In accordance with the algebra of the CES production function, $\rho_j^{KD} = \frac{1-\sigma_j^{KD}}{\sigma_j^{KD}}$ and $\rho_j^{LD} = \frac{1-\sigma_j^{LD}}{\sigma_j^{LD}}$ (Appendix C2).

Finally, returning to the second level, but on the intermediate consumption side, aggregate intermediate consumption is made up of various goods and services. Here it is assumed that intermediate inputs are perfectly complementary, and are combined following a Leontief production function. No substitutions are possible.

9. $DI_{i,j} = aij_{i,j} CI_j$

where

$DI_{i,j}$: Intermediate consumption of commodity *i* by industry *j*

$aij_{i,j}$: Input-output coefficient

2. INCOME AND SAVINGS

The PEP-1-1 model offers the possibility of several categories of households and businesses, respectively indexed as $h, hj \in H \subset AG = \{H_1, ..., H_h, ...\}$, and $f, fj \in F \subset AG = \{F_1, ..., F_f, ...\}$, together with government, designated as *GVT*, and the rest of the world, *ROW*. Elements of the set *AG* of all agents are designated as:

$$ag, agj \in AG = H \cup F \cup \{GVT, ROW\} = \{H_1, ..., H_h, ..., F_1, ..., F_f, ... GVT, ROW\}.$$

2.1 Households

Household incomes come from three sources: labor income, capital income, and transfers received from other agents.

10. $YH_h = YHL_h + YHK_h + YHTR_h$

where

YH_h : Total income of type *h* households

YHK_h : Capital income of type *h* households

YHL_h : Labor income of type *h* households

$YHTR_h$: Transfer income of type *h* households

Each household type receives a fixed share of the earnings of each type of labor (equation 11). Likewise, total capital income is distributed between agents, including households, in fixed proportions (equation 12). Finally, transfer income is simply the sum of all transfers received by type *h* households (equation 13).

11. $YHL_h = \sum_l \lambda_{h,l}^{WL} \left(W_l \sum_j LD_{l,j} \right)$

12. $YHK_h = \sum_k \lambda_{h,k}^{RK} \left(\sum_j R_{k,j} KD_{k,j} \right)$

13. $YHTR_h = \sum_{ag} TR_{h,ag}$

where

$R_{k,j}$: Rental rate of type *k* capital in industry *j*

$TR_{h,ag}$: Transfers from agent *ag* to type *h* households

W_l : Wage rate of type *l* labor

$\lambda^{RK}_{ag,k}$: Share of type *k* capital income received by agent *ag*

$\lambda^{WL}_{h,l}$: Share of type *l* labor income received by type *h* households

Subtracting direct taxes and household transfers to government yields type *h* household disposable income (equation 14). Indeed, since household transfers to government are mostly contributions to various social programs, our calculation of disposable income is consistent with national accounts. Whatever disposable income is left after savings and transfers to other agents is entirely dedicated to consumption (equation 15).

Finally, household savings are a linear function of disposable income. This differs from the frequently used specification where savings are a fixed proportion of income. Equation 16, by contrast, allows for the marginal propensity to save to be different from the average propensity. This choice is motivated by the fact that it is common for certain household categories to have negative savings. Now, if it is assumed that the marginal propensity to save is equal to the average propensity, and if that parameter is calibrated on negative observed savings, then there results an undesirable consequence: a fall in the income of these households increases their savings, or a rise in income leads to more endebtedness. Our formulation avoids this pitfall, but introduces an extra free parameter: instead of just having to calibrate the average propensity to save, the modeler must also determine the marginal propensity. Usually, it is the latter that is handled as a free parameter, and its value is determined from the literature or by econometric estimation. Once the marginal propensity has been determined, the savings function intercept is calibrated from the SAM. For household categories with negative savings, the intercept will be negative, while the slope (the marginal propensity) is positive. In addition, equation 16 makes it possible to fully of partially index the intercept to changes in the consumer price index. This is especially useful for testing the model's homogeneity, in which case price elasticity η is set to 1.

14. $YDH_h = YH_h - TDH_h - TR_{gvt,h}$

15. $CTH_h = YDH_h - SH_h - \sum_{agng} TR_{agng,h}$

16. $SH_h = PIXCON^{\eta} sh0_h + sh1_h YDH_h$

where

CTH_h : Consumption budget of type *h* households

$PIXCON$: Consumer price index

SH_h : Savings of type *h* households

TDH_h : Income taxes of type *h* households

YDH_h : Disposable income of type *h* households

η : Price elasticity of indexed transfers and parameters

$sh0_h$: Intercept (type *h* household savings)

$sh1_h$: Slope (type *h* household savings)

agng: Index of non-government agents;

$agng \in AGNG \subset AG = H \cup F \cup \{ROW\} = \{H_1,...,H_h,...,F_1,...,F_f,...,ROW\}$

2.2 Businesses

Business income consists, on one hand, of its share of capital income, and, on the other hand, of transfers received from other agents (including the transfer part of interest on consumer debt).

17. $YF_f = YFK_f + YFTR_f$

18. $YFK_f = \sum_k \lambda^{RK}_{f,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$

19. $YFTR_f = \sum_{ag} TR_{f,ag}$

where

YF_f : Total income of type *f* businesses

YFK_f : Capital income of type *f* businesses

$YFTR_f$: Transfer income of type *f* businesses

Deducting business income taxes from total income yields the disposable income of each type of business (equation 20). Likewise, business savings are the residual that remains after subtracting transfers to other agents from disposable income (equation 21).

20. $YDF_f = YF_f - TDF_f$

21. $SF_f = YDF_f - \sum_{ag} TR_{ag,f}$

where

SF_f : Savings of type *f* businesses

TDF_f : Income taxes of type *f* businesses

YDF_f : Disposable income of type *f* businesses

2.3 Government

In the PEP-1-1 model, it is possible to take into account a large variety of tax instruments. Indeed, equation 22 says that the government draws its income from household and business income taxes, taxes on products and on imports (*TPRCTS*), and other taxes on production (*TPRODN*). According to the 1993 *System of National Accounts* (SNA93)[2], taxes on products (not « production ») and imports consist of indirect taxes on consumption, taxes and duties on imports, and export taxes, while other taxes on production consist of payroll taxes, taxes on capital, and taxes on production (see Appendix B1). In addition to these various forms of fiscal revenue, government receives part of the remuneration of capital and transfers from other agents. Equations 22 to 34 describe the different government revenue sources.

22. $YG = YGK + TDHT + TDFT + TPRODN + TPRCTS + YGTR$

23. $YGK = \sum_k \lambda_{gvt,k}^{RK} \left(\sum_j R_{k,j} KD_{k,j} \right)$

24. $TDHT = \sum_h TDH_h$

25. $TDFT = \sum_f TDF_f$

26. $TPRODN = TIWT + TIKT + TIPT$

27. $TIWT = \sum_{l,j} TIW_{l,j}$

28. $TIKT = \sum_{k,j} TIK_{k,j}$

29. $TIPT = \sum_j TIP_j$

30. $TPRCTS = TICT + TIMT + TIXT$

31. $TICT = \sum_i TIC_i$

[2] Throughout this document, we refer to the 1993 System of National Accounts. The reader should be aware that the 2008 System of National Accounts is now the international standard. Changes between the 1993 and 2008 SNAs are outlined in INTER-SECRETARIAT WORKING GROUP ON NATIONAL ACCOUNTS (2009), pp. xlvii-xlvix. However, the fundamental concepts which are discussed here have been maintained in the 2008 SNA.

32. $TIMT = \sum_i TIM_i$

33. $TIXT = \sum_i TIX_i$

34. $YGTR = \sum_{agng} TR_{gvt,agng}$

where

$TDFT$: Total government revenue from business income taxes

$TDHT$: Total government revenue from household income taxes

TIC_i : Government revenue from indirect taxes on product i

$TICT$: Total government receipts of indirect taxes on commodities

$TIK_{k,j}$: Government revenue from taxes on type k capital used by industry j

$TIKT$: Total government revenue from from taxes on capital

TIM_i : Government revenue from import duties on product i

$TIMT$: Total government revenue from import duties

TIP_j : Government revenue from taxes on industry j production (excluding taxes directly related to the use of capital and labor)

$TIPT$: Total government revenue from production taxes (excluding taxes directly related to the use of capital and labor)

$TIW_{l,j}$: Government revenue from payroll taxes on type l labor in industry j

$TIWT$: Total government revenue from payroll taxes

TIX_i : Government revenue from export taxes on product i

$TIXT$: Total government revenue from export taxes

$TPRCTS$: Total government revenue from taxes on products and imports

$TPRODN$: Total government revenue from other taxes on production[3]

YG : Total government income

YGK : Government capital income

3 That is, taxes on production other than taxes on products and taxes and duties on imports (see Appendix B1).

$YGTR$: Government transfer income

Similarly to what has been done with household savings, income taxes are described as a linear function of total income, whether it be for households (equation 35) or for businesses (equation 36). That way, when a non-zero intercept is applied, the marginal rate of taxation is different from the average rate. Such an arrangement can be useful for simulating fiscal changes: for instance, marginal rates of taxation can be computed from fiscal parameters[4]; given these marginal rates, the intercept is then calibrated from SAM values. Moreover, the intercept may be partially or fully indexed to changes in the consumer price index.

35. $TDH_h = PIXCON^{\eta} ttdh0_h + ttdh1_h YH_h$

36. $TDF_f = PIXCON^{\eta} ttdf0_f + ttdf1_f YFK_f$

where

$ttdf0_f$: Intercept (income taxes of type f businesses)

$ttdf1_f$: Marginal income tax rate of type f businesses

$ttdh0_h$: Intercept (income taxes of type h households)

$ttdh1_h$: Marginal income tax rate of type h households

As mentioned earlier, the model allows for taxes on production factors (payroll taxes and capital taxes), as well as for taxes on production itself (together, these three forms of taxation constitute « other taxes on production » in the SNA93 – see Appendix B1). First, as regards taxes on factors of production, the model notation distinguishes tax rates by industry, and also by type of labor or capital. Each rate then applies to the corresponding transactions (equations 37 and 38). Next, a tax may be applied to the total value of production (equation 39).

37. $TIW_{l,j} = ttiw_{l,j} W_l LD_{l,j}$

38. $TIK_{k,j} = ttik_{k,j} R_{k,j} KD_{k,j}$

39. $TIP_j = ttip_j PP_j XST_j$

where

PP_j : Industry j unit cost, including taxes directly related to the use of capital and labor, but excluding other taxes on production

4 This opens the door to applying the « marginal effective tax rates » (METR) approach in the CGE (Decaluwé *et al.*, 2005 and 2006).

$ttik_{k,j}$: Tax rate on type *k* capital used in industry *j*

$ttip_j$: Tax rate on the production of industry *j*

$ttiw_{l,j}$: Tax rate on type *l* worker compensation in industry *j*

Finally, the government can implement three types of taxes on products (for the definition of « taxes on products », see Appendix B1); equation 40 describes how these taxes are levied. It should be noted that these taxes apply on the sales value including margins (trade and transport margins are discussed in Appendix B3) and custom duties whenever the latter exist. Other taxes collected are taxes and duties on imported products (equation 41), and export taxes (equation 42).

40. $$TIC_i = ttic_i \left[\left(PL_i + \sum_{ij} PC_{ij}\, tmrg_{ij,i} \right) DD_i + \left(\left(1 + ttim_i\right) PWM_i\ e\ + \sum_{ij} PC_{ij}\, tmrg_{ij,i} \right) IM_i \right]$$

41. $$TIM_i = ttim_i\, PWM_i\, e\, IM_i$$

42. $$TIX_i = ttix_i \left(PE_i + \sum_{ij} PC_{ij}\, tmrg^X_{ij,i} \right) EXD_i$$

where

DD_i : Domestic demand for commodity *i* produced locally

e : Exchange rate[5]; price of foreign currency in terms of local currency

EX_i : Quantity of product *i* exported

IM_i : Quantity of product *i* imported

PE_i : Price received for exported commodity *i* (excluding export taxes)

PL_i : Price of local product *i* (excluding all taxes on products)

PWM_i : World price of imported product *i* (expressed in foreign currency)

$ttic_i$: Tax rate on commodity *i*

$ttim_i$: Rate of taxes and duties on imports of commodity *i*

$ttix_i$: Export tax rate on exported commodity *i*

5 In the standard model, exchange rate *e* is chosen as the numeraire.

$tmrg_{ij,i}$: Rate of margin *ij* applied to commodity *i*

$tmrg^{X}_{ij,i}$: Rate of margin *ij* applied to export *i*

The current government budget surplus or deficit (positive or negative savings) is the difference between its revenue and its expenditures. The latter consist of transfers to agents and current expenditures on goods and services.

43. $$SG = YG - \sum_{agng} TR_{agng,gvt} - G$$

where

SG : Government savings

G : Current government expenditures on goods and services

2.4 Rest of the world

The rest of the world receives payments for the value of imports, part of the income of capital, and transfers from domestic agents (equation 44). Foreign spending in the domestic economy consists of the value of exports, and transfers to domestic agents. The difference between foreign receipts and spending is the amount of rest-of-the-world savings (equation 45), which are equal in absolute value to the current accoung balance, but of opposite sign (equation 46).

44. $$YROW = e \sum_{i} PWM_i \; IM_i + \sum_{k} \lambda^{RK}_{row,k} \left(\sum_{j} R_{k,j} \; KD_{k,j} \right) + \sum_{agd} TR_{row,agd}$$

45. $$SROW = YROW - \sum_{i} PE^{FOB}_{i} \; EXD_i - \sum_{agd} TR_{agd,row}$$

46. $$SROW = -CAB$$

where

CAB : Current account balance

PE^{FOB}_{i} : FOB price of exported product *i* (in the national currency)

$SROW$: Rest-of-the-world savings

$YROW$: Rest-of-the-world income

2.5 Transfers

The way to treat transfers in a CGE model is not obvious. In most cases, indeed, these are payments without any real counterpart, and they are not explicitly related to a specific form of economic behavior.

For lack of information on the precise nature of each type of transfer, they should be treated in the most neutral way possible, to prevent them from becoming a factor modifying economic agents' behavior. So household transfers to non-government agents and business transfers are simply proportional to disposable income. As for household transfers to government, they are akin to social program contributions: as such, they are treated in the same way as household income taxes. All other transfers are initially set equal to their SAM values, and indexed, fully or partially, to the consumer price index.

47. $TR_{agng,h} = \lambda^{TR}_{agng,h} YDH_h$

48. $TR_{gvt,h} = PIXCON^{\eta} tr0_h + tr1_h YH_h$

49. $TR_{ag,f} = \lambda^{TR}_{ag,f} YDF_f$

50. $TR_{agng,gvt} = PIXCON^{\eta} TR^0_{agng,gvt}$

51. $TR_{agd,row} = PIXCON^{\eta} TR^0_{agd,row}$

where

$\lambda^{TR}_{ag,agj}$: Share parameter (transfer functions)

$tr0_{gvt,h}$: Intercept (transfers by type *h* households to government)

$tr1_{gvt,h}$: Marginal rate of transfers by type *h* households to government

3. DEMAND

The demand for goods and services, whether domestically produced or imported, consists of intermediate demand, household consumption demand, investment demand, demand by public administrations, and demand as transport or trade margins (for the treatment of margins in the SNA93, see Appendix B3).

It is assumed that households have Stone-Geary utility functions (from which derives the Linear Expenditure System). A characteristic of these utility functions is that there is a minimum level of consumption of each commodity (which may be zero for some commodities). Contrary to Cobb-Douglas utility functions, often used in the literature, this specification imposes neither zero cross-price elasticities between all pairs of goods, nor unit income-elasticities for all goods. Thus, it offers a degree of flexibility with respect to substitution possibilities in response to relative price changes. Type *h* household demand for each good (equation 52) is determined by utility maximization subject to the budget constraint (Appendix C4).

52. $$PC_i\, C_{i,h} = PC_i\, C_{i,h}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_h - \sum_{ij} PC_{ij}\, C_{ij,h}^{MIN}\right)$$

where

$C_{i,h}$: Consumption of commodity *i* by type *h* households

$C_{i,h}^{MIN}$: Minimum consumption of commodity *i* by type *h* households

PC_i : Purchaser price of composite comodity *i* (including all taxes and margins)

$\gamma_{i,h}^{LES}$: Marginal share of commodity *i* in type *h* household consumption budget

Investment demand includes both gross fixed capital formation (GFCF) and changes in inventories. The two components of investment demand are quite different. In particular, GFCF cannot be negative (even though *net* investment, that is, gross investment minus depreciation, may be), whereas changes in inventories in the SAM may be positive or negative: roughly speaking, GFCF can be thought of as irreversible, while inventory accumulation is almost fully reversible. Endogenizing negative inventory changes is difficult to achieve satisfactorily in a CGE model. To avoid these complications, inventory changes are exogenous in PEP-1-1, fixed in volume. GFCF, on the contrary, is endogenous in the default closure of PEP-1-1, where total investment expenditure is determined by the savings-investment equilibrium constraint (equation 87), with savings endogenous. GFCF expenditure, obtained by subtracting the cost of changes in inventories from total investment expenditure (equation 53), is distributed among commodities in fixed shares (equation 54); implicitly, the production function of new

capital is Cobb-Douglas. So, for a given amount of investment expenditures, the quantity demanded of each commodity *i* for investment purposes is inversely related to its purchaser price. The same hypothesis is made regarding government current expenditures on goods and services (equation 55). With a given current expenditure budget, the quantity demanded of each commodity varies inversely with its price.

53. $GFCF = IT - \sum_i PC_i \, VSTK_i$

54. $PC_i INV_i = \gamma_i^{INV} GFCF$

55. $PC_i CG_i = \gamma_i^{GVT} G$

where

$GFCF$: Gross fixed capital formation

INV_i : Final demand of commodity *i* for investment purposes

IT : Total investment expenditures

$VSTK_i$: Inventory change of commodity *i*

γ_i^{INV} : Share of commodity *i* in total investment expenditures

CG_i : Public consumption of commodity *i* (volume)

γ_i^{GVT} : Share of commodity *i* in total current public expenditures on goods and services

In addition to being required for final demand, goods and services are used as inputs in the production process. Intermediate demand for each commodity is the sum of industry demands.

56. $DIT_i = \sum_j DI_{i,j}$

where

DIT_i : Total intermediate demand for commodity *i*

Finally, some services, such as transport and retail and wholesale trade, are used to move commodities and make them available to the market. So margin rates are applied to the volume of domestic production and imports to determine the quantities of these margin services required to distribute commodities to buyers (trade and transport margins are discussed in Appendix B3).

57. $MRGN_i = \sum_{ij} tmrg_{i,ij} \, DD_{ij} + \sum_{ij} tmrg_{i,ij} \, IM_{ij} + \sum_{ij} tmrg_{i,ij}^{X} \, EXD_{ij}$

where

$MRGN_i$: Demand for commodity *i* as a trade or transport margin

4. PRODUCER SUPPLIES OF PRODUCTS AND INTERNATIONAL TRADE

In this section, we define the trade relations with the rest of the world, that is, the supply of exports and the demand for imports. This is achieved through specifying domestic buyers' behavior with respect to the different supply sources, and domestic producers' supply behavior. The latter comprises two aspects: first, how composite output translates into the supply of products, and, second, how the supply of each product is directed to destination markets. The small-country hypothesis is adopted, in the sense that the world price of traded goods (imports and exports) is exogenous.

The section on production describes how industries combine inputs to produce total aggregate output XST_j. Industries usually produce more than one product. The Leontief-style one-to-one correspondence between products and industries is a special case, and the 1993 *System of National Accounts* recommends constructing input-output tables in the rectangular format, where there are generally more goods than industries. If an industry's aggregate output were simply the sum of its products, the profit-maximizing firm would concentrate all of its output on the product with the highest price. Here, however, it is assumed that, although an industry can reorganize its production to change the proportions of goods produced, the different products are not perfectly « transformable » into one another. This is represented by means of a constant elasticity of transformation (CET) function that describes how easily the product-mix can be adjusted in response to price changes (equation 58):

$$58. \qquad XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

where

$XS_{j,i}$: Industry j production of commodity i

B_j^{XT} : Scale parameter (CET – total output)

$\beta_{j,i}^{XT}$: Share parameter (CET – total output)

ρ_j^{XT} : Elasticity parameter (CET – total output) ; $1 < \rho_j^{XT} < \infty$

Producers allocate output among products so as to maximize sales revenue, given product prices, subject to equation 58. Individual product supply functions (equation 59) are derived from the first-order conditions of revenue maximizing (Appendix C5).

59. $$XS_{j,i} = \frac{XST_j}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i}}{\beta_{j,i}^{XT} PT_j} \right]^{\sigma_j^{XT}}$$

where

$P_{j,i}$: Basic price of industry *j*'s production of commodity *i*

σ_j^{XT} : Elasticity of transformation (CET – total output) ; $0 < \sigma_j^{XT} < \infty$

In accordance with the algebra of the CET transformation function, $\rho_j^{XT} = \frac{1+\sigma_j^{XT}}{\sigma_j^{XT}}$ (Appendix C5).

Next, the output of every product of an industry is shared out among markets (domestic or export), again with the goal of maximizing the firm's total revenue, given the demand in each market and the various taxes that apply. It is assumed that production directed to one market is somewhat different from production directed to another market. This imperfect substitutability is represented in PEP-1-1 by means of a constant elasticity of transformation (CET) aggregator function that describes how readily production can be redirected from one market to another.[6]

60. $$XS_{j,i} = B_{j,i}^{X} \left[\beta_{j,i}^{X} EX_{j,i}^{\rho_{j,i}^{X}} + \left(1-\beta_{j,i}^{X}\right) DS_{j,i}^{\rho_{j,i}^{X}} \right]^{\frac{1}{\rho_{j,i}^{X}}}$$

where

$DS_{j,i}$: Supply of commodity *i* by sector *j* to the domestic market

$B_{j,i}^{X}$: Scale parameter (CET – exports and local sales)

$\beta_{j,i}^{X}$: Share parameter (CET – exports and local sales)

$\rho_{j,i}^{X}$: Elasticity parameter (CET – exports and local sales) ; $1 < \rho_{j,i}^{X} < \infty$

Relative supply functions are derived from the first-order conditions of revenue maximizing subject to the CET aggregator function (equation 60) (Appendix C6).

6 Equation 60 implies that there is a single trading partner, the « Rest-of-the-world ». It is left up to the modeler to adapt the model, whenever appropriate, to distinguish more than one trading partner.

61. $$EX_{j,i} = \left[\frac{1-\beta^X_{j,i}}{\beta^X_{j,i}} \frac{PE_i}{PL_i} \right]^{\sigma^X_{j,i}} DS_{j,i}$$

where

$\sigma^X_{j,i}$: Elasticity of transformation (CET – exports and local sales) ; $0 < \sigma^X_{j,i} < \infty$

In accordance with the algebra of the CET transformation function, $\rho^X_{j,i} = \frac{1+\sigma^X_{j,i}}{\sigma^X_{j,i}}$ (Appendix C6).

To summarize, producers' supply behavior is represented by nested CET functions: on the upper level, aggregate output is allocated to individual products; on the lower level, the supply of each product is distributed between the domestic market and exports.

Many CGE models presume that producers can always sell as much as they wish on the world market at the (exogenous) current price; we take a different view (and, in so doing, we depart from the « pure » form of the small-country hypothesis): equation 62 says that a local producer can increase his share of the world market only by offering a price PE^{FOB}_i that is advantageous relative to the (exogenous) world price PWX_i. The ease with which his share can be increased depends on the degree of substitutability of the proposed product to competing products; in other words, it depends on the price-elasticity of export demand. Equation 62 also makes it possible to simulate an exogenous variation in world demand for the product, through a change in the variable EXD^O_i .

62. $$EXD_i = EXD^O_i \left(\frac{e\, PWX_i}{PE^{FOB}_i} \right)^{\sigma^{XD}_i}$$

where

EXD_i : World demand for exports of product *i*

PE^{FOB}_i : FOB price of exported commodity *i* (in local currency)

PWX_i : World price of exported product *i* (expressed in foreign currency)

σ^{XD}_i : Price-elasticity of the world demand for exports of product *i*

Buyer behavior is symmetrical to producer behavior, in that it is assumed that local products are imperfect substitutes for imports, or, in other words, that goods are heterogenous with respect to their origin. So

commodities demanded on the domestic market are composite goods, combinations of locally produced goods and imports. The imperfect substitutability between the two is represented by a constant elasticity of substitution (CES) aggregator function (equation 63).

$$63. \quad Q_i = B_i^M \left[\beta_i^M IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{\frac{-1}{\rho_i^M}}$$

where

Q_i : Quantity demanded of composite commodity *i*

B_i^M : Scale parameter (CES – composite commodity)

β_i^M : Share parameter (CES – composite commodity)

ρ_i^M : Elasticity parameter (CES – composite commodity); $-1 < \rho_i^M < \infty$

Just as sellers seek to maximize revenue, buyers minimize expenses, subject to the CES aggregation function (equation 63). Relative demand functions derive from the first-order optimum conditions (Appendix C7).

$$64. \quad IM_i = \left[\frac{\beta_i^M}{1-\beta_i^M} \frac{PD_i}{PM_i} \right]^{\sigma_i^M} DD_i$$

where

PD_i : Price of local product *i* sold on the domestic market (including all taxes and margins)

PM_i : Price of imported product *i* (including all taxes and margins)

σ_i^M : Elasticity of substitution (CES – composite commodity); $0 < \sigma_i^M < \infty$

In accordance with the algebra of CES aggregator functions, $\rho_i^M = \frac{1-\sigma_i^M}{\sigma_i^M}$ (Appendix C7).

While equation 64 specifies the (relative) demand for imports, the supply function of imports in PEP-1-1 is implicit. According to the small-country hypothesis, the price-elasticity of import supply is assumed to be infinite at the going world price: this is what is implied by fixing the world price of imports as exogenous in equation 78 below.

5. PRICES

5.1 Production

The different prices and price indexes naturally depend on the hypotheses and functional forms already stated. In aggregations, the price of an aggregate is a weighted sum of the prices of its components. The weights are determined by equating the value of the aggregate to the sum of the values of its components, given the quantity of the aggregate (which is determined from the aggregator function). The weight assigned the price of each component is therefore the ratio of its volume (or quantity) to the volume (or quantity) of the aggregate[7]. Only in Leontief fixed-proportions aggregations are the weights invariant to relative price changes; in other cases, component proportions, and, consequently, component price weights, change in response to relative price changes, and they change more or less sharply, depending on the elasticity of substitution or transformation. For instance, the unit cost of an industry's output (including taxes directly related to the use of capital and labor, but excluding other taxes on production) is a weighted sum of the prices of value added and aggregate intermediate consumption (equation 65).

65. $$PP_j = \frac{PVA_j VA_j + PCI_j CI_j}{XST_j}$$

Here, the weights are VA_j / XST_j and CI_j / XST_j. Multiplying both sides of equation 65 by XST_j yields the value accounting identity $PP_j XST_j = PVA_j VA_j + PCI_j CI_j$. The same principle applies to the prices of other aggregates. The price of aggregate intermediate consumption is a combination of the commodity prices of the industry's intermediate inputs (equation 67), just as the price of value added is a combination of the prices of composite labor and composite capital (equation 68). So is it with the prices of composite factors. The price of an industry's composite labor is a weighted sum of the wage rates (including payroll taxes) of the different categories of labor used by that industry (equation 69). In the same way, the price of an industry's composite capital is a weighted sum of the rental rates of the different types of capital used by that industry (equation 71).

Since various forms of taxation appear in the model, it is necessary to define the relationship between prices before taxes, and prices including taxes. The basic price of production (for a definition of « basic

7 Note that, in general, the weights do not add up to 1. An alternative, mathematically equivalent, modeling approach would have been to determine aggregate prices from the cost (or value) functions dual to the aggregation functions, and then to compute the quantity indexes of the aggregates from the identities between the value of an aggregate and the sum of its components' values.

price », see Appendix B2) is obtained from the unit cost by adding taxes on production (other than taxes on labor or capital, already included in the unit cost) (equation 66). Likewise, wages paid by industry differ from wages received by workers by the amount of payroll taxes (equation 70). The same applies to the rental rate of capital (equation 72). The principles of price aggregation and tax accounting yield the following price equations, in addition to equation 65, stated earlier.

66. $PT_j = \left(1 + ttip_j\right) PP_j$

67. $PCI_j = \dfrac{\sum_i PC_i DI_{i,j}}{CI_j}$

68. $PVA_j = \dfrac{WC_j LDC_j + RC_j KDC_j}{VA_j}$

69. $WC_j = \dfrac{\sum_l WTI_{l,j} LD_{l,j}}{LDC_j}$ (redundant, given equations 5 and 6; see Appendix E2)

70. $WTI_{l,j} = W_l \left(1 + ttiw_{l,j}\right)$

71. $RC_j = \dfrac{\sum_k RTI_{k,j} KD_{k,j}}{KDC_j}$ (redundant, given equations 7 and 8; see Appendix E3)

72. $RTI_{k,j} = R_{k,j} \left(1 + ttik_{k,j}\right)$

where

PT_j : Basic price of industry *j*'s output

PCI_j : Intermediate consumption price index of industry *j*

Finally, the rental rate received by the owners of capital, $R_{k,j}$, is determined in one of two manners, depending on the option selected by the user regarding the mobility of capital. In PEP-1-1, parameter *kmob* acts as a switch. If *kmob* = 1, capital is assumed to be perfectly mobile, and the aggregate supply of type *k* capital KS_k is exogenous, fixed at its initial SAM value, so the use of capital by the industries is constrained by the supply-demand equilibrium condition (equation 86). In that case, the allocation of capital between industries is the result of the arbitrage process that makes the rental rate received by owners equal across industries (equation 73). If *kmob* = 0, capital is assumed to be industry-specific, equation 73 is not in effect, the $KD_{k,j}$ are exogenous, fixed at their initial SAM values, and rents paid on the use of capital are Ricardian rents.

73. $R_{k,j} = RK_k, \quad if\ capital\ is\ mobile$

where

RK_k : Rental rate of type *k* capital (if capital is mobile)

5.2 International trade

Exporting industries have the possibility of selling their output on the international market or the domestic market. So the price of their aggregate production is a weighted sum of the price obtained on each market, following the price aggregation principle. The weight assigned to each market is proportional to the quantity sold on that market (equation 74); these weights vary in response to relative price changes, more or less sharply, depending on the elasticity of transformation in the CET. The basic price (for a definition, see Appendix B2) obtained by industry *j* is a weighted sum of its basic price on the domestic market and its basic price on the export market (equation 75). The FOB price paid by purchasers on the export market is different from the one received by the producer, since margins and export taxes must be added on (equation 76).

74. $PT_j = \dfrac{\sum_i P_{j,i}\ XS_{j,i}}{XST_j}$ (redundant, given equations 58 and 59, except if an industry produces a single commodity; see Appendix E4)

75. $P_{j,i} = \dfrac{PE_i\ EX_{j,i} + PL_i\ DS_{j,i}}{XS_{j,i}}$

76. $PE_i^{FOB} = \left(PE_i + \sum_{ij} PC_{ij}\ tmrg_{ij,i}^{X} \right) \left(1 + ttix_i\right)$

As was previously explained, commodities purchased on the domestic market are composites. The price of the composite is a weighted sum of the price paid for domestically produced, and imported goods (equation 79). The price paid for the local product is the sum of the price received by the producer, margins, and indirect taxes (equation 77). Similarly, the price paid for the imported product is the world price, translated into the local currency, plus taxes and duties on imports, margins, and domestic indirect taxes (equation 78).

77. $PD_i = \left(1 + ttic_i\right) \left(PL_i + \sum_{ij} PC_i\ tmrg_{ij,i} \right)$

78. $$PM_i = \left(1 + ttic_i\right)\left(\left(1 + ttim_i\right) e\, PWM_i + \sum_{ij} PC_{ij}\, tmrg_{ij,i}\right)$$

79. $$PC_i = \frac{PM_i\, IM_i + PD_i\, DD_i}{Q_i}$$

5.3 Price indexes

Finally, four price indexes have been defined: the GDP deflator (equation 80), the consumer price index (equation 81), the investment price index (equation 82), and the public expenditures price index (equation 83). The first is a Fisher index (Appendix C8), the second is a Laspeyres index, and the third and fourth are exact price indexes, dual to the Cobb-Douglas functions which describe commodity demand for investment purposes and for public consumption (Appendix C9).

80. $$PIXGDP = \sqrt{\frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j}\right) VA_j^O}{\sum_j \left(PVA_j^O VA_j^O + TIP_j^O\right)} \frac{\sum_j \left(PVA_j VA_j + TIP_j\right)}{\sum_j \left(PVA_j^O + \frac{TIP_j^O}{VA_j^O}\right) VA_j}}$$

81. $$PIXCON = \frac{\sum_i PC_i \sum_h C_{i,h}^0}{\sum_{ij} PC_{ij}^0 \sum_h C_{ij,h}^0}$$

82. $$PIXINV = \prod_i \left(\frac{PC_i}{PC_i^0}\right)^{\gamma_i^{INV}}$$

83. $$PIXGVT = \prod_i \left(\frac{PC_i}{PC_i^0}\right)^{\gamma_i^{GVT}}$$

where

PIXGDP : GDP deflator

PIXGVT : Public expenditures price index

PIXINV : Investment price index

6. EQUILIBRIUM

Whether it be for the goods and services market or the factor market, supply and demand equilibrium must be verified. Thus, equation 84 defines the equilibrium between the supply and demand of each commodity on the domestic market. Equations 85 and 86 ensure the equilibrium between total demand for each factor and available supply. Likewise, total investment expenditure must be equal to the sum of agents' savings (equation 87). The sum of supplies of every commodity by local producers must be equal to domestic demand for that commodity produced locally (equation 88). And finally, supply to the export market of each good must be matched by demand (equation 89).

84. $$Q_i = \sum_h C_{i,h} + CG_i + INV_i + VSTK_i + DIT_i + MRGN_i$$

85. $$\sum_j LD_{l,j} = LS_l$$

86. $$\sum_j KD_{k,j} = KS_k$$

87. $$IT = \sum_h SH_h + \sum_f SF_f + SG + SROW$$

88. $$\sum_j DS_{j,i} = DD_i$$

89. $$\sum_j EX_{j,i} = EXD_i$$

where

LS_l : Supply of type l labor

KS_k : Supply of type k capital

7. GROSS DOMESTIC PRODUCT

GDP at basic prices is equal to payments made to factors, plus taxes on production other than taxes on labor or capital already included in factor costs (equation 90). On the other hand, GDP at market prices from the final demand perspective is the sum of net final expenditures: household consumption, current public expenditures on goods and services, investment expenditures, plus the value of exports, minus the value of imports (equation 93). As for GDP at market prices from the income perspective (equation 92), it is equal to the sum total of income paid to labor and to capital, plus taxes on products and imports (*TPRCTS* – equation 30), plus other taxes on production (*TPRODN* – equation 26). GDP at market prices exceeds GDP at basic prices by exactly the amount of taxes on products and imports (*TPRCTS*). For a discussion of GDP concepts according to the SNA93, see Appendix B4.

90. $$GDP^{BP} = \sum_j PVA_j VA_j + TIPT$$

91. $$GDP^{MP} = GDP^{BP} + TPRCTS$$

92. $$GDP^{IB} = \sum_{l,j} W_l \, LD_{l,j} + \sum_{k,j} R_{k,j} KD_{k,j} + TPRODN + TPRCTS$$

93. $$GDP^{FD} = \sum_i PC_i \left[\sum_h C_{i,h} + CG_i + INV_i + VSTK_i \right] + \sum_i PE_i^{FOB} EXD_i - e \sum_i PWM_i \, IM_i$$

where

GDP^{BP} : GDP at basic prices

GDP^{FD} : GDP at purchasers' prices from the perspective of final demand

GDP^{IB} : GDP at market prices (income-based)

GDP^{MP} : GDP at market prices

8. REAL (VOLUME) VARIABLES COMPUTED FROM PRICE INDICES

Real household consumption (equation 94), real government expenditures (equation 95) and real gross fixed capital formation (equation 98) are computed from the nominal variables using the appropriate indexes (see 5.3). Real GDP at basic prices and at market prices are similarly calculated.

94. $$CTH_h^{REAL} = \frac{CTH_h}{PIXCON}$$

95. $$G^{REAL} = \frac{G}{PIXGVT}$$

96. $$GDP^{BP\_REAL} = \frac{GDP^{BP}}{PIXGDP}$$

97. $$GDP^{MP\_REAL} = \frac{GDP^{MP}}{PIXCON}$$

98. $$GFCF^{REAL} = \frac{GFCF}{PIXINV}$$

where

CTH_h^{REAL} : Real consumption expenditures of household h

G^{REAL} : Real government expenditures

GDP^{BP_REAL} : Real GDP at basic prices

GDP^{MP_REAL} : Real GDP at market prices

$GFCF^{REAL}$: Real gross fixed capital formation

REFERENCES

DECALUWÉ, Bernard, André LEMELIN, David BAHAN (2006) « Oferta endógena de trabajo y capital parcialmente móvil en un MEGC birregional: Versión estática del modelo de equilibrio general computable del Ministerio de Hacienda de Québec », *Investigación Económica*, 258, octubre-diciembre.

DECALUWÉ, Bernard, André LEMELIN, David BAHAN et Nabil ANNABI (2005) « Offre de travail endogène et mobilité du capital dans un MEGC bi-régional: la version statique du modèle d'équilibre général calculable du Ministère des Finances du Québec », texte d'une conférence donnée à Séville, lors de l'atelier international *The State-of-the-Art in Regional Modeling*, 21-23 octobre 2004, co-organisé par le Global Economic Modeling Network (ECOMOD) et la Fundación Centro de Estudio Andaluces (centrA), Ministère des Finances du Québec, collection *Feuille d'argent*, Travaux de recherche 2005-001, 62 pages.
http://www.finances.gouv.qc.ca/documents/feuille/fr/2005_001.pdf

DECALUWÉ, Bernard, André LEMELIN, Véronique ROBICHAUD, David BAHAN, et Daniel FLOREA (2004). « Le modèle d'équilibre général calculable du ministère des Finances, de l'Économie et de la recherche du Québec: un modèle bi-régional du Québec et du Reste-du-Canada », chapitre 14, p. 285-297 dans CLOUTIER, L. Martin et Christian DEBRESSON, avec la collaboration d'Érik DIETZENBACHER, *Changement climatique, flux technologiques, financiers et commerciaux – nouvelles directions d'analyse entrée-sortie*, Actes de la Quatorzième Conférence internationale de techniques d'analyse entrée-sortie, tenue à Montréal, 10-15 octobre 2002, Presses de l'Université du Québec.

DECALUWÉ, Bernard, André LEMELIN, Véronique ROBICHAUD et David BAHAN (2003). *Modèle d'équilibre général du ministère des Finances du Québec (MEGFQ): caractéristiques et structure du modèle*, ministère des Finances du Québec, Collection *Feuille d'argent*, Travaux de recherche 2003-002
http://www.finances.gouv.qc.ca/documents/feuille/fr/2003_002.pdf
Disponible en version anglaise sous le titre: *General equilibrium model of the ministère des Finances du Québec (GEMFQ): Characteristics and structure of the model*
http://www.finances.gouv.qc.ca/documents/Feuille/en/2003_002_eng.pdf

DECALUWÉ, B., A. MARTENS et L. SAVARD (2001). *La politique économique du développement et les modèles d'équilibre général calculable*, Les Presses de l'Université de Montréal, Montréal.

INTER-SECRETARIAT WORKING GROUP ON NATIONAL ACCOUNTS (2009). « System of National Accounts 2008 » (SNA93), Eurostat, International Monetary Fund, OECD, United Nations, World Bank; Bruxelles-Luxembourg, New York, Paris, Washington (D.C.), 662 p.
http://unstats.un.org/unsd/nationalaccount/sna2008.asp

INTER-SECRETARIAT WORKING GROUP ON NATIONAL ACCOUNTS (1993). « System of National Accounts 1993 (SNA93) », Eurostat, International Monetary Fund, OECD, United Nations, World Bank; Bruxelles-Luxembourg, New York, Paris, Washington (D.C.), 711 p.
http://unstats.un.org/unsd/sna1993/toctop.asp

APPENDIX A: EQUATIONS, SETS, VARIABLES AND PARAMETERS

A1. Equations

A1.1 PRODUCTION

1. $VA_j = v_j XST_j$
2. $CI_j = io_j XST_j$
3. $VA_j = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}$
4. $LDC_j = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}} \frac{RC_j}{WC_j}\right]^{\sigma_j^{VA}} KDC_j$
5. $LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$
6. $LD_{l,j} = \left[\frac{\beta_{l,j}^{LD}\ WC_j}{WTI_{l,j}}\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j$
7. $KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD}\ KD_{k,j}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$
8. $KD_{k,j} = \left[\frac{\beta_{k,j}^{KD}\ RC_j}{RTI_{k,j}}\right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j$
9. $DI_{i,j} = aij_{i,j} CI_j$

A1.2 INCOME AND SAVINGS

A1.2.1 Households

10. $YH_h = YHL_h + YHK_h + YHTR_h$

11. $YHL_h = \sum_l \lambda^{WL}_{h,l} \left(W_l \sum_j LD_{l,j} \right)$
12. $YHK_h = \sum_k \lambda^{RK}_{h,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$
13. $YHTR_h = \sum_{ag} TR_{h,ag}$
14. $YDH_h = YH_h - TDH_h - TR_{gvt,h}$
15. $CTH_h = YDH_h - SH_h - \sum_{agng} TR_{agng,h}$
16. $SH_h = PIXCON^{\eta} sh0_h + sh1_h YDH_h$

A1.2.2 Firms

17. $YF_f = YFK_f + YFTR_f$
18. $YFK_f = \sum_k \lambda^{RK}_{f,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$
19. $YFTR_f = \sum_{ag} TR_{f,ag}$
20. $YDF_f = YF_f - TDF_f$
21. $SF_f = YDF_f - \sum_{ag} TR_{ag,f}$

A1.2.3 Government

22. $YG = YGK + TDHT + TDFT + TPRODN + TPRCTS + YGTR$
23. $YGK = \sum_k \lambda^{RK}_{gvt,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$
24. $TDHT = \sum_h TDH_h$
25. $TDFT = \sum_f TDF_f$
26. $TPRODN = TIWT + TIKT + TIPT$
27. $TIWT = \sum_{l,j} TIW_{l,j}$
28. $TIKT = \sum_{k,j} TIK_{k,j}$

29. $$TIPT = \sum_j TIP_j$$

30. $$TPRCTS = TICT + TIMT + TIXT$$

31. $$TICT = \sum_i TIC_i$$

32. $$TIMT = \sum_i TIM_i$$

33. $$TIXT = \sum_i TIX_i$$

34. $$YGTR = \sum_{agng} TR_{gvt,agng}$$

35. $$TDH_h = PIXCON^{\eta} ttdh0_h + ttdh1_h YH_h$$

36. $$TDF_f = PIXCON^{\eta} ttdf0_f + ttdf1_f YFK_f$$

37. $$TIW_{l,j} = ttiw_{l,j} W_l LD_{l,j}$$

38. $$TIK_{k,j} = ttik_{k,j} R_{k,j} KD_{k,j}$$

39. $$TIP_j = ttip_j PP_j XST_j$$

40. $$TIC_i = ttic_i \left[\left(PL_i + \sum_{ij} PC_{ij}\, tmrg_{ij,i} \right) DD_i + \left(\left(1 + ttim_i\right) PWM_i\ e\ + \sum_{ij} PC_{ij}\, tmrg_{ij,i} \right) IM_i \right]$$

41. $$TIM_i = ttim_i\, PWM_i\ e\ IM_i$$

42. $$TIX_i = ttix_i \left(PE_i + \sum_{ij} PC_{ij}\, tmrg^X_{ij,i} \right) EXD_i$$

43. $$SG = YG - \sum_{agng} TR_{agng,gvt} - G$$

A1.2.4 Rest of the world

44. $$YROW = e \sum_i PWM_i \; IM_i + \sum_k \lambda_{row,k}^{RK} \left(\sum_j R_{k,j} \; KD_{k,j} \right) + \sum_{agd} TR_{row,agd}$$

45. $$SROW = YROW - \sum_i PE_i^{FOB} \; EXD_i - \sum_{agd} TR_{agd,row}$$

46. $$SROW = -CAB$$

A1.2.5 Transfers

47. $$TR_{agng,h} = \lambda_{agng,h}^{TR} YDH_h$$

48. $$TR_{gvt,h} = PIXCON^{\eta} tr0_h + tr1_h YH_h$$

49. $$TR_{ag,f} = \lambda_{ag,f}^{TR} YDF_f$$

50. $$TR_{agng,gvt} = PIXCON^{\eta} TR_{agng,gvt}^{0}$$

51. $$TR_{agd,row} = PIXCON^{\eta} TR_{agd,row}^{0}$$

A1.3 DEMAND

52. $$PC_i \; C_{i,h} = PC_i \; C_{i,h}^{MIN} + \gamma_{i,h}^{LES} \left(CTH_h - \sum_{ij} PC_{ij} \; C_{ij,h}^{MIN} \right)$$

53. $$GFCF = IT - \sum_i PC_i \; VSTK_i$$

54. $$PC_i INV_i = \gamma_i^{INV} GFCF$$

55. $$PC_i CG_i = \gamma_i^{GVT} G$$

56. $$DIT_i = \sum_j DI_{i,j}$$

57. $$MRGN_i = \sum_{ij} tmrg_{i,ij}\ DD_{ij} + \sum_{ij} tmrg_{i,ij}\ IM_{ij} + \sum_{ij} tmrg^{X}_{i,ij}\ EXD_{ij}$$

A1.4 PRODUCER SUPPLIES OF PRODUCTS AND INTERNATIONAL TRADE

58. $$XST_j = B^{XT}_j \left[\sum_i \beta^{XT}_{j,i}\ XS^{\rho^{XT}_j}_{j,i} \right]^{\frac{1}{\rho^{XT}_j}}$$

59. $$XS_{j,i} = \frac{XST_j}{\left(B^{XT}_j\right)^{1+\sigma^{XT}_j}} \left[\frac{P_{j,i}}{\beta^{XT}_{j,i}\ PT_j} \right]^{\sigma^{XT}_j}$$

60. $$XS_{j,i} = B^{X}_{j,i} \left[\beta^{X}_{j,i} EX^{\rho^{X}_{j,i}}_{j,i} + \left(1-\beta^{X}_{j,i}\right) DS^{\rho^{X}_{j,i}}_{j,i} \right]^{\frac{1}{\rho^{X}_{j,i}}}$$

61. $$EX_{j,i} = \left[\frac{1-\beta^{X}_{j,i}}{\beta^{X}_{j,i}} \frac{PE_i}{PL_i} \right]^{\sigma^{X}_{j,i}} DS_{j,i}$$

62. $$EXD_i = EXD^{O}_i \left(\frac{e\ PWX_i}{PE^{FOB}_i} \right)^{\sigma^{XD}_i}$$

63. $$Q_i = B^{M}_i \left[\beta^{M}_i\ IM_i^{-\rho^{M}_i} + \left(1-\beta^{M}_i\right) DD_i^{-\rho^{M}_i} \right]^{\frac{-1}{\rho^{M}_i}}$$

64. $$IM_i = \left[\frac{\beta^{M}_i}{1-\beta^{M}_i} \frac{PD_i}{PM_i} \right]^{\sigma^{M}_i} DD_i$$

A1.5 PRICES

A1.5.1 Production

65. $$PP_j = \frac{PVA_j VA_j + PCI_j CI_j}{XST_j}$$

66. $$PT_j = \left(1 + ttip_j\right) PP_j$$

67. $$PCI_j = \frac{\sum_i PC_i DI_{i,j}}{CI_j}$$

68. $$PVA_j = \frac{WC_j LDC_j + RC_j KDC_j}{VA_j}$$

69. $$WC_j = \frac{\sum_l WTI_{l,j} LD_{l,j}}{LDC_j}$$ (redundant, given equations 5 and 6; see Appendix E2)

70. $$WTI_{l,j} = W_l \left(1 + ttiw_{l,j}\right)$$

71. $$RC_j = \frac{\sum_k RTI_{k,j} KD_{k,j}}{KDC_j}$$ (redundant, given equations 7 and 8; see Appendix E3)

72. $$RTI_{k,j} = R_{k,j} \left(1 + ttik_{k,j}\right)$$

73. $$R_{k,j} = RK_k, \quad \textit{if capital is mobile}$$

A1.5.2 International trade

74. $$PT_j = \frac{\sum_i P_{j,i} XS_{j,i}}{XST_j}$$ (redundant, given equations 58 and 59, except if an industry produces a single commodity; see Appendix E4)

75. $$P_{j,i} = \frac{PE_i\ EX_{j,i} + PL_i\ DS_{j,i}}{XS_{j,i}}$$

76. $$PE_i^{FOB} = \left(PE_i + \sum_{ij} PC_{ij}\ tmrg_{ij,i}^{X} \right) \left(1 + ttix_i\ \right)$$

77. $$PD_i = \left(1 + ttic_i\ \right) \left(PL_i + \sum_{ij} PC_i\ tmrg_{ij,i} \right)$$

78. $$PM_i = \left(1 + ttic_i\ \right) \left(\left(1 + ttim_i\ \right) e\ PWM_i + \sum_{ij} PC_{ij}\ tmrg_{ij,i} \right)$$

79. $$PC_i = \frac{PM_i\ IM_i + PD_i\ DD_i}{Q_i}$$

A1.5.3 Price indexes

80. $$PIXGDP = \sqrt{\frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j} \right) VA_j^O}{\sum_j \left(PVA_j^O VA_j^O + TIP_j^O \right)} \frac{\sum_j \left(PVA_j VA_j + TIP_j \right)}{\sum_j \left(PVA_j^O + \frac{TIP_j^O}{VA_j^O} \right) VA_j}}$$

81. $$PIXCON = \frac{\sum_i PC_i \sum_h C_{i,h}^0}{\sum_{ij} PC_{ij}^0 \sum_h C_{ij,h}^0}$$

82. $$PIXINV = \prod_i \left(\frac{PC_i}{PC_i^0} \right)^{\gamma_i^{INV}}$$

83. $$PIXGVT = \prod_i \left(\frac{PC_i}{PC_i^0} \right)^{\gamma_i^{GVT}}$$

A1.6 EQUILIBRIUM

84. $$Q_i = \sum_h C_{i,h} + CG_i + INV_i + VSTK_i + DIT_i + MRGN_i$$

85. $$\sum_j LD_{l,j} = LS_l$$

86. $$\sum_j KD_{k,j} = KS_k$$

87. $$IT = \sum_h SH_h + \sum_f SF_f + SG + SROW$$

88. $$\sum_j DS_{j,i} = DD_i$$

89. $$\sum_j EX_{j,i} = EXD_i$$

A1.7 GROSS DOMESTIC PRODUCT

90. $$GDP^{BP} = \sum_j PVA_j VA_j + TIPT$$

91. $$GDP^{MP} = GDP^{BP} + TPRCTS$$

92. $$GDP^{IB} = \sum_{l,j} W_l \, LD_{l,j} + \sum_{k,j} R_{k,j} KD_{k,j} + TPRODN + TPRCTS$$

93. $$GDP^{FD} = \sum_i PC_i \left[\sum_h C_{i,h} + CG_i + INV_i + VSTK_i \right] + \sum_i PE_i^{FOB} EXD_i - e \sum_i PWM_i \, IM_i$$

A1.8 REAL (VOLUME) VARIABLES COMPUTED FROM PRICE INDICES

94. $$CTH_h^{REAL} = \frac{CTH_h}{PIXCON}$$

95. $G^{REAL} = \frac{G}{PIXGVT}$

96. $GDP^{BP\_REAL} = \frac{GDP^{BP}}{PIXGDP}$

97. $GDP^{MP\_REAL} = \frac{GDP^{MP}}{PIXCON}$

98. $GFCF^{REAL} = \frac{GFCF}{PIXINV}$

A2. Sets

A2.1 INDUSTRIES AND COMMODITIES

All industries: $j, jj \in J = \{J_1,...,J_j,...\}$

All commodities: $i,ij \in I = \{I_1,...,I_i,...\}$

A2.2 PRODUCTION FACTORS

Labor categories: $l \in L = \{L_1,...,L_l,...\}$

Capital categories: $k \in K = \{K_1,...,K_k,...\}$

A2.3 AGENTS

All agents: $ag,agj \in AG = H \cup F \cup \{GVT,ROW\} = \{H_1,...,H_h,...,F_1,...,F_f,...,GVT,ROW\}$

Household categories: $h,hj \in H \subset AG = \{H_1,...,H_h,...\}$

Firm categories: $f, fj \in F \subset AG = \{F_1,...,F_f,...\}$

Non governmental agent:

$agng \in AGNG \subset AG = H \cup F \cup \{ROW\} = \{H_1,...,H_h,...,F_1,...,F_f,...,ROW\}$

Domestic agents: $agd \in AGD \subset AG = H \cup F \cup \{GVT\} = \{H_1,...,H_h,...,F_1,...,F_f,...,GVT\}$

A3. Variables

NOTE: In what follows, the word “taxes” should be understood as “taxes, minus subsidies”.

A3.1 VOLUME VARIABLES

$C_{i,h}$: Consumption of commodity *i* by type *h* households

$C_{i,h}^{MIN}$: Minimum consumption of commodity *i* by type *h* households

CG_i : Public consumption of commodity *i*

CI_j : Total intermediate consumption of industry *j*

CTH_h^{REAL} : Real consumption expenditures of household *h*

DD_i : Domestic demand for commodity *i* produced locally

$DI_{i,j}$: Intermediate consumption of commodity *i* by industry *j*

DIT_i : Total intermediate demand for commodity *i*

$DS_{j,i}$: Supply of commodity *i* by sector *j* to the domestic market

$EX_{j,i}$: Quantity of product *i* exported by sector *j*

EXD_i : World demand for exports of product *i*

G^{REAL} : Real government expenditures

GDP^{BP_REAL} : Real GDP at basic prices

GDP^{MP_REAL} : Real GDP at market prices

$GFCF^{REAL}$: Real gross fixed capital formation

IM_i : Quantity of product *i* imported

INV_i : Final demand of commodity *i* for investment purposes

$KD_{k,j}$: Demand for type *k* capital by industry *j*

KDC_j : Industry *j* demand for composite capital

KS_k : Supply of type *k* capital

$LD_{l,j}$: Demand for type *l* labor by industry *j*

LDC_j : Industry *j* demand for composite labor

LS_l : Supply of type *l* labor

$MRGN_i$: Demand for commodity *i* as a trade or transport margin

Q_i : Quantity demanded of composite commodity *i*

VA_j : Value added of industry *j*

$VSTK_i$: Inventory change of commodity *i*

$XS_{j,i}$: Industry *j* production of commodity *i*

XST_j : Total aggregate output of industry *j*

A3.2 PRICE VARIABLES

e : Exchange rate[8]; price of foreign currency in terms of local currency

$P_{j,i}$: Basic price of industry *j*'s production of commodity *i*

PC_i : Purchaser price of composite comodity *i* (including all taxes and margins)

PCI_j : Intermediate consumption price index of industry *j*

PD_i : Price of local product *i* sold on the domestic market (including all taxes and margins)

PE_i : Price received for exported commodity *i* (excluding export taxes)

PE_i^{FOB} : FOB price of exported commodity *i* (in local currency)

PIXCON : Consumer price index

PIXGDP : GDP deflator

PIXGVT : Public expenditures price index

PIXINV : Investment price index

PL_i : Price of local product *i* (excluding all taxes on products)

PM_i : Price of imported product *i* (including all taxes and tariffs)

PP_j : Industry *j* unit cost, including taxes directly related to the use of capital and labor, but excluding other taxes on production

PT_j : Basic price of industry *j*'s output

PVA_j : Price of industry *j* value added (including taxes on production directly related to the use of capital and labour)

8 The default choice of numeraire in PEP-1-1 is the exchange rate *e*. This is implemented by fixing the value of *e* as exogenous. But the choice of numeraire in a CGE model is arbitrary (although the interpretation of results can be more or less easy, depending on which numeraire is selected).

PWM_i : World price of imported product *i* (expressed in foreign currency)

PWX_i : World price of exported product *i* (expressed in foreign currency)

$R_{k,j}$: Rental rate of type *k* capital in industry *j*

RC_j : Rental rate of industry *j* composite capital

RK_k : Rental rate of type *k* capital (if capital is mobile)

$RTI_{k,j}$: Rental rate paid by industry *j* for type *k* capital, including capital taxes

W_l : Wage rate of type *l* labor

WC_j : Wage rate of industry *j* composite labor

$WTI_{l,j}$: Wage rate paid by industry *j* for type *l* labor, including payroll taxes

A3.3 NOMINAL (VALUE) VARIABLES

CAB : Current account balance

CTH_h : Consumption budget of type *h* households

G : Current government expenditures on goods and services

GDP^{BP} : GDP at basic prices

GDP^{FD} : GDP at purchasers' prices from the perspective of final demand

GDP^{IB} : GDP at market prices (income-based)

GDP^{MP} : GDP at market prices

$GFCF$: Gross fixed capital formation

IT : Total investment expenditures

SF_f : Savings of type *f* businesses

SG : Government savings

SH_h : Savings of type *h* households

$SROW$: Rest-of-the-world savings

TDF_f : Income taxes of type *f* businesses

$TDFT$: Total government revenue from business income taxes

TDH_h : Income taxes of type *h* households

TDHT : Total government revenue from household income taxes

TIC_i : Government revenue from indirect taxes on product *i*

TICT : Total government receipts of indirect taxes on commodities

$TIK_{k,j}$: Government revenue from taxes on type *k* capital used by industry *j*

TIKT : Total government revenue from from taxes on capital

TIM_i : Government revenue from import duties on product *i*

TIMT : Total government revenue from import duties

TIP_j : Government revenue from taxes on industry *j* production (excluding taxes directly related to the use of capital and labor)

TIPT : Total government revenue from production taxes (excluding taxes directly related to the use of capital and labor)

$TIW_{l,j}$: Government revenue from payroll taxes on type *l* labor in industry *j*

TIWT : Total government revenue from payroll taxes

TIX_i : Government revenue from export taxes on product *i*

TIXT : Total government revenue from export taxes

TPRCTS : Total government revenue from taxes on products and imports

TPRODN : Total government revenue from other taxes on production[9]

$TR_{ag,agj}$: Transfers from agent *agj* to agent *ag*

YDF_f : Disposable income of type *f* businesses

YDH_h : Disposable income of type *h* households

YF_f : Total income of type *f* businesses

YFK_f : Capital income of type *f* businesses

$YFTR_f$: Transfer income of type *f* businesses

9 That is, taxes on production other than taxes on products and taxes and duties on imports (see Appendix B1).

YG : Total government income

YGK : Government capital income

$YGTR$: Government transfer income

YH_h : Total income of type h households

YHK_h : Capital income of type h households

YHL_h : Labor income of type h households

$YHTR_h$: Transfer income of type h households

$YROW$: Rest-of-the-world income

A3.4 RATES, INTERCEPTS AND OTHER VARIABLE PARAMETERS

The following are parameters that are formally treated as exogenous variables.

$sh0_h$: Intercept (type h household savings)

$sh1_h$: Slope (type h household savings)

$tr0_h$: Intercept (transfers by type h households to government)

$tr1_h$: Marginal rate of transfers by type h households to government

$ttdf0_f$: Intercept (income taxes of type f businesses)

$ttdf1_f$: Marginal income tax rate of type f businesses

$ttdh0_h$: Intercept (income taxes of type h households)

$ttdh1_h$: Marginal income tax rate of type h households

$ttic_i$: Tax rate on commodity i

$ttik_{k,j}$: Tax rate on type k capital used in industry j

$ttim_i$: Rate of taxes and duties on imports of commodity i

$ttip_j$: Tax rate on the production of industry j

$ttiw_{l,j}$: Tax rate on type l worker compensation in industry j

$ttix_i$: Export tax rate on exported commodity i

A4. Parameters

$aij_{i,j}$: Input-output coefficient

B_j^{KD} : Scale parameter (CES – composite capital)

B_j^{LD} : Scale parameter (CES – composite labor)

B_i^{M} : Scale parameter (CES – composite commodity)

B_j^{VA} : Scale parameter (CES – value added)

$B_{j,i}^{X}$: Scale parameter (CET – exports and local sales)

B_j^{XT} : Scale parameter (CET – total output)

$\beta_{k,j}^{KD}$: Share parameter (CES – composite capital)

$\beta_{l,j}^{LD}$: Share parameter (CES – composite labor)

β_i^{M} : Share parameter (CES – composite commodity)

β_j^{VA} : Share parameter (CES – value added)

$\beta_{j,i}^{X}$: Share parameter (CET – exports and local sales)

$\beta_{j,i}^{XT}$: Share parameter (CET – total output)

η : Price elasticity of indexed transfers and parameters

γ_i^{GVT} : Share of commodity *i* in total current public expenditures on goods and services

γ_i^{INV} : Share of commodity *i* in total investment expenditures

$\gamma_{i,h}^{LES}$: Marginal share of commodity *i* in type *h* household consumption budget

io_j : Coefficient (Leontief – intermediate consumption)

$\lambda_{ag,k}^{RK}$: Share of type *k* capital income received by agent *ag*

$\lambda_{ag,agj}^{TR}$: Share parameter (transfer functions)

$\lambda_{h,l}^{WL}$: Share of type *l* labor income received by type *h* households

ρ_j^{KD} : Elasticity parameter (CES – composite capital); $-1 < \rho_j^{KD} < \infty$

ρ_j^{LD} : Elasticity parameter (CES – composite labor); $-1 < \rho_j^{LD} < \infty$

ρ_i^{M} : Elasticity parameter (CES – composite commodity); $-1 < \rho_i^{M} < \infty$

ρ_j^{VA} : Elasticity parameter (CES – value added) ; $-1 < \rho_j^{VA} < \infty$

$\rho_{j,i}^{X}$: Elasticity parameter (CET – exports and local sales) ; $1 < \rho_{j,i}^{X} < \infty$

ρ_j^{XT} : Elasticity parameter (CET – total output) ; $1 < \rho_j^{XT} < \infty$

σ_j^{KD} : Elasticity of substitution (CES – composite capital); $0 < \sigma_j^{KD} < \infty$

σ_j^{LD} : Elasticity of substitution (CES – composite labor); $0 < \sigma_j^{LD} < \infty$

σ_i^{M} : Elasticity of substitution (CES – composite commodity); $0 < \sigma_i^{M} < \infty$

σ_j^{VA} : Elasticity of transformation (CES – value added) ; $0 < \sigma_j^{VA} < \infty$

$\sigma_{j,i}^{X}$: Elasticity of transformation (CET – exports and local sales) ; $0 < \sigma_{j,i}^{X} < \infty$

σ_i^{XD} : Price elasticity of the world demand for exports of product *i*

σ_j^{XT} : Elasticity of transformation (CET – total output) ; $0 < \sigma_j^{XT} < \infty$

$tmrg_{i,ij}$: Rate of margin *i* applied to commodity *ij*

$tmrg_{i,ij}^{X}$: Rate of margin *i* applied to exported commodity *ij*

v_j : Coefficient (Leontief – value added)

A5. Variables that are fixed in the default closure[10]

$C_{i,h}^{MIN}$: Minimum consumption of commodity *i* by type *h* households

CAB : Current account balance

e : Exchange rate; price of foreign currency in terms of local currency

G : Current government expenditures on goods and services

$KD_{k,j}$: Demand for type *k* capital by industry *j*, **if capital is not mobile** (*kmob* = 0)

10 See Appendix G.

KS_k : Supply of type *k* capital, **if capital is mobile** (*kmob* = 1)

LS_l : Supply of type *l* labor

PWM_i : World price of imported product *i* (expressed in foreign currency)

PWX_i : World price of exported product *i* (expressed in foreign currency)

$sh0_h$: Intercept (type *h* household savings)

$sh1_h$: Slope (type *h* household savings)

$tr0_h$: Intercept (transfers by type *h* households to government)

$tr1_h$: Marginal rate of transfers by type *h* households to government

$ttdf0_f$: Intercept (income taxes of type *f* businesses)

$ttdf1_f$: Marginal income tax rate of type *f* businesses

$ttdh0_h$: Intercept (income taxes of type *h* households)

$ttdh1_h$: Marginal income tax rate of type *h* households

$ttic_i$: Tax rate on commodity *i*

$ttik_{k,j}$: Tax rate on type *k* capital used in industry *j*

$ttim_i$: Rate of taxes and duties on imports of commodity *i*

$ttip_j$: Tax rate on the production of industry *j*

$ttiw_{l,j}$: Tax rate on type *l* worker compensation in industry *j*

$ttix_i$: Export tax rate on exported commodity *i*

$VSTK_i$: Inventory change of commodity *i*

APPENDIX B: MODEL VARIABLES AND CONCEPTS OF THE 1993 SYSTEM OF NATIONAL ACCOUNTS (SNA93)

This Appendix is dedicated to clarifying the following concepts, on the basis of the 1993 System of National Accounts (INTER-SECRETARIAT WORKING GROUP ON NATIONAL ACCOUNTS, 1993)[11]:

Taxes on production and imports

Taxes on products

Other taxes on production

Basic prices and value added at basic prices

Producers' prices and value added at producers' prices

Purchasers' prices

GDP at basic prices

GDP at market prices

B1. « Indirect » taxes

Paragraph 7.49 of the SNA93 says that taxes on ***products*** are a ***subset*** of taxes on ***production***, rather than a separate category. Taxes on production, together with taxes and duties on imports, constitute the set of ***Taxes on production and imports***.

> 7.49. ***Taxes on production and imports consist of***:
> ***taxes on products*** payable on goods and services when they are produced, delivered, sold, transferred or otherwise disposed of by their producers; they include
> ***taxes and duties on imports*** that become payable when goods enter the economic territory by crossing the frontier or when services are delivered to resident units by non-resident units; when outputs are valued at basic prices, taxes on domestically produced products are not recorded in the accounts of the System as being payable by their producers
>
> plus:
> ***other taxes on production***, consisting mainly of taxes on the ownership or use of land, buildings or other assets used in production or on the labour employed, or compensation of employees paid.
> Taxes on the personal use of vehicles, etc., by households are recorded under current taxes on income, wealth, etc.

11 *http://unstats.un.org/unsd/sna1993/toctop.asp*. Throughout this document, we refer to the 1993 System of National Accounts. The reader should be aware that the 2008 System of National Accounts is now the international standard (*http://unstats.un.org/unsd/nationalaccount/sna2008.asp*). Changes between the 1993 and 2008 SNAs are outlined in INTER-SECRETARIAT WORKING GROUP ON NATIONAL ACCOUNTS (2009), pp. xlvii-xlvix. However, the fundamental concepts which are discussed here have been maintained in the 2008 SNA.

The word « other » is important here. This implies the following classification scheme:

<table>
<tr><td rowspan="3">Taxes on production and imports</td><td colspan="2">Taxes and duties on imports</td></tr>
<tr><td rowspan="2">Taxes on production</td><td>Taxes on products</td></tr>
<tr><td>Other taxes on production</td></tr>
</table>

Paragraph 7.50 defines taxes on production, and says that they correspond *grosso modo* to « ***indirect taxes*** », although that expression is no longer part of the national accounts terminology (it is nonetheless still used, by Statistics Canada, among others – see box below).

7.50. ***At the level of an individual enterprise, taxes on production are recorded as being payable out of its value added***. Similarly, in business accounting, taxes on production, except invoiced VAT, are usually regarded as costs of production that may be charged against sales or other receipts when calculating profits for tax or other purposes. ***They correspond grosso modo to "indirect taxes" as traditionally understood, indirect taxes being taxes that supposedly can be passed on, in whole or in part, to other institutional units by increasing the prices of the goods or services sold***. However, it is extremely difficult, if not impossible, to determine the real incidence of different kinds of taxes, and the use of the terms "direct" and "indirect" taxes has fallen out of favour in economics and is no longer used in the System.

B1.1 OTHER TAXES ON PRODUCTION

As indicated in 7.49, and detailed in 7.70 below, ***Other taxes on production*** include payroll taxes, taxes on capital, as well as property or real estate taxes. But they ***do not include taxes on products***, defined in Paragraph 7.62 below.

3. Other taxes on production (D.29)

7.70. ***These consist of all taxes, except taxes on products, that enterprises incur as a result of engaging in production***. Such taxes ***do not include any taxes on the profits or other income*** received by the enterprise and are payable irrespective of the profitability of the production. They may be payable on the land, fixed assets or labour employed in the production process or on certain activities or transactions. Other taxes on production include the following:

(a) ***Taxes on payroll or work force***: these consist of taxes payable by enterprises assessed either as a proportion of the wages and salaries paid or as a fixed amount per person employed. They do not include compulsory social security contributions paid by employers or any taxes paid by the employees themselves out of their wages or salaries (GFS, 3; OECD, 3000);

(b) ***Recurrent taxes on land, buildings or other structures***: these consist of taxes payable regularly, usually each year, in respect of the use or ownership of land,

buildings or other structures utilized by enterprises in production, whether the enterprises own or rent such assets (GFS, 4.1; OECD, 4100);

(c) ***Business and professional licences***: these consist of taxes paid by enterprises in order to obtain a licence to carry on a particular kind of business or profession. However, if the government carries out checks on the suitability, or safety of the business premises, on the reliability, or safety, of the equipment employed, on the professional competence of the staff employed, or on the quality or standard of goods or services produced, as a condition for granting such a licence, the payments are not unrequited and should be treated as payments for services rendered, unless the amounts charged for the licences are out of all proportion to the costs of the checks carried out by governments (GFS, 5.5.1; OECD, 5210). (See also paragraph 8.54 (c) of chapter VIII for the treatment of licences obtained by households for their own personal use.);

(d) ***Taxes on the use of fixed assets or other activities***: these include taxes levied periodically on the use of vehicles, ships, aircraft or other machinery or equipment used by enterprises for purposes of production, whether such assets are owned or rented. These taxes are often described as licences, and are usually fixed amounts which do not depend on the actual rate of usage (GFS, 5.5.2 and 5.5.3; OECD, 5200);

(e) ***Stamp taxes***: these consist of stamp taxes which do not fall on particular classes of transactions already identified, for example, stamps on legal documents or cheques. These are treated as taxes on the production of business or financial services. However, stamp taxes on the sale of specific products, such as alcoholic beverages or tobacco, are treated as taxes on products (GFS, 7.2; OECD, 6200);

(f) ***Taxes on pollution***: these consist of taxes levied on the emission or discharge into the environment of noxious gases, liquids or other harmful substances. They do not include payments made for the collection and disposal of waste or noxious substances by public authorities, which constitute intermediate consumption of enterprises (GFS, 7.3; OECD, 5200);

(g) ***Taxes on international transactions***: these consist of taxes on travel abroad, foreign remittances or similar transactions with non-residents (GFS, 6.5 and 6.6; OECD, 5127).

B1.2 TAXES ON PRODUCTS

Taxes on products are defined in 7.62.

2. Taxes on products (D.21)

7.62. ***A tax on a product*** is a tax that is ***payable per unit of some good or service***. The tax may be a specific amount of money per unit of quantity of a good or service (the quantity units being measured either in terms of discrete units or continuous physical variables such as volume, weight, strength, distance, time, etc.), or it may be calculated ad valorem as a specified percentage of the price per unit or value of the goods or services transacted. A tax on a product usually becomes payable when it is produced, sold or imported, but it may also become payable in other circumstances, such as when a good is exported, leased, transferred, delivered, or used for own consumption or own capital formation. An enterprise may or may not itemize the amount of a tax on a product separately on the invoice or bill which they charge their customers.

B1.3 CORRESPONDING VARIABLES IN PEP-1-1

Variables In PEP-1-1 which correspond to these concepts are:

TIC_i : Government revenue from indirect taxes on product *i;*
part of SNA93 « taxes on products »

$TIK_{k,j}$: Government revenue from taxes on type *k* capital used by industry *j;*
part of SNA93 « other taxes on production »

TIM_i : Government revenue from import duties on product *i;*
part of SNA93 « taxes and duties on imports »

TIP_j : Government revenue from taxes on industry *j* production (excluding taxes directly related to the use of capital and labor)*;*
part of SNA93 « other taxes on production »

$TIW_{l,j}$: Government revenue from payroll taxes on type *l* labor in industry *j;*
part of SNA93 « other taxes on production »

TIX_i : Government revenue from export taxes on product *i;*
part of SNA93 « taxes on products »

TPRCTS : Total government revenue from taxes on products and imports*;*
correspond to SNA93 « taxes on products »

TPRODN : Total government revenue from other taxes on production*;*
correspond to SNA93 « other taxes on production »

B2. Price concepts

B2.1 PRODUCERS' PRICES AND BASIC PRICES

Value added is defined at the level of individual producer units, and is aggregated to sectors or industries, or to the whole economy. It is calculated by subtracting the value of intermediate consumption from the value of production. Now, the values of intermediate consumption and production depend on which price concepts are used in their measurement. Consequently, SNA93 defines price concepts in reference to the valuation of production and intermediate consumption.

Price concepts differ according to which taxes are included or excluded. ***Taxes on imports*** are recorded only at the level of the total economy, as they are not payable out of the values added of domestic producers: consequently, they are not relevant in the valuation of production. Output valued at ***basic prices*** excludes all taxes (subsidies) on products payable (receivable) on the goods or services produced as outputs, but ***includes other taxes on production*** (see Paragraph 7.53 below). ***Producers' prices*** also ***include all taxes or subsidies on products*** payable or receivable on outputs, except invoiced VAT or similar deductible taxes as invoiced VAT is never included in the value of output.

7.52. In the generation of income account, taxes on imports are recorded only at the level of the total economy as they are not payable out of the values added of domestic producers. Moreover, at the level of an individual institutional unit or sector, ***only those taxes on products that have not been deducted from the value of the output of that unit or sector need to be recorded under uses in its generation of income account. These vary*** depending upon the way in which output is valued. ***When output is valued at basic prices, all taxes (subsidies) on products payable (receivable) on the goods or services produced as outputs are deducted from (added to) the value of that output at producers' prices. They do not, therefore, have to be recorded under uses in the generation of income account of the units or sectors concerned***, being recorded only at the level of the total economy, in the same way as taxes on imports. ***When output is valued at producers' prices, all taxes or subsidies on products payable or receivable on outputs have to be recorded under uses in the generation of income accounts of the units or sectors concerned, except invoiced VAT or similar deductible taxes as invoiced VAT is never included in the value of output***. Non-deductible VAT and similar taxes are recorded under uses only at the level of the total economy, like taxes on imports.

7.53. ***Other taxes or subsidies on production*** - i.e., taxes payable on the land, assets, labour, etc., employed in production - ***are not taxes payable per unit of output*** and cannot be deducted from the producer's price. They are recorded as being payable out of the values added of the individual producers or sectors concerned.

The implications of the above are presented in the two following figures: in Figure B1, value added is recorded at basic prices; in Figure B2, it is recorded at producer prices. In both cases, the starting point is production at producers' prices. But in the calculation of value added at basic prices, taxes on products are immediately deducted to obtain production at basic prices. It follows that taxes on products do not appear in the « Generation of income account » when value added is at basic prices, but they do when value added is at producer prices.

Figure B1 – Value added of a single producer unit at basic prices

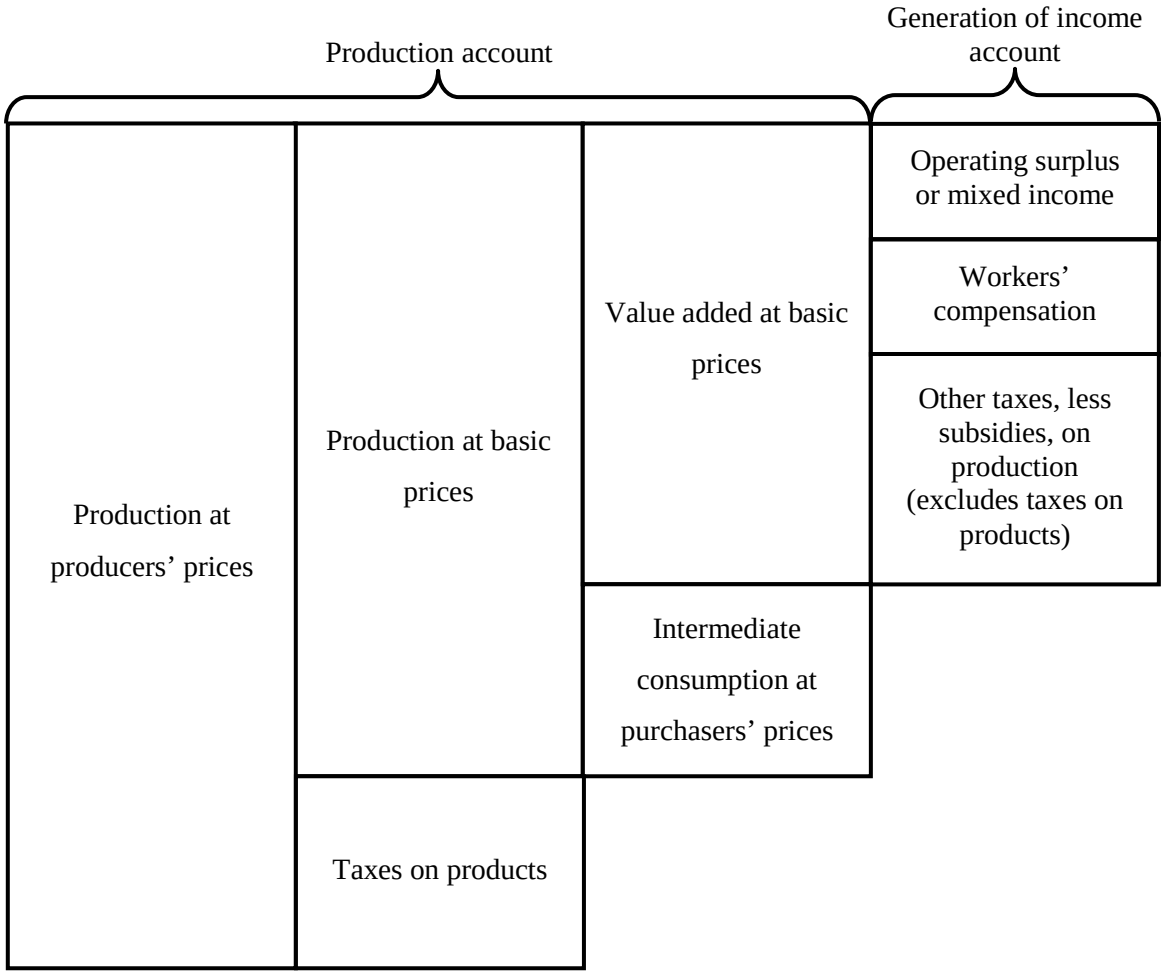
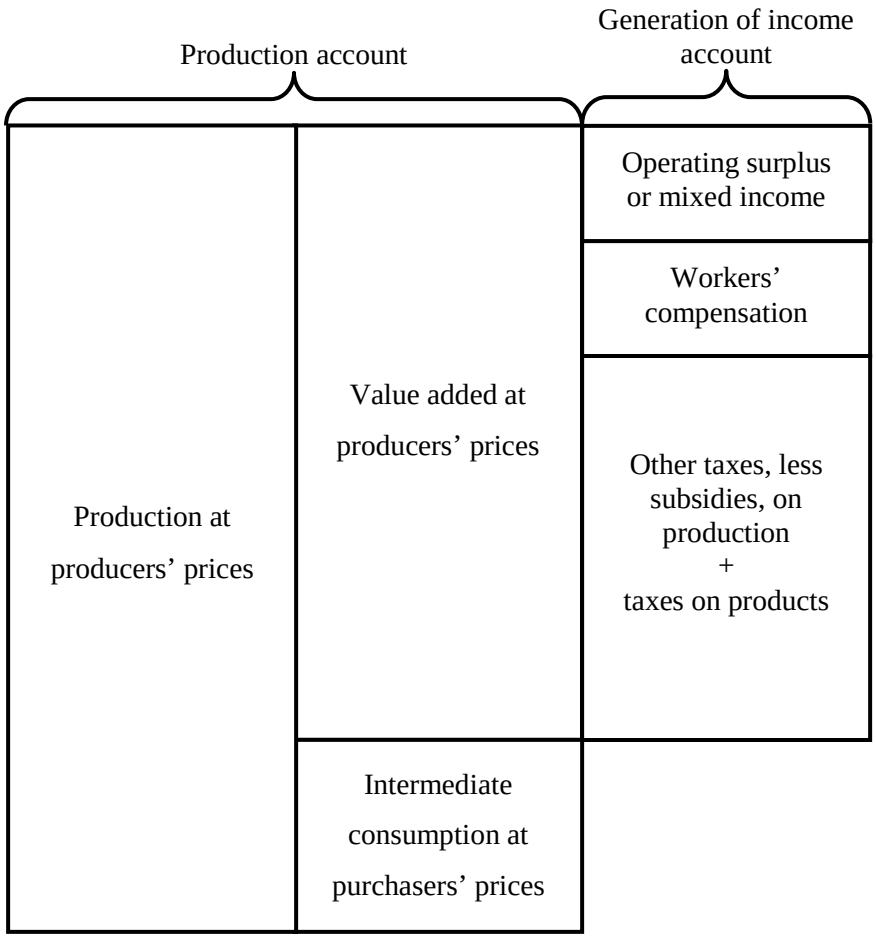


Figure B2 – Value added of a single producer unit at producers' prices



B2.2 PURCHASERS' PRICES

The reader will have noticed that, in computing value added, whether at basic prices or at producers' prices, intermediate consumption ***at purchasers' prices*** is deducted from the value of production. This is justified, particularly in the case of value added at basic prices, by the fact that « From the point of view of the producer, purchasers' prices for inputs and basic prices for outputs represent the prices actually paid and received » (SNA93, Paragraph 6.226).

As a general principle, the SNA records ***product uses at purchasers' prices***, which include taxes and margins.

> 3.81. Usually, the producer and the user of a given product perceive its value differently owing to the existence of taxes and subsidies on products, transport costs to be paid and the occurrence of trade margins. In order to keep as close as possible to the views of the economic transactors themselves, ***the System records all uses at purchasers' prices including these elements, but excludes them from the value of output of the product.***

The most explicit definition of purchasers' prices is given in Paragraph 3.83 (and repeated in 6.215):

> 3.83. Use of products is recorded at purchasers' prices. The ***purchaser's price*** is defined as the ***amount payable by the purchaser, excluding any deductible VAT or similar deductible tax***, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchaser's price of a good ***includes any transport charges*** paid separately by the purchaser to take delivery at the required time and place.

But there may be more than one definition of purchasers' price for a given product, when it goes through several successive transactions before its final use.

> 6.216. When ***comparing the purchaser's price with the producer's or basic price,*** it is important to specify whether they refer to the same transaction or two different transactions. For certain purposes, including input-output analysis, it may be convenient to compare the ***price paid by the final purchaser of a good after it has passed through the wholesale and retail distribution chains*** with the producer's price received by its original producer. In this case the prices refer to two different transactions taking place at quite different times and locations: they must differ at least by the amount of the ***wholesale and retail trade margins***.

Paragraph 6.217 is useful in that it indirectly confirms that the difference between producer price and basic price is indeed « the value of any taxes less subsidies on the product (other than VAT) ».

> 6.217. ***When the prices refer to the same transaction,*** that is, the purchaser buys directly from the producer, the purchaser's price may exceed the ***producer's price*** by:
> (a) The value of any ***non-deductible VAT***, payable by the purchaser; and
> (b) The value of any ***transport charges*** on a good paid separately by the purchaser and not included in the producer's price.
> ***It follows that the purchaser's price may exceed the basic price by the amount of the two items just listed plus the value of any taxes less subsidies on the product (other than VAT).***

The existence of a value-added tax (VAT) is a complicating factor (see Paragraphs 6.207 to 6.214, not reproduced here).

B2.3 CORRESPONDING VARIABLES IN PEP-1-1

Variables In PEP-1-1 which correspond to these concepts are:

P_j : Basic price of industry *j*'s output
⇒ SNA93 « basic price » of aggregate output

PCI_j : Intermediate consumption price index of industry *j*
⇒ SNA93 « purchaser price » index of intermediate consumption

PC_i : Purchaser price of composite comodity *i* (including all taxes and margins)
⇒ SNA93 « purchaser price »

PD_i : Price of local product *i* sold on the domestic market (including all taxes and margins)
⇒ SNA93 « purchaser price »

PM_i : Price of imported product *i* (including all taxes and margins)
⇒ SNA93 « purchaser price »

PE_i : Price received for exported commodity *i* (excluding export taxes)
⇒ SNA93 « basic price » of exports

PE_i^{FOB} : FOB price of exported commodity *i* (in local currency)
⇒ SNA93 « producer price » ***and*** « purchaser price » of exported products

PL_i : Price of local product *i* (excluding all taxes on products)
⇒ SNA93 « basic price » of local products sold on the domestic market

PP_j : Industry *j* unit cost, including taxes directly related to the use of capital and labor, but excluding other taxes on production
⇒ SNA93 « basic price », ***minus*** taxes on production not directly related to the use of capital and labor

There is no variable in PEP-1-1 corresponding to producer prices, except for PE_i^{FOB}. Subtracting margins from PD_i would yield producer prices of local products sold domestically.

B3. Trade and transport margins

In the SNA93, the output of wholesale and retail trade is not measured by the value of their sales, but rather by the value of the services rendered as intermediaries between producers and buyers. The value of these services is the gross trade margin. In the SNA, a purchase is recorded as two simultaneous flows:

one is the value of what is purchased, and the other is the trade margin that is included in the price paid by the buyer.[12]

> 3.30. The System's recording of transactions for wholesalers and retailers does not mirror the way in which those involved view them. The purchases of goods for resale by wholesalers and retailers are not recorded explicitly, and they are viewed as selling, not the goods, but the services of storing and displaying a selection of goods in convenient locations and making them easily available for customers. This partitioning implements the System's measure of output for traders, which is by the value of the margins on goods they purchase for resale.

Transport services are treated both as margins and as directly purchased services. But transport services produced for own use within enterprises are not recorded separately (see SNA93 Paragraph 6.103).

Trade and transport margins appear in the supply part of the supply-and-use table. SNA93 Table 2.10, reproduced after section B4.3 below, provides an example of how trade margins are recorded in the System.

> 2.214. The upper part of the table shows the origin of the resources of goods and services. In the rows, the various types of products are presented according to a classification which can be used at various levels of detail. In the columns, starting from the right side, imports are shown first. Then a matrix showing the output of industries, according to the activity classification, appears. This is the make matrix. It may be valued either at basic prices or at producers' prices in the absence of a value added tax (VAT), or at producers' prices in the presence of VAT. The actual figures in the table are at basic prices which is the preferred method of valuation for output. The column for total industries records the total output of industries for each kind of product. The output of a given industry may cover a number of different products, the principal and the secondary ones.
>
> *Text refers to:* table 2.10.

> 2.215. Taxes, less subsidies, on products - with varying content according to the valuation of output - and trade and transport margins are recorded in two columns in order to get total supply of each type of product valued at purchasers' prices. The corresponding trade and transport services are deducted globally at the intersection between the relevant rows and the column for trade and transport margins. Thus the total of the latter is zero.
>
> *Text refers to:* table 2.10.

In column (2) of the SNA93 Table 2.10, the production of trade and transport services as margins is subtracted from total supply (–68 for trade, and –10 for transport), so that the column total is zero. In PEP-1-1, margins are treated in a different, but arithmetically equivalent, manner. In the underlying SAM,

[12] Also see SNA93 Paragraphs 6.110 to 6.114 (not reproduced here).

there is a « Trade and transport margins » column in the use table (bottom part of the supply-and-use table): margins are formally treated as a (fictitious) industry. Its sales are the amount of trade and transport margins included in the supply of goods and services (78 = 2 + 2 + 74); its intermediate purchases are trade services (68) and transport services (10); no value added is generated. The only difference with Table 2.10 is that total supply of trade services (line 6 of the supply table – top part of Table 2.10) is then increased by 68, and that of transport services (line 7) by 10, while total uses of these services are increased by the same amounts (lines 6 and 7 of the use table – bottom part of Table 2.10). See variable $MRGN_i$ in equations 57 and 84.

B4. GDP concepts

B4.1 GDP AT BASIC PRICES AND AT PRODUCERS' PRICES

GDP is the sum of value added of all resident producer units. So, just as value added can be evaluated at basic prices or producer prices, so can GDP be evaluated at both sets of prices.

> 2.172. Basically, ***GDP is a concept of value added***. It is the ***sum of gross value added of all resident producer units (institutional sectors or, alternatively, industries) plus that part (possibly the total) of taxes, less subsidies, on products which is not included in the valuation of output.**** Gross value added is the difference between output and intermediate consumption.
>
> **** If basic prices are used for valuing output, GDP is equal to the sum of gross value added of all resident producer units plus all taxes on products (less subsidies on products)***. If producers' prices are used for valuing output, GDP is equal to the sum of gross value added of all resident producer units plus taxes and duties on imports, less import subsidies - in absence of a value added tax system - or plus taxes and duties on imports (less import subsidies) and value added type taxes - when such a taxation system does exist.

GDP at basic prices is computed from gross value added at basic prices, defined as:

> 6.226. ***Gross value added at basic prices is defined as output valued at basic prices less intermediate consumption valued at purchasers' prices.*** Although the outputs and inputs are valued using different sets of prices, for brevity the value added is described by the prices used to value the outputs. From the point of view of the producer, purchasers' prices for inputs and basic prices for outputs represent the prices actually paid and received. Their use leads to a measure of gross value added which is particularly relevant for the producer. The resulting measure has also some convenient properties for aggregation purposes as explained later, ***although there is no named aggregate in the System which corresponds to the sum of the gross values added of all enterprises measured at basic prices.***

GDP at producers' prices is computed from gross value added at producers' prices, defined as:

> 6.227. ***Gross value added at producers' prices is defined as output valued at producers' prices less intermediate consumption valued at purchasers' prices.*** As already explained, in the absence of VAT, the total value of the intermediate inputs consumed is the same whether they are valued at producers' or at purchasers' prices, in which case this measure of gross value added is the same as one

which uses producers' prices to value both inputs and outputs. It is an economically meaningful measure that is equivalent to the traditional measure of gross value added at market prices. However, in the presence of VAT, the producer's price excludes invoiced VAT, and it would be inappropriate to describe this measure as being at "market" prices.

The difference between the two measures of GDP is the sum of taxes included in value added at producers' prices and at basic prices:

6.228. Both this measure of gross value added and that described in the previous section use purchasers' prices to value intermediate inputs. ***The difference between the two measures is entirely attributable to their differing treatments of taxes or subsidies on products payable on outputs (other than invoiced VAT)***. By definition, the value of output at producers' prices exceeds that at basic prices by the amount, if any, of the taxes, less subsidies, on the output so that the two associated measures of gross value added must differ by the same amount.

B4.2 GDP AT PURCHASERS' PRICES FROM THE PERSPECTIVE OF FINAL DEMAND

GDP can also be computed from final demand. Since final demand is valued at purchasers' prices, this measure of GDP is different from gross value added aggregations:

2.173. Next, ***GDP is also equal to the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, less the value of imports of goods and services.***

B4.3 GDP FROM THE INCOME PERSPECTIVE

Finally, GDP can be computed as the sum of incomes distributed by resident producer units:

2.174. Finally, ***GDP is also equal to the sum of primary incomes distributed by resident producer units.***

This is detailed in Paragraph 2.222. This paragraph refers to Table 2.10, which may be downloaded from the SNA93 site (reproduced on the following page).

2.222. The three approaches to GDP (1,854) appear in the supply and use table, as well as in the integrated economic accounts:

From the production side, GDP is equal to total output (3,604) minus total intermediate consumption (1,883) plus taxes, less subsidies, on products (133) not included in the value of output.

From the demand side, GDP is equal to final consumption expenditure (1,015 + 16 + 156 + 212) plus gross capital formation (376 + 28 + 10) plus exports (540) minus imports (499).

From the income side, GDP is equal to compensation of employees (762) plus taxes, less subsidies, on production and imports (191), plus mixed income, gross (442), plus operating surplus, gross (459).

Table 2.10. Supply and use (reduced format)

Supply of products

Resources		Total supply at purchasers' prices (1)	Trade and transport margins (2)	Taxes less subsidies on products (3)	Output in industries (by ISIC categories): Agri-culture hunting, forestry fishing (A+B) (4)	Mining and quarrying (C) (5)	Manufac-turing, electricity (D+E) (6)	Construc-tion (F) (7)	Wholesale, retail trade, repair motor vehicles and hshld goods, hotels, restaurants (G+H) (8)	Transport, storage, and com-munication (I) (9)	Financial interme-diation, real estate, other business services (J+K) (10)	Education, health, personal services, pub. admin. and defense (M+N+O+P+L) (11)	Total industry, in basic prices (12)	(13)	Imports of goods and services (14)
Goods and services (by CPC sections)															
1. Agriculture, forestry and fishery products	(0)	128	2	2	87	0	0	0	0	0	0	0	87		37
2. Ores and minerals	(1)	103	2	0	0	30	10	0	1	0	0	0	41		60
3. Electricity, gas and water	(17-18)	160	0	5	0	2	152	0	0	0	0	0	154		1
4. Manufacturing	(2-4)	2 160	74	89	2	2	1 666	11	16	8	7	2	1 714		283
5. Construction work and construction, land	(5)	262	0	17	0	0	7	232	0	5	0	0	244		1
6. Trade services, restaurant and hotel services	(6)	179	-68	3	0	0	8	1	149	7	0	0	165		79
7. Transport, storage and communication services	(7)	111	-10	5	0	0	0	0	21	75	0	0	96		20
8. Business services	(8)	590	0	8	0	1	0	0	2	3	465	98	569		13
9. Community, social and pers. serv. excl. public admin.	(9)	375	0	4	0	0	1	0	2	2	6	355	366		5
10. Public administration	(91)	168	0	0	0	0	0	0	0	0	0	168	168		0
11. *Total*		4 236	0	133	89	35	1 844	244	191	100	478	623	3 604		499

Use of products, purchasers' price

Uses		Total uses in purchasers' prices (1)	(2)	Taxes less subsidies on products (3)	Intermediate consumption in industries (by ISIC categories): Agri-culture hunting, forestry fishing (A+B) (4)	Mining and quarrying (C) (5)	Manufac-turing, electricity (D+E) (6)	Construc-tion (F) (7)	Wholesale, retail trade, repair motor vehicles and hshld goods, hotels, restaurants (G+H) (8)	Transport, storage, and com-munication (I) (9)	Financial interme-diation, real estate, other business services (J+K) (10)	Education, health, personal services, pub. admin. and defense (M+N+O+P+L) (11)	Total industry (12)	Total economy (13)	Exports of goods and services (14)	Final consumption expenditure: Households (14)	NPISH individual (15)	General government individual (16)	General government collective (17)	Gross capital formation: Gross fixed capital formation (18)	Changes in inven-tories (19)	Net purchases of valuables (20)
Goods and services (by CPC sections)																						
1. Agriculture, forestry and fishery products	(0)	128			3	0	71	0	3	1	5	5	88		7	28	0	0	2	2	1	
2. Ores and minerals	(1)	103			1	3	91	0	0	0	1	0	96		6	2	0	0	0		-1	
3. Electricity, gas and water	(17-18)	160			2	2	96	1	5	3	4	10	123		1	36	0	0	0		0	
4. Manufacturing	(2-4)	2 160			32	7	675	80	36	21	45	96	992		422	567	0	0	3	161	5	10
5. Construction work and construction, land	(5)	262			1	2	7	5	2	1	3	19	40		6	3	0	0	0	190	23	
6. Trade services, restaurant and hotel services	(6)	179			2	1	34	1	9	6	4	4	61		67	51	0	0	0		0	
7. Transport, storage and communication services	(7)	111			2	1	29	3	19	12	5	7	78		19	14	0	0	0		0	
8. Business services	(8)	590			3	1	117	23	25	15	54	71	309		8	250	0	0	0	23	0	
9. Community, social and pers. serv. excl. pub. ad.	(9)	375			1	0	7	1	1	1	11	73	95		4	58	14	0	204	0	0	
10. Public administration	(91)	168			0	0	0	0	0	0	0	1	1		0	6	2	156	3		0	
11. *Total uses in purchasers' prices*		4 236			47	17	1 127	114	100	60	132	286	1 883		540	1 015	16	156	212	376	28	10
12. *Total gross value added/GDP*				133	42	18	717	130	91	40	346	337	1 721	1 854								
13. Compensation of employees					9	13	336	58	44	16	54	232	762	762								
14. Taxes less subsidies on production and imports				133	-2	-2	46	5	0	-6	12	5	58	191								
15. Taxes less subsidies on products				133										133								
16. Other taxes less subsidies on production					-2	-2	46	5	0	-6	12	5	58	58								
17. Mixed income, net					14	0	227	35	36	3	99	18	432	432								
18. Operating surplus, net					10	4	30	21	-4	12	127	47	247	247								
19. Consumption of fixed capital					11	3	78	11	15	15	54	35	222	222								
20. Mixed income, gross					17	0	228	36	36	7	99	19	442	442								
21. Operating surplus, gross					18	7	107	31	11	23	181	81	459	459								
22. *Total*					89	35	1 844	244	191	100	478	623	3 604									
23. *Labour inputs (hours worked)*					2 058	292	31 982	5 024	7 078	2 032	3 700	17 203	69 369									
24. *Gross fixed capital formation*					11	6	117	9	20	39	144	30	376									
25. *Stocks of fixed assets*					159	90	1 788	160	298	572	2 260	456	5 783									

GDP

B4.4 WHAT ABOUT GDP AT FACTOR COST?

This concept no longer exists in the System of National Accounts. Nonetheless, GDP at factor costs can easily be computed. In the absence of *other taxes on production*, GDP at factor costs is identical to GDP at basic prices.

6.229. ***Gross value added at factor cost is not a concept used explicitly in the System***. Nevertheless, it can easily be derived from either of the measures of gross value added presented above by subtracting the value of any taxes, less subsidies, on production payable out of gross value added as defined. For example, the only taxes on production remaining to be paid out of gross value added at basic prices consist of "other taxes on production". These consist mostly of current taxes (or subsidies) on the labour or capital employed in the enterprise, such as payroll taxes or current taxes on vehicles or buildings. Gross value added at factor cost can, therefore, be derived from gross value added at basic prices by subtracting "other taxes, less subsidies, on production".

6.230. The conceptual difficulty with gross value added at factor cost is that there is no observable vector of prices such that gross value added at factor cost is obtained directly by multiplying the price vector by the vector of quantities of inputs and outputs that defines the production process. By definition, "other taxes or subsidies on production" are not taxes or subsidies on products that can be eliminated from the input and output prices. Thus, despite its traditional name, gross value added at factor cost is not strictly a measure of value added.

6.231. Gross value added at factor cost is essentially a measure of income and not output. It represents the amount remaining for distribution out of gross value added, however defined, after the payment of all taxes on production and the receipt of all subsidies on production. It makes no difference which measure of gross value added is used because the measures considered above differ only in respect of the amounts of the taxes or subsidies on production which remain payable out of gross value added.

6.232. Claims on gross value added, other than payments of taxes, less subsidies, to government used to be described as "factor incomes". While the concept of factor income is no longer used in the System, gross value added at factor cost could be interpreted as measuring the value of the fund out of which so-called "factor incomes" can be paid: it follows that it is equal to the total value of the "factor" incomes generated by production.

Statistics Canada, among other statistical agencies, has abandoned the concept of « GDP at factor costs »:

What is the difference between the GDP at factor cost and the GDP at basic prices?

Whereas in the past, Statistics Canada published net domestic product at factor cost, this practice changed with the publication of the estimates of the first quarter of 2001 of the national economic and financial accounts. To bring the Canadian System of National Economic Accounts into line with international standards, the valuation of production is now done according to basic prices.

The concept of GDP at basic prices differs from the concept of GDP at factor costs in that the former includes net indirect taxes (indirect taxes less subsidies) attached to factors of production. For example, whereas property taxes, capital taxes and payroll taxes were not included in the valuation of GDP at factor costs, they are included in the

valuation of GDP at basic prices. These production expenses are included in GDP at basic prices, subtracting from them any subsidies attached to factors of production, such as subsidies allocated for job creation and training.

The concept of GDP at basic prices also differs from GDP at market prices, but in this case the difference concerns the taxes and subsidies on the products themselves, such as sales taxes, fuel taxes, duties and taxes on imports, excise taxes on tobacco and alcohol products and subsidies paid on agricultural commodities, transportation services and energy. Whereas production at basic prices excludes taxes and subsidies on products, GDP at market prices includes taxes net of subsidies on products.

Source: http://www.statcan.gc.ca/nea-cen/faq-foq/gdp-pib-eng.htm

APPENDIX C: MATHEMATICAL DERIVATIONS

C1. Relative demand of capital and labor

C1.1 COST-MINIMIZING PROBLEM

The production function of value added is given by equation 3:

3. $$VA_j = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}$$

The producer's problem is to minimize the cost of value added

C001. $WC_j LDC_j + RC_j KDC_j$

subject to 3 and the constraint $VA_j = \overline{VA_j}$. Form the Lagrangian

C002. $$\Lambda = WC_j LDC_j + RC_j KDC_j - \lambda\left(VA_j - \overline{VA_j}\right)$$

C003. $$\Lambda = WC_j LDC_j + RC_j KDC_j - \lambda\left(B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}} - \overline{VA_j}\right)$$

First order conditions are:

C004. $$\frac{\partial \Lambda}{\partial \lambda} = -\left(VA_j - \overline{VA_j}\right) = 0$$

C005. $$\frac{\partial \Lambda}{\partial LDC_j} = WC_j - \lambda\left(\frac{\partial VA_j}{\partial LDC_j}\right) = 0$$

C006. $$\frac{\partial \Lambda}{\partial KDC_j} = RC_j - \lambda\left(\frac{\partial VA_j}{\partial KDC_j}\right) = 0$$

with

C007. $$\frac{\partial VA_j}{\partial LDC_j} = \frac{\partial}{\partial LDC_j} B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}$$

C008. $$\frac{\partial VA_j}{\partial LDC_j} = B_j^{VA}\left(\frac{-1}{\rho_j^{VA}}\right)\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1}\left(-\rho_j^{VA}\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}\right)$$

C009. $$\frac{\partial VA_j}{\partial LDC_j} = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1}\left(\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}\right)$$

Likewise,

C010. $$\frac{\partial VA_j}{\partial KDC_j} = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1}\left(\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}\right)$$

C1.2 RELATIVE DEMAND

It follows from equations C005, C006, C009, and C010 that

C011. $$\frac{WC_j}{RC_j} = \frac{B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1}\left(\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}\right)}{B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1}\left(\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}\right)}$$

C012. $$\frac{WC_j}{RC_j} = \frac{\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}}{\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}}$$

C013. $$\left(\frac{LDC_j}{KDC_j}\right)^{-\rho_j^{VA}-1} = \frac{1-\beta_j^{VA}}{\beta_j^{VA}}\frac{WC_j}{RC_j}$$

C014. $$\frac{LDC_j}{KDC_j} = \left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\frac{WC_j}{RC_j}\right)^{-\frac{1}{\rho_j^{VA}+1}}$$

Substituting $\sigma_j^{VA} = \frac{1}{\rho_j^{VA}+1}$, equation 4 follows

4. $$LDC_j = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}}\frac{RC_j}{WC_j}\right]^{\sigma_j^{VA}} KDC_j$$

C1.3 ELASTICITY OF SUBSTITUTION

In C1.2 above, nothing was said about the interpretation of $\sigma_j^{VA} = \frac{1}{\rho_j^{VA}+1}$. Here we show that σ_j^{VA} is indeed the elasticity of substitution. The elasticity of substitution between composite labor and composite capital is defined as

C015. $$\frac{\partial \ln\left(\frac{LDC_j}{KDC_j}\right)}{\partial \ln\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)} = \frac{\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)}{\left(\frac{LDC_j}{KDC_j}\right)} \frac{\partial\left(\frac{LDC_j}{KDC_j}\right)}{\partial\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)}$$

where $\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}$ is the marginal rate of substitution between composite labor and composite capital ($MRS_j^{LDC,KDC}$):

C016. $$MRS_j^{LDC,KDC} = -\frac{d\ LDC_j}{d\ kDC_j} = \frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}$$

Substitute from equations C009 and C010,

$$\text{C017.}\quad MRS_j^{LDC,KDC} = \frac{B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1} \left(\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}\right)}{B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}}\right]^{\frac{-1}{\rho_j^{VA}}-1} \left(\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}\right)}$$

$$\text{C018.}\quad MRS_j^{LDC,KDC} = \frac{\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}}{\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}}$$

The elasticity of substitution is therefore

$$\text{C019.}\quad \frac{\partial \ln\left(\frac{LDC_j}{KDC_j}\right)}{\partial \ln\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)} = \frac{\left(\frac{\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}}{\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}}\right)}{\left(\frac{LDC_j}{KDC_j}\right)} \frac{\partial\left(\frac{LDC_j}{KDC_j}\right)}{\partial\left(\frac{\left(1-\beta_j^{VA}\right) KDC_j^{-\rho_j^{VA}-1}}{\beta_j^{VA} LDC_j^{-\rho_j^{VA}-1}}\right)}$$

$$\text{C020.}\quad \frac{\partial \ln\left(\frac{LDC_j}{KDC_j}\right)}{\partial \ln\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)} = \frac{\left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\right)\left(\frac{KDC_j}{LDC_j}\right)^{-\rho_j^{VA}-1}}{\left(\frac{LDC_j}{KDC_j}\right)} \left[\frac{\partial\left(\left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\right)\left(\frac{KDC_j}{LDC_j}\right)^{-\rho_j^{VA}-1}\right)}{\partial\left(\frac{LDC_j}{KDC_j}\right)}\right]^{-1}$$

Noting that $\left(\frac{KDC_j}{LDC_j}\right)^{-\rho_j^{VA}-1} = \left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}+1}$, simplify as

C021. $$\frac{\partial \ln\left(\frac{LDC_j}{KDC_j}\right)}{\partial \ln\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)} = \frac{\left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\right)\left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}+1}}{\left(\frac{LDC_j}{KDC_j}\right)} \left[\frac{\partial\left(\left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\right)\left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}+1}\right)}{\partial\left(\frac{LDC_j}{KDC_j}\right)}\right]^{-1}$$

C022. $$\frac{\partial \ln\left(\frac{LDC_j}{KDC_j}\right)}{\partial \ln\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)} = \frac{\left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\right)\left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}+1}}{\left(\frac{LDC_j}{KDC_j}\right)} \left(\frac{1-\beta_j^{VA}}{\beta_j^{VA}}\right)^{-1}\left[\left(\rho_j^{VA}+1\right)\left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}}\right]^{-1}$$

C023. $$\frac{\partial \ln\left(\frac{LDC_j}{KDC_j}\right)}{\partial \ln\left(\frac{\partial VA_j/\partial KDC_j}{\partial VA_j/\partial LDC_j}\right)} = \left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}}\left[\left(\rho_j^{VA}+1\right)\left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}}\right]^{-1} = \frac{1}{\rho_j^{VA}+1}$$

Hence $\sigma_j^{VA} = \frac{1}{\rho_j^{VA}+1}$ is indeed the elasticity of substitution.

C2. Labor demand by category

C2.1 WAGE BILL MINIMIZING PROBLEM

The aggregator function of composite labor is given by equation 5:

5. $$LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

The producer's problem is to minimize the wage bill $\sum_l WTI_{l,j} LD_{l,j}$ subject to equation 5 and the constraint $LDC_j = \overline{LDC_j}$. Form the Lagrangian

C024. $\Lambda = \sum_l WTI_{l,j} LD_{l,j} - \lambda\left(LDC_J - \overline{LDC_j}\right)$

C025. $\Lambda = \sum_l WTI_{l,j} LD_{l,j} - \lambda\left\{B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}} - \overline{LDC_j}\right\}$

First order conditions are:

C026. $\frac{\partial \Lambda}{\partial \lambda} = -\left(LDC_J - \overline{LDC_j}\right) = 0$

C027. $\frac{\partial \Lambda}{\partial LD_{lj,j}} = WTI_{lj,j} - \lambda \frac{\partial LDC_j}{\partial LD_{lj,j}} = 0$

with

C028. $\frac{\partial LDC_j}{\partial LD_{lj,j}} = \frac{\partial}{\partial LD_{lj,j}} B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$

C029. $\frac{\partial LDC_j}{\partial LD_{lj,j}} = B_j^{LD}\left(-\frac{1}{\rho_j^{LD}}\right)\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}-1}\left(-\rho_j^{LD}\beta_{lj,j}^{LD}\ LD_{lj,j}^{-\rho_j^{LD}-1}\right)$

C030. $\frac{\partial LDC_j}{\partial LD_{lj,j}} = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}-1}\left(\beta_{lj,j}^{LD}\ LD_{lj,j}^{-\rho_j^{LD}-1}\right)$

C2.2 RELATIVE LABOR DEMAND

It follows from equations C027 and C030 that

C031. $$\frac{WTI_{li,j}}{WTI_{lj,j}} = \frac{B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}-1}\left(\beta_{li,j}^{LD}\ LD_{li,j}^{-\rho_j^{LD}-1}\right)}{B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}-1}\left(\beta_{lj,j}^{LD}\ LD_{lj,j}^{-\rho_j^{LD}-1}\right)}$$

C032. $$\frac{WTI_{li,j}}{WTI_{lj,j}} = \frac{\beta_{li,j}^{LD}\ LD_{li,j}^{-\rho_j^{LD}-1}}{\beta_{lj,j}^{LD}\ LD_{lj,j}^{-\rho_j^{LD}-1}}$$

C033. $$\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)^{-\rho_j^{LD}-1} = \frac{\beta_{lj,j}^{LD}\ WTI_{li,j}}{\beta_{li,j}^{LD}\ WTI_{lj,j}}$$

C034. $$\frac{LD_{li,j}}{LD_{lj,j}} = \left(\frac{\beta_{lj,j}^{LD}\ WTI_{li,j}}{\beta_{li,j}^{LD}\ WTI_{lj,j}}\right)^{\frac{1}{-\rho_j^{LD}-1}}$$

Substituting $\sigma_j^{LD} = \frac{1}{\rho_j^{LD}+1}$, it follows that

C035. $$\frac{LD_{li,j}}{LD_{lj,j}} = \left(\frac{\beta_{lj,j}^{LD}\ WTI_{li,j}}{\beta_{li,j}^{LD}\ WTI_{lj,j}}\right)^{-\sigma_j^{LD}} = \left(\frac{\beta_{li,j}^{LD}\ WTI_{lj,j}}{\beta_{lj,j}^{LD}\ WTI_{li,j}}\right)^{\sigma_j^{LD}}$$

C036. $$LD_{li,j} = \left(\frac{\beta_{li,j}^{LD}\ WTI_{lj,j}}{\beta_{lj,j}^{LD}\ WTI_{li,j}}\right)^{\sigma_j^{LD}} LD_{lj,j}$$

C2.3 UNIT COST OF COMPOSITE LABOR

Remembering that $\sigma_j^{LD} = \frac{1}{\rho_j^{LD}+1}$, and substituting equation C036 into 5,

C037. $$LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\left(\left(\frac{\beta_{l,j}^{LD}\ WTI_{lj,j}}{\beta_{lj,j}^{LD}\ WTI_{l,j}}\right)^{\frac{1}{\rho_j^{LD}+1}} LD_{lj,j}\right)^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

C038. $$LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\left(\frac{\beta_{l,j}^{LD}\ WTI_{lj,j}}{\beta_{lj,j}^{LD}\ WTI_{l,j}}\right)^{-\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} LD_{lj,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

C039. $$LDC_j = LD_{lj,j}B_j^{LD}\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{1-\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}}\right)^{-\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

C040. $$LDC_j = LD_{lj,j}\left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}}\right)^{\frac{1}{\rho_j^{LD}+1}} B_j^{LD}\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

C041. $$LD_{lj,j} = \frac{LDC_j}{B_j^{LD}}\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}\right]^{\frac{1}{\rho_j^{LD}}} \left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}}\right)^{-\frac{1}{\rho_j^{LD}+1}}$$

Now, the unit cost of composite labor is defined by equation 69

69. $$WC_j = \frac{\sum_l WTI_{l,j} LD_{l,j}}{LDC_j}$$

Substituting $LD_{lj,j}$ from equation C041 for $LD_{l,j}$ in equation 69 yields

C042. $$WC_j = \frac{1}{B_j^{LD}} \left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \right]^{\frac{1}{\rho_j^{LD}}} \left[\sum_{lj} WTI_{lj,j} \left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}} \right)^{-\frac{1}{\rho_j^{LD}+1}} \right]$$

C043. $$WC_j = \frac{1}{B_j^{LD}} \left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \right]^{\frac{1}{\rho_j^{LD}}} \left[\sum_{lj} \left(\beta_{lj,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{lj,j}\right)^{1-\frac{1}{\rho_j^{LD}+1}} \right]$$

where

C044. $$\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \right] \equiv \left[\sum_{lj} \left(\beta_{lj,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{lj,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \right]$$

Hence,

C045. $$WC_j = \frac{1}{B_j^{LD}} \left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \right]^{1+\frac{1}{\rho_j^{LD}}}$$

C046. $$WC_j = \frac{1}{B_j^{LD}} \left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \right]^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}$$

Using $\sigma_j^{LD} = \dfrac{1}{\rho_j^{LD}+1}$,

C047. $$WC_j = \frac{1}{B_j^{LD}}\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\sigma_j^{LD}} \left(WTI_{l,j}\right)^{1-\sigma_j^{LD}}\right]^{\frac{1}{1-\sigma_j^{LD}}}$$

C2.4 LABOR DEMAND FOR A SINGLE CATEGORY IN TERMS OF RELATIVE WAGE RATES

From equation C047, it follows that

C048. $$\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\sigma_j^{LD}} \left(WTI_{l,j}\right)^{1-\sigma_j^{LD}}\right]^{\frac{\sigma_j^{LD}}{1-\sigma_j^{LD}}} = \left(B_j^{LD}\right)^{\sigma_j^{LD}} WC_j^{\sigma_j^{LD}}$$

Substituting equation C048 into equation C0141 yields

C049. $$LD_{lj,j} = \frac{LDC_j}{B_j^{LD}}\left(B_j^{LD}\right)^{\sigma_j^{LD}} WC_j^{\sigma_j^{LD}} \left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}}\right)^{-\sigma_j^{LD}}$$

After rearranging, equation 6 follows.

6. $$LD_{l,j} = \left[\frac{\beta_{l,j}^{LD}\, WC_j}{WTI_{l,j}}\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j$$

C2.5 ELASTICITY OF SUBSTITUTION

In C2.2 above, nothing was said about the interpretation of $\sigma_j^{LD} = \dfrac{1}{\rho_j^{LD}+1}$. Here we show that σ_j^{LD} is indeed the elasticity of substitution. The elasticity of substitution between type *li* and type *lj* labor is defined as

C050. $$\frac{\partial \ln\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial \ln\left(\frac{\partial LDC_j/\partial LD_{lj,j}}{\partial LDC_j/\partial LD_{li,j}}\right)} = \frac{\left(\frac{\partial LDC_j/\partial LD_{lj,j}}{\partial LDC_j/\partial LD_{li,j}}\right)}{\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)} \frac{\partial\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial\left(\frac{\partial LDC_j/\partial LD_{lj,j}}{\partial LDC_j/\partial LD_{li,j}}\right)}$$

where $\frac{\partial LDC_j/\partial LD_{lj,j}}{\partial LDC_j/\partial LD_{li,j}}$ is the marginal rate of substitution between *li* and *lj* in industry *j* ($MRS_j^{li,lj}$):

C051. $$MRS_j^{li,lj} = -\frac{dLD_{li,j}}{dLD_{lj,j}} = \frac{\partial LDC_j/\partial LD_{lj,j}}{\partial LDC_j/\partial LD_{li,j}}$$

Substitute from equation C030,

C052. $$MRS_j^{li,lj} = -\frac{dLD_{li,j}}{dLD_{lj,j}} = \frac{B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}-1}\left(\beta_{lj,j}^{LD}\ LD_{lj,j}^{-\rho_j^{LD}-1}\right)}{B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\ LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}-1}\left(\beta_{li,j}^{LD}\ LD_{li,j}^{-\rho_j^{LD}-1}\right)}$$

C053. $$MRS_j^{li,lj} = -\frac{dLD_{li,j}}{dLD_{lj,j}} = \frac{\left(\beta_{lj,j}^{LD}\ LD_{lj,j}^{-\rho_j^{LD}-1}\right)}{\left(\beta_{li,j}^{LD}\ LD_{li,j}^{-\rho_j^{LD}-1}\right)} = \frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\left(\frac{LD_{lj,j}}{LD_{li,j}}\right)^{-\rho_j^{LD}-1}$$

The elasticity of substitution is therefore

C054. $$\frac{\partial \ln\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial \ln\left(\frac{\partial LDC_j/\partial LD_{lj,j}}{\partial LDC_j/\partial LD_{li,j}}\right)} = \frac{\frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\left(\frac{LD_{lj,j}}{LD_{li,j}}\right)^{-\rho_j^{LD}-1}}{\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)} \frac{\partial\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial\left(\frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\left(\frac{LD_{lj,j}}{LD_{li,j}}\right)^{-\rho_j^{LD}-1}\right)}$$

C055. $$\frac{\partial \ln\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial \ln\left(\frac{\partial LDC_j / \partial LD_{lj,j}}{\partial LDC_j / \partial LD_{li,j}}\right)} = \frac{\frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\left(\frac{LD_{lj,j}}{LD_{li,j}}\right)^{-\rho_j^{LD}-1}}{\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}\left[\frac{\partial\left(\frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\left(\frac{LD_{lj,j}}{LD_{li,j}}\right)^{-\rho_j^{LD}-1}\right)}{\partial\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}\right]^{-1}$$

Noting that $\left(\frac{LD_{lj,j}}{LD_{li,j}}\right)^{-\rho_j^{LD}-1} = \left(\frac{LD_{li,j}}{LD_{lj,j}}\right)^{\rho_j^{LD}+1}$, simplify as

C056. $$\frac{\partial \ln\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial \ln\left(\frac{\partial LDC_j / \partial LD_{lj,j}}{\partial LDC_j / \partial LD_{li,j}}\right)} = \frac{\frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)^{\rho_j^{LD}+1}}{\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}\left(\frac{\beta_{lj,j}^{LD}}{\beta_{li,j}^{LD}}\right)^{-1}\left[\frac{\partial\left(\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)^{\rho_j^{LD}+1}\right)}{\partial\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}\right]^{-1}$$

C057. $$\frac{\partial \ln\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)}{\partial \ln\left(\frac{\partial LDC_j / \partial LD_{lj,j}}{\partial LDC_j / \partial LD_{li,j}}\right)} = \left(\frac{LD_{li,j}}{LD_{lj,j}}\right)^{\rho_j^{LD}}\left[\left(\rho_j^{LD}+1\right)\left(\frac{LD_{li,j}}{LD_{lj,j}}\right)^{\rho_j^{LD}}\right]^{-1} = \frac{1}{\rho_j^{LD}+1}$$

Hence $\sigma_j^{LD} = \frac{1}{\rho_j^{LD}+1}$ is indeed the elasticity of substitution.

C3. Demand for capital by category

The CES aggregator function of composite capital has the same form as the aggregator function of composite labor. It is straightforward to rewrite the developments of C2 for the demand of type *k* capital by industry *j*.

C4. Stone-Geary utility and the demand for consumer goods

The utility function of the representative agent of type *h* households is a Stone-Geary utility function:

C058. $U_h = \prod_i \left(C_{i,h} - C_{i,h}^{MIN}\right)^{\gamma_{i,h}^{LES}}$, where

C059. $\sum_i \gamma_{i,h}^{LES} = 1$

Utility function C058 is equivalent to

C060. $\ln U_h = \sum_i \gamma_{i,h}^{LES} \ln\left(C_{i,h} - C_{i,h}^{MIN}\right)$

The representative household maximizes utility subject to the budget constraint

C061. $\sum_i PC_i C_{i,h} = CTH_h$

Form the Lagrangian:

C062. $\Lambda = \sum_i \gamma_{i,h}^{LES} \ln\left(C_{i,h} - C_{i,h}^{MIN}\right) - \lambda\left(\sum_i PC_i C_{i,h} - CTH_h\right)$

The first-order conditions are:

C063. $\frac{\partial \Lambda}{\partial \lambda} = -\left(\sum_i PC_i C_{i,h} - CTH_h\right) = 0$

C064. $\frac{\partial \Lambda}{\partial C_{i,h}} = \frac{\gamma_{i,h}^{LES}}{\left(C_{i,h} - C_{i,h}^{MIN}\right)} - \lambda\ PC_i = 0$

First-order condition equation C064 is equivalent to

C065. $\lambda\ PC_i\left(C_{i,h} - C_{i,h}^{MIN}\right) = \gamma_{i,h}^{LES}$

Summing equation C065 over *i*, remembering equation C059, yields

C066. $\lambda \sum_i PC_i\left(C_{i,h} - C_{i,h}^{MIN}\right) = \sum_i \gamma_{i,h}^{LES} = 1$

C067. $\sum_i PC_i\left(C_{i,h} - C_{i,h}^{MIN}\right) = \frac{1}{\lambda}$

And, given first-order condition equation C063,

C068. $CTH_h - \sum_i PC_i C_{i,h}^{MIN} = \frac{1}{\lambda}$

Substituting equation C068 into equation C067 and rearranging, one obtains demand function equation 52:

52. $PC_i\ C_{i,h} = PC_i\ C_{i,h}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_h - \sum_{ij} PC_{ij}\ C_{ij,h}^{MIN}\right)$

It should be mentioned in passing that methods of calibration of the Linear Expenditure System parameters often make use of the Frisch parameter, given by: $-\lambda\ CTH_h = -\frac{CTH_h}{CTH_h - \sum_i PC_i C_{i,h}^{MIN}}$.

C5. Allocation of aggregate output to product supplies

C5.1 SALES REVENUE MAXIMIZING PROBLEM

The aggregator function of production sold on the domestic market and exported is given by equation 58:

58. $XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\ XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$

The producer's problem is to maximize sales revenue $\sum_i P_{j,i} XS_{j,i}$ subject to equation 58 and the constraint $XST_j = \overline{XST_j}$. Form the Lagrangian

C069. $\Lambda = \sum_i P_{j,i} XS_{j,i} - \lambda\left(XST_j - \overline{XST_j}\right)$

C070. $\Lambda = \sum_i P_{j,i} XS_{j,i} - \lambda\left(B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\ XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}} - \overline{XST_j}\right)$

First order conditions are:

C071. $$\frac{\partial \Lambda}{\partial \lambda} = -\left(XST_j - \overline{XST_j}\right) = 0$$

C072. $$\frac{\partial \Lambda}{\partial\ XS_{j,i}} = P_{j,i} - \lambda \frac{\partial\ XST_j}{\partial\ XS_{j,i}}$$

with

C073. $$\frac{\partial\ XST_j}{\partial\ XS_{j,ij}} = \frac{\partial}{\partial\ XS_{j,ij}} B_j^{XT} \left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}}$$

C074. $$\frac{\partial\ XST_j}{\partial\ XS_{j,ij}} = B_j^{XT} \left(\frac{1}{\rho_j^{XT}} \right) \left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}-1} \left(\rho_j^{XT} \beta_{j,ij}^{XT} XS_{j,ij}^{\rho_j^{XT}-1} \right)$$

C075. $$\frac{\partial\ XST_j}{\partial\ XS_{j,ij}} = B_j^{XT} \left[\sum_i \beta_j^{XT} XS_{j,i}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}-1} \left(\beta_{j,ij}^{XT} XS_{j,ij}^{\rho_j^{XT}-1} \right)$$

C5.2 RELATIVE SUPPLY OF PRODUCTS

It follows from equations C072 and C075 that

C076. $$\frac{P_{j,ii}}{P_{j,ij}} = \frac{B_j^{XT} \left[\sum_i \beta_j^{XT} XS_{j,i}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}-1} \left(\beta_{j,ii}^{XT} XS_{j,ii}^{\rho_j^{XT}-1} \right)}{B_j^{XT} \left[\sum_i \beta_j^{XT} XS_{j,i}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}-1} \left(\beta_{j,ij}^{XT} XS_{j,ij}^{\rho_j^{XT}-1} \right)}$$

C077. $$\frac{P_{j,ii}}{P_{j,ij}} = \frac{\left(\beta_{j,ii}^{XT} XS_{j,ii}^{\rho_j^{XT}-1} \right)}{\left(\beta_{j,ij}^{XT} XS_{j,ij}^{\rho_j^{XT}-1} \right)} = \frac{\beta_{j,ii}^{XT}}{\beta_{j,ij}^{XT}} \left(\frac{XS_{j,ii}}{XS_{j,ij}} \right)^{\rho_j^{XT}-1}$$

C078. $$\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)^{\rho_j^{XT}-1} = \frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\frac{P_{j,ii}}{P_{j,ij}}$$

C079. $$\frac{XS_{j,ii}}{XS_{j,ij}} = \left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\frac{P_{j,ii}}{P_{j,ij}}\right)^{\frac{1}{\rho_j^{XT}-1}}$$

Substituting $\sigma_j^{XT} = \frac{1}{\rho_j^{XT}-1}$, it follows that:

C080. $$\frac{XS_{j,ii}}{XS_{j,ij}} = \left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\frac{P_{j,ii}}{P_{j,ij}}\right)^{\sigma_j^{XT}}$$

C081. $$XS_{j,ii} = \left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\frac{P_{j,ii}}{P_{j,ij}}\right)^{\sigma_j^{XT}} XS_{j,ij}$$

C5.3 PRICE OF AGGREGATE OUTPUT

Remembering that $\sigma_j^{XT} = \frac{1}{\rho_j^{XT}-1}$, and substituting equation C081 into equation 58,

C082. $$XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\left(\left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,i}^{XT}}\frac{P_{j,i}}{P_{j,ij}}\right)^{\frac{1}{\rho_j^{XT}-1}} XS_{j,ij}\right)^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

C083. $$XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,i}^{XT}}\frac{P_{j,i}}{P_{j,ij}}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} XS_{j,ij}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

C084. $$XST_j = B_j^{XT} XS_{j,ij}\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{1-\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \left(\frac{\beta_{j,ij}^{XT}}{P_{j,ij}}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\right]^{\frac{1}{\rho_j^{XT}}}$$

C085. $$XST_j = B_j^{XT} XS_{j,ij}\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \left(\frac{P_{j,ij}}{\beta_{j,ij}^{XT}}\right)^{-\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\right]^{\frac{1}{\rho_j^{XT}}}$$

C086. $$XST_j = B_j^{XT} XS_{j,ij}\left(\frac{P_{j,ij}}{\beta_{j,ij}^{XT}}\right)^{-\frac{1}{\rho_j^{XT}-1}}\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{1-\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\right]^{\frac{1}{\rho_j^{XT}}}$$

C087. $$XS_{j,ij} = \frac{XST_j}{B_j^{XT}}\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\right]^{-\frac{1}{\rho_j^{XT}}} \left(\frac{P_{j,ij}}{\beta_{j,ij}^{XT}}\right)^{\frac{1}{\rho_j^{XT}-1}}$$

Now, the price of the aggregate output is defined by equation 74

74. $$PT_j = \frac{\sum_i P_{j,i}\ XS_{j,i}}{XST_j}$$

Substituting $XS_{j,ij}$ from equation C087 for $XS_{j,i}$ in equation 74 yields

C088. $$PT_j = \frac{1}{B_j^{XT}} \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{-\frac{1}{\rho_j^{XT}}} \left[\sum_{ij} P_{j,ij} \left(\frac{P_{j,ij}}{\beta_{j,ij}^{XT}} \right)^{\frac{1}{\rho_j^{XT}-1}} \right]$$

C089. $$PT_j = \frac{1}{B_j^{XT}} \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{-\frac{1}{\rho_j^{XT}}} \left[\sum_{ij} \left(\beta_{j,ij}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,ij}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]$$

where

C090. $$\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right] \equiv \left[\sum_{ij} \left(\beta_{j,ij}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,ij}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]$$

Hence,

C091. $$PT_j = \frac{1}{B_j^{XT}} \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{1-\frac{1}{\rho_j^{XT}}}$$

C092. $$PT_j = \frac{1}{B_j^{XT}} \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}}$$

Given $\sigma_j^{XT} = \frac{1}{\rho_j^{XT}-1}$, we have

C093. $$PT_j = \frac{1}{B_j^{XT}} \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\sigma_j^{XT}} \left(P_{j,i}\right)^{\sigma_j^{XT}+1} \right]^{\frac{1}{\sigma_j^{XT}+1}}$$

C5.4 SUPPLY OF INDIVIDUAL PRODUCTS

Using $\sigma_j^{XT} = \frac{1}{\rho_j^{XT}-1}$ and equation C093, one obtains

C094. $$\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{-\frac{1}{\rho_j^{XT}}} = \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\sigma_j^{XT}} \left(P_{j,i}\right)^{\sigma_j^{XT}+1} \right]^{-\frac{\sigma_j^{XT}}{\sigma_j^{XT}+1}}$$

C095. $$\left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{-\frac{1}{\rho_j^{XT}}} = \left(B_j^{XT}\right)^{-\sigma_j^{XT}} PT_j^{-\sigma_j^{XT}}$$

Substituting into equation C087 yields

C096. $$XS_{j,ij} = \frac{XST_j}{B_j^{XT}} \left(B_j^{XT}\right)^{-\sigma_j^{XT}} PT_j^{-\sigma_j^{XT}} \left(\frac{P_{j,ij}}{\beta_{j,ij}^{XT}}\right)^{\sigma_j^{XT}}$$

After rearranging, equation 59 follows:

$$59. \quad XS_{j,i} = \frac{XST_j}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i}}{\beta_{j,i}^{XT} \, PT_j} \right]^{\sigma_j^{XT}}$$

C5.5 ELASTICITY OF TRANSFORMATION

In C5.2 above, nothing was said about the interpretation of $\sigma_j^{XT} = \frac{1}{\rho_j^{XT} - 1}$. Here we show that σ_j^{XT} is indeed the elasticity of transformation.

Here, the elasticity of transformation between products is defined as[13]

$$C097. \quad -\frac{\partial \ln\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial \ln\left(\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}\right)} = -\frac{\left(\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}\right)}{\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)} \frac{\partial\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial\left(\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}\right)}$$

where $\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}$ is the marginal rate of transformation between industry *j*'s products *ii* and *ij* ($MRT_j^{ii,ij}$):

$$C098. \quad MRT_j^{ii,ij} = -\frac{d\ XS_{j.ii}}{d\ XS_{j.ij}} = \frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}$$

Substitute from C077

[13] In microeconomic textbooks, the elasticity of transformation and the elasticity of substitution are identically defined. What differenciates them in practice is that the former is negative, while the latter is positive (think of movement along an two-factor isoquant, compared to movement along a two-goods transformation curve, in response to changes in relative prices: they are in opposite directions). Here the elasticity of transformation is defined with a minus sign, so it will take on positive values.

C099. $$MRT_j^{ii,ij} = -\frac{d\ XS_{j.ii}}{d\ XS_{j.ij}} = \frac{B_j^{XT}\left[\sum_i \beta_j^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}-1}\left(\beta_{j,ij}^{XT} XS_{j,ij}^{\rho_j^{XT}-1}\right)}{B_j^{XT}\left[\sum_i \beta_j^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}-1}\left(\beta_{j,ii}^{XT} XS_{j,ii}^{\rho_j^{XT}-1}\right)}$$

C100. $$MRT_j^{ii,ij} = -\frac{d\ XS_{j.ii}}{d\ XS_{j.ij}} = \frac{\left(\beta_{j,ij}^{XT} XS_{j,ij}^{\rho_j^{XT}-1}\right)}{\left(\beta_{j,ii}^{XT} XS_{j,ii}^{\rho_j^{XT}-1}\right)} = \frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\left(\frac{XS_{j,ij}}{XS_{j,ii}}\right)^{\rho_j^{XT}-1}$$

The elasticity of transformation is therefore

C101. $$-\frac{\partial \ln\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial \ln\left(\frac{\partial XST_j/\partial XS_{j.ij}}{\partial XST_j/\partial XS_{j.ii}}\right)} = -\frac{\left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\left(\frac{XS_{j,ij}}{XS_{j,ii}}\right)^{\rho_j^{XT}-1}\right)}{\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)} \frac{\partial\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial\left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\left(\frac{XS_{j,ij}}{XS_{j,ii}}\right)^{\rho_j^{XT}-1}\right)}$$

C102. $$-\frac{\partial \ln\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial \ln\left(\frac{\partial XST_j/\partial XS_{j.ij}}{\partial XST_j/\partial XS_{j.ii}}\right)} = -\frac{\left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\left(\frac{XS_{j,ij}}{XS_{j,ii}}\right)^{\rho_j^{XT}-1}\right)}{\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)} \left[\frac{\partial\left(\frac{\beta_{j,ij}^{XT}}{\beta_{j,ii}^{XT}}\left(\frac{XS_{j,ij}}{XS_{j,ii}}\right)^{\rho_j^{XT}-1}\right)}{\partial\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}\right]^{-1}$$

Noting that $\left(\frac{XS_{j,ij}}{XS_{j,ii}}\right)^{\rho_j^{XT}-1} = \left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)^{1-\rho_j^{XT}}$, simplify as

C103. $$-\frac{\partial \ln\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial \ln\left(\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}\right)} = -\frac{\left(\frac{\beta^{XT}_{j,ij}}{\beta^{XT}_{j,ii}}\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)^{1-\rho^{XT}_j}\right)}{\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}\left[\frac{\partial\left(\frac{\beta^{XT}_{j,ij}}{\beta^{XT}_{j,ii}}\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)^{1-\rho^{XT}_j}\right)}{\partial\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}\right]^{-1}$$

C104. $$-\frac{\partial \ln\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial \ln\left(\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}\right)} = -\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)^{-\rho^{XT}_j}\left[\left(1-\rho^{XT}_j\right)\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)^{-\rho^{XT}_j}\right]^{-1}$$

C105. $$-\frac{\partial \ln\left(\frac{XS_{j,ii}}{XS_{j,ij}}\right)}{\partial \ln\left(\frac{\partial XST_j / \partial XS_{j.ij}}{\partial XST_j / \partial XS_{j.ii}}\right)} = -\frac{1}{1-\rho^{XT}_j} = \frac{1}{\rho^{XT}_j - 1}$$

Hence $\sigma^{XT}_j = \frac{1}{\rho^{XT}_j - 1}$ is indeed the elasticity of transformation.

C6. Supply on domestic and export markets

C6.1 SALES REVENUE MAXIMIZING PROBLEM

The aggregator function of production sold on the domestic market and exported is given by equation 60:

60. $$XS_{j,i} = B^X_{j,i}\left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}}$$

The producer's problem is to maximize sales revenue of exportable product *i*:

C106. $PE_i \; EX_{j,i} + PL_i \; DS_{j,i}$

subject to 60 and the constraint $XS_{j,i} = \overline{XS_{j,i}}$. Form the Lagrangian

C107. $$\Lambda = PE_i \; EX_{j,i} + PL_i \; DS_{j,i} - \lambda \left(XS_{j,i} - \overline{XS_{j,i}} \right)$$

C108. $$\Lambda = PE_i \; EX_{j,i} + PL_i \; DS_{j,i} - \lambda \left(B^X_{j,i} \left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1 - \beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i} \right]^{\frac{1}{\rho^X_{j,i}}} - \overline{XS_{j,i}} \right)$$

First order conditions are:

C109. $$\frac{\partial \Lambda}{\partial \lambda} = -\left(XS_{j,i} - \overline{XS_{j,i}} \right) = 0$$

C110. $$\frac{\partial \Lambda}{\partial \; EX_{j,i}} = PE_i - \lambda \frac{\partial \; XS_{j,i}}{\partial \; EX_{j,i}}$$

C111. $$\frac{\partial \Lambda}{\partial \; DS_{j,i}} = PL_i - \lambda \frac{\partial \; XS_{j,x}}{\partial \; D_{j,x}}$$

with

C112. $$\frac{\partial \; XS_{j,i}}{\partial \; EX_{j,i}} = \frac{\partial}{\partial \; EX_{j,i}} \left\{ B^X_{j,i} \left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1 - \beta^X_i\right) DS^{\rho^X_{j,i}}_{j,i} \right]^{\frac{1}{\rho^X_{j,i}}} \right\}$$

C113. $$\frac{\partial \; XS_{j,i}}{\partial \; EX_{j,i}} = B^X_{j.i} \frac{1}{\rho^X_{j,i}} \left[\beta^X_{j,i} \; EX^{\rho^X_{j,i}}_{j,i} + \left(1 - \beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i} \right]^{\frac{1}{\rho^X_{j,i}} - 1} \left(\beta^X_{j,i} \; \rho^X_{j,i} \; EX^{\rho^X_{j,i} - 1}_{j,i} \right)$$

C114. $$\frac{\partial \; XS_{j,i}}{\partial \; EX_{j,i}} = B^X_{j.i} \left[\beta^X_{j,i} \; EX^{\rho^X_{j,i}}_{j,i} + \left(1 - \beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i} \right]^{\frac{1}{\rho^X_{j,i}} - 1} \left(\beta^X_{j,i} EX^{\rho^X_{j,i} - 1}_{j,i} \right)$$

and, similarly,

C115. $$\frac{\partial\, XS_{j,i}}{\partial\, DS_{j,i}} = B^X_{j.i}\left[\beta^X_{j,i}\, EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}-1} \left(\left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}-1}_{j,i}\right)$$

C6.2 RELATIVE SUPPLY ON THE DOMESTIC AND EXPORT MARKETS

It follows from C110. C111, C114, and C115 that

C116. $$\frac{PE_i}{PL_i} = \frac{\lambda\, B^X_{j.i}\left[\beta^X_{j,i}\, EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}-1} \left(\beta^X_{j,i}\, EX^{\rho^X_{j,i}-1}_{j,i}\right)}{\lambda\, B^X_{j.i}\left[\beta^X_{j,i}\, EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}-1} \left(\left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}-1}_{j,i}\right)}$$

C117. $$\frac{PE_i}{PL_i} = \frac{\left(\beta^X_{j,i}\, EX^{\rho^X_{j,i}-1}_{j,i}\right)}{\left(\left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}-1}_{j,i}\right)}$$

C118. $$\left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{\rho^X_{j,i}-1} = \frac{\left(1-\beta^X_{j,i}\right) PE_i}{\beta^X_{j,i}\, PL_i}$$

C119. $$\frac{EX_{j,i}}{DS_{j,i}} = \left[\frac{\left(1-\beta^X_{j,i}\right) PE_i}{\beta^X_{j,i}\, PL_i}\right]^{\frac{1}{\rho^X_{j,i}-1}}$$

Substituting $\sigma^X_{j,i} = \dfrac{1}{\rho^X_{j,i}-1}$, equation 61 follows:

61. $$EX_{j,i} = \left[\frac{1-\beta^X_{j,i}}{\beta^X_{j,i}} \frac{PE_i}{PL_i}\right]^{\sigma^X_{j,i}} DS_{j,i}$$

C6.3 ELASTICITY OF TRANSFORMATION

In C2.3 above, nothing was said about the interpretation of $\sigma^X_{j,i} = \frac{1}{\rho^X_{j,i} - 1}$. Here we show that $\sigma^X_{j,i}$ is indeed the elasticity of transformation.

Here, the elasticity of transformation between production sold on the domestic market and production exported is defined as[14]

$$\text{C120.} \quad -\frac{\partial \ln\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial \ln\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)} = -\frac{\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)}{\left(\frac{EX_{j,i}}{DS_{j,i}}\right)} \frac{\partial\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)}$$

where $\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}$ is the marginal rate of transformation between production sold locally and exported ($MRT^{EX,DS}_{j,i}$):

$$\text{C121.} \quad MRT^{EX,DS}_{j,i} = -\frac{d\ EX_{j,i}}{d\ DS_{j,i}} = \frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}$$

Substitute from equations C114 and C115

$$\text{C122.} \quad MRT^{EX,DS}_{j,i} = -\frac{d\ EX_{j,i}}{d\ DS_{j,i}} = \frac{B^X_{j.i}\left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}-1} \left(\left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}-1}_{j,i}\right)}{B^X_{j.i}\left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,i}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}-1} \left(\beta^X_{j,i} EX^{\rho^X_{j,i}-1}_{j,i}\right)}$$

[14] In microeconomic textbooks, the elasticity of transformation and the elasticity of substitution are identically defined. What differenciates them in practice is that the former is negative, while the latter is positive (think of movement along an two-factor isoquant, compared to movement along a two-goods transformation curve, in response to changes in relative prices: they are in opposite directions). Here the elasticity of transformation is defined with a minus sign, so it will take on positive values.

C123. $$MRT_{j,i}^{EX,DS} = -\frac{d\ EX_{j,i}}{d\ DS_{j,i}} = \left(\frac{1-\beta_{j,u}^{X}}{\beta_{j,u}^{X}}\right)\left(\frac{DS_{j,i}}{EX_{j,i}}\right)^{\rho_{j,i}^{X}-1}$$

The elasticity of transformation is therefore

C124. $$-\frac{\partial \ln\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial \ln\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)} = -\frac{\left(\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\right)\left(\frac{DS_{j,i}}{EX_{j,i}}\right)^{\rho_{j,i}^{X}-1}}{\left(\frac{EX_{j,i}}{DS_{j,i}}\right)} \frac{\partial\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial\left(\left(\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\right)\left(\frac{DS_{j,i}}{EX_{j,i}}\right)^{\rho_{j,i}^{X}-1}\right)}$$

C125. $$-\frac{\partial \ln\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial \ln\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)} = -\frac{\left(\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\right)\left(\frac{DS_{j,i}}{EX_{j,i}}\right)^{\rho_{j,i}^{X}-1}}{\left(\frac{EX_{j,i}}{DS_{j,i}}\right)} \left[\frac{\partial\left(\left(\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\right)\left(\frac{DS_{j,i}}{EX_{j,i}}\right)^{\rho_{j,i}^{X}-1}\right)}{\partial\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}\right]^{-1}$$

Noting that $\left(\frac{DS_{j,i}}{EX_{j,i}}\right)^{\rho_{j,i}^{X}-1} = \left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{1-\rho_{j,i}^{X}}$, simplify as

C126. $$-\frac{\partial \ln\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial \ln\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)} = -\frac{\left(\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\right)\left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{1-\rho_{j,i}^{X}}}{\left(\frac{EX_{j,x}}{DS_{j,x}}\right)} \left(\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\right)^{-1} \left[\frac{\partial\left(\left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{1-\rho_{j,i}^{X}}\right)}{\partial\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}\right]^{-1}$$

C127. $$-\frac{\partial \ln\left(\frac{EX_{j,i}}{DS_{j,i}}\right)}{\partial \ln\left(\frac{\partial XS_{j,i}/\partial DS_{j,i}}{\partial XS_{j,i}/\partial EX_{j,i}}\right)} = -\left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{\rho^X_{j,x}} \left[\left(1-\rho^X_{j,i}\right)\left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{\rho^X_{j,i}}\right]^{-1} = -\frac{1}{1-\rho^X_{j,i}} = \frac{1}{\rho^X_{j,i}-1}$$

Hence $\sigma^X_{j,i} = \frac{1}{\rho^X_{j,i}-1}$ is indeed the elasticity of transformation.

C7. Demand for local products and imports

C7.1 Expenditure minimizing problem

The aggregator function of composite commodity is given by equation 63:

63. $$Q_i = B^M_i \left[\beta^M_i IM_i^{-\rho^M_i} + \left(1-\beta^M_i\right) DD_i^{-\rho^M_i}\right]^{\frac{-1}{\rho^M_i}}$$

The buyer's problem is to minimize expenditure on the composite commodity

C128. $PM_i\ IM_i + PD_i\ DD_i$

subject to 63 and the constraint $Q_i = \overline{Q_i}$. Form the Lagrangian

C129. $\Lambda = PM_i\ IM_i + PD_i\ DD_i - \lambda\left(Q_i - \overline{Q_i}\right)$

C130. $$\Lambda = PM_i\ IM_i + PD_i\ DD_i - \lambda\left(B^M_i\left[\beta^M_i IM_i^{-\rho^M_i} + \left(1-\beta^M_i\right) DD_i^{-\rho^M_i}\right]^{\frac{-1}{\rho^M_i}} - \overline{Q_i}\right)$$

First order conditions are:

C131. $$\frac{\partial \Lambda}{\partial \lambda} = -\lambda\left(Q_i - \overline{Q_i}\right) = 0$$

C132. $$\frac{\partial \Lambda}{\partial\ IM_i} = PM_i - \lambda \frac{\partial Q_i}{\partial\ IM_i} = 0$$

C133. $$\frac{\partial \Lambda}{\partial\ DD_i} = PD_i - \lambda \frac{\partial Q_i}{\partial\ DD_i} = 0$$

with

C134. $$\frac{\partial Q_i}{\partial\ IM_i} = B_i^M \frac{\partial}{\partial\ IM_i}\left[\beta_i^M\, IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{\frac{-1}{\rho_i^M}}$$

C135. $$\frac{\partial Q_i}{\partial\ IM_i} = B_i^M \left(\frac{-1}{\rho_i^M}\right)\left[\beta_i^M\, IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(-\rho_i^M \left(\beta_i^M\, IM_i^{-\rho_i^M-1}\right)\right)$$

C136. $$\frac{\partial Q_i}{\partial\ IM_i} = B_i^M \left[\beta_i^M\, IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(\beta_i^M\, IM_i^{-\rho_i^M-1}\right)$$

Likewise,

C137. $$\frac{\partial Q_i}{\partial\ DD_i} = B_i^M \left[\beta_i^M\, IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(1-\beta_i^M\right)\left(DD_i^{-\rho_i^M-1}\right)$$

C7.2 RELATIVE DEMAND FOR LOCAL PRODUCTS AND IMPORTS

It follows from equations C132, C133, C136, and C137 that

C138. $$\frac{PM_i}{PD_i} = \frac{B_i^M \left[\beta_i^M\, IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(\beta_i^M\, IM_i^{-\rho_i^M-1}\right)}{B_i^M \left[\beta_i^M\, IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(1-\beta_i^M\right)\left(DD_i^{-\rho_i^M-1}\right)}$$

C139. $$\frac{PM_i}{PD_i} = \left(\frac{\beta_i^M}{1-\beta_i^M}\right)\left(\frac{IM_i}{DD_i}\right)^{-\rho_i^M-1}$$

C140. $$\left(\frac{IM_i}{DD_i}\right)^{-\rho_i^M-1} = \left(\frac{1-\beta_i^M}{\beta_i^M}\right)\frac{PM_i}{PD_i}$$

C141. $$\frac{IM_i}{DD_i} = \left[\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\frac{PM_i}{PD_i}\right]^{\frac{1}{-\rho_i^M-1}} = \left[\left(\frac{\beta_i^M}{1-\beta_i^M}\right)\frac{PD_i}{PM_i}\right]^{\frac{1}{\rho_i^M+1}}$$

Substituting $\sigma_i^M = \frac{1}{\rho_i^M+1}$, equation 64 follows

64. $$IM_i = \left[\frac{\beta_i^M}{1-\beta_i^M}\frac{PD_i}{PM_i}\right]^{\sigma_i^M} DD_i$$

C7.3 ELASTICITY OF SUBSTITUTION

In C7.2 above, nothing was said about the interpretation of $\sigma_i^M = \frac{1}{\rho_i^M+1}$. Here we show that σ_i^M is indeed the elasticity of substitution. The elasticity of substitution between imported and locally produced commodity *i* is defined as

C142. $$\frac{\partial \ln\left(\frac{IM_i}{DD_i}\right)}{\partial \ln\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)} = \frac{\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)}{\left(\frac{IM_i}{DD_i}\right)} \frac{\partial\left(\frac{IM_i}{DD_i}\right)}{\partial\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)}$$

where $\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}$ is the marginal rate of substitution between imported and locally produced commodity *i* ($MRS_i^{IM,DD}$):

C143. $$MRS_i^{IM,DD} = -\frac{d\ IM_i}{d\ DD_i} = \frac{\partial Q_i / \partial DD_i}{\partial Q_i / \partial IM_i}$$

Substitute from C136 and C137

C144. $$MRS_i^{IM,DD} = -\frac{d\ IM_i}{d\ DD_i} = \frac{B_i^M \left[\beta_i^M IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(1-\beta_i^M\right) \left(DD_i^{-\rho_i^M-1} \right)}{B_i^M \left[\beta_i^M IM_i^{-\rho_i^M} + \left(1-\beta_i^M\right) DD_i^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}-1} \left(\beta_i^M IM_i^{-\rho_i^M-1} \right)}$$

C145. $$MRS_i^{IM,DD} = -\frac{d\ IM_i}{d\ DD_i} = \left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{DD_i}{IM_i}\right)^{-\rho_i^M-1}$$

The elasticity of substitution is therefore

C146. $$\frac{\partial \ln\left(\frac{IM_i}{DD_i}\right)}{\partial \ln\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)} = \frac{\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{DD_i}{IM_i}\right)^{-\rho_i^M-1}\right)}{\left(\frac{IM_i}{DD_i}\right)} \frac{\partial\left(\frac{IM_i}{DD_i}\right)}{\partial\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{DD_i}{IM_i}\right)^{-\rho_i^M-1}\right)}$$

C147. $$\frac{\partial \ln\left(\frac{IM_i}{DD_i}\right)}{\partial \ln\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)} = \frac{\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{DD_i}{IM_i}\right)^{-\rho_i^M-1}\right)}{\left(\frac{IM_i}{DD_i}\right)} \left[\frac{\partial\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{DD_i}{IM_i}\right)^{-\rho_i^M-1}\right)}{\partial\left(\frac{IM_i}{DD_i}\right)}\right]^{-1}$$

Noting that $\left(\frac{DD_i}{IM_i}\right)^{-\rho_i^M-1} = \left(\frac{IM_i}{DD_i}\right)^{\rho_i^M+1}$, simplify as

C148. $$\frac{\partial \ln\left(\frac{IM_i}{DD_i}\right)}{\partial \ln\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)} = \frac{\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{IM_i}{DD_i}\right)^{\rho_i^M+1}\right)}{\left(\frac{IM_i}{DD_i}\right)} \left[\frac{\partial\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{IM_i}{DD_i}\right)^{\rho_i^M+1}\right)}{\partial\left(\frac{IM_i}{DD_i}\right)}\right]^{-1}$$

C149. $$\frac{\partial \ln\left(\frac{IM_i}{DD_i}\right)}{\partial \ln\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)} = \frac{\left(\left(\frac{1-\beta_i^M}{\beta_i^M}\right)\left(\frac{IM_i}{DD_i}\right)^{\rho_i^M+1}\right)}{\left(\frac{IM_i}{DD_i}\right)} \left(\frac{1-\beta_i^M}{\beta_i^M}\right)^{-1} \left[\frac{\partial\left(\left(\frac{IM_i}{DD_i}\right)^{\rho_i^M+1}\right)}{\partial\left(\frac{IM_i}{DD_i}\right)}\right]^{-1}$$

C150. $$\frac{\partial \ln\left(\frac{IM_i}{DD_i}\right)}{\partial \ln\left(\frac{\partial Q_i/\partial DD_i}{\partial Q_i/\partial IM_i}\right)} = \left(\frac{IM_i}{DD_i}\right)^{\rho_i^M} \left[\left(\rho_i^M+1\right)\left(\frac{IM_i}{DD_i}\right)^{\rho_i^M}\right]^{-1} = \frac{1}{\rho_i^M+1}$$

Hence $\sigma_i^M = \frac{1}{\rho_i^M+1}$ is indeed the elasticity of substitution.

C8. A GDP deflator consistent with the concept of GDP at basic prices

GDP at basic prices is computed as

90. $$GDP^{BP} = \sum_j PVA_j VA_j + TIPT$$

If there were no « Other taxes on production » except for taxes directly related to the use of capital and labor (see Appendix B1.1 and B1.3), that is, if *TIPT* were zero, then the Fisher GDP price index consistent with the concept of GDP at basic prices would be

C151. $$PIXGDP_{z,t} = \sqrt{\frac{\sum_j PVA_{j,z,t} VA^O_{j,z}}{\sum_j PVA^O_{j,z} VA^O_{j,z}} \frac{\sum_j PVA_{j,z,t} VA_{j,z,t}}{\sum_j PVA^O_{j,z} VA_{j,z,t}}}$$

In constructing Fisher price and quantity indexes of GDP, how can we take into account the existence of the *TIPT* component of other taxes on production? Start with

29. $$TIPT = \sum_j TIP_j$$

39. $$TIP_j = ttip_j PP_j XST_j$$

Since

1. $$VA_j = v_j XST_j$$

equation 39 is equivalent to

C152. $$TIP_j = ttip_j PP_j \frac{VA_j}{v_j}$$

Let

C153. $$\tau_j = \frac{TIP_j}{PVA_j VA_j} = \frac{ttip_j PP_j \frac{VA_j}{v_j}}{PVA_j VA_j} = \frac{ttip_j PP_j}{v_j PVA_j}$$

Whence

C154. $$\left(1+\tau_j\right) PVA_j VA_j = PVA_j VA_j + TIP_j$$

C155. $$\sum_j \left(1+\tau_j\right) PVA_j VA_j = \sum_j PVA_j VA_j + TIPT = GDP^{BP}$$

It is thanks to equation C152 that the *TIPT* component of « Other taxes on production » can be defined in equation C153 as an *ad valorem* tax on value added. But it must be kept in mind that equation C152 relies on the Leontief specification of equation 1. Otherwise, we would have

C156. $$\tau_j = \frac{TIP_j}{PVA_j VA_j} = \frac{ttip_j PP_j XS_j}{PVA_j VA_j}$$

and the rate of taxation τ_j would be dependent, not only on the ratio of prices PP_j and PVA_j, but on the ratio of quantities XS_j and VA_j as well. In either case, nonetheless, equation C155 holds, and, if the

Leontief assumption is dropped, τ_j may be treated as the endogenous *ad valorem* value added tax rate equivalent to the production tax rate $ttip_j$.

Hence, considering that the price of value added in GDP at basic prices is $\left(1+\tau_j\right)PVA_j$, the proper Fisher GDP price index is

C157. $$PIXGDP = \sqrt{\frac{\sum_j \left(1+\tau_j\right)PVA_j VA_j^O}{\sum_j \left(1+\tau_j^O\right)PVA_j^O VA_j^O} \frac{\sum_j \left(1+\tau_j\right)PVA_j VA_j}{\sum_j \left(1+\tau_j^O\right)PVA_j^O VA_j}}$$

Combining C157 and C153, the GDP deflator can be written as

C158. $$PIXGDP = \sqrt{\frac{\sum_j \left(1+\frac{TIP_j}{PVA_j VA_j}\right)PVA_j VA_j^O}{\sum_j \left(1+\frac{TIP_j^O}{PVA_j^O VA_j^O}\right)PVA_j^O VA_j^O} \frac{\sum_j \left(1+\frac{TIP_j}{PVA_j VA_j}\right)PVA_j VA_j}{\sum_j \left(1+\frac{TIP_j^O}{PVA_j^O VA_j^O}\right)PVA_j^O VA_j}}$$

80. $$PIXGDP = \sqrt{\frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j}\right)VA_j^O}{\sum_j \left(PVA_j^O VA_j^O + TIP_j^O\right)} \frac{\sum_j \left(PVA_j VA_j + TIP_j\right)}{\sum_j \left(PVA_j^O + \frac{TIP_j^O}{VA_j^O}\right)VA_j}}$$

The corresponding quantity index is

C159. $$QIXGDP = \sqrt{\frac{\sum_j \left(1+\tau_j^O\right)PVA_j^O VA_j}{\sum_j \left(1+\tau_j^O\right)PVA_j^O VA_j^O} \frac{\sum_j \left(1+\tau_j\right)PVA_j VA_j}{\sum_j \left(1+\tau_j\right)PVA_j VA_j^O}}$$

Note that

C160. $$PIXGDP\,QIXGDP = \frac{\sum_j \left(1+\tau_j\right)PVA_j VA_j}{\sum_j \left(1+\tau_j^O\right)PVA_j^O VA_j^O} = \frac{GDP^{BP}}{GDP^{BPO}}$$

C9. Exact price indexes *PIXINV* and *PIXGVT*

The GFCF demand for commodities is given by equation 54, where total GFCF expenditure is distributed among commodities in fixed shares:

54. $PC_i INV_i = \gamma_i^{INV} GFCF$

C161. $INV_i = \dfrac{\gamma_i^{INV} GFCF}{PC_i}$

Implicitly, the production function of new capital is a Cobb-Douglas function of the form:

C162. $\Delta K = A^K \prod_i INV_i^{\gamma_i^{INV}}$

The indirect production function is obtained by substituting equation C161 into equation C162:

C163. $\Delta K = A^K \prod_i \left(\gamma_i^{INV} \dfrac{GFCF}{PC_i} \right)^{\gamma_i^{INV}} = A^K GFCF^{\sum_i \gamma_i^{INV}} \prod_i \left(\dfrac{\gamma_i^{INV}}{PC_i} \right)^{\gamma_i^{INV}}$

C164. $\Delta K = A^K GFCF \prod_i \left(\dfrac{\gamma_i^{INV}}{PC_i} \right)^{\gamma_i^{INV}}$

Let

$GFCF^0$: gross fixed capital formation expenditures in the SAM

PC_i^0 : initial commodity prices

$GFCF^*$: expenditure necessary to produce the same quantity of new capital at current prices PC_i

$GFCF^*$ is calculated by solving

C165. $A^K GFCF^* \prod_i \left(\dfrac{\gamma_i^{INV}}{PC_i} \right)^{\gamma_i^{INV}} = A^K GFCF^0 \prod_i \left(\dfrac{\gamma_i^{INV}}{PC_i^0} \right)^{\gamma_i^{INV}}$

An exact[15] GFCF price index is a formula which will yield the ratio $GFCF^* / GFCF^0$ as a function of the price ratios for any initial level of expenditures $GFCF^0$. The exact price index is therefore

15 Diewert, W. E. (1976) « Exact and superlative index numbers » Journal of Econometrics 4: 115-145. Reproduced in W. E. Diewert and A. O. Nakamura (1993), Essays in Index Number Theory, Vol. 1, North-Holland Publishing Co., Amsterdam, p. 223-257. Available on line at http://www.econ.ubc.ca/diewert/hmpgdie.htm.

C166. $$\frac{GFCF^{*}}{GFCF^{0}} = \frac{A^{K}\prod_{i}\left(\frac{\gamma_{i}^{INV}}{PC_{i}^{0}}\right)^{\gamma_{i}^{INV}}}{A^{K}\prod_{i}\left(\frac{\gamma_{i}^{INV}}{PC_{i}}\right)^{\gamma_{i}^{INV}}} = \prod_{i}\left(\frac{PC_{i}}{PC_{i}^{0}}\right)^{\gamma_{i}^{INV}}$$

which is precisely *PIXINV* as given in equation 82.

82. $$PIXINV = \prod_{i}\left(\frac{PC_{i}}{PC_{i}^{0}}\right)^{\gamma_{i}^{INV}}$$

It can be shown in the same manner that *PIXGVT* in equation 83 is also an exact price index of government current expenditures on goods and services.

APPENDIX D: NOTE ON THE RENTAL RATE AND THE RATE OF RETURN ON CAPITAL

Throughout this document, we have been careful to avoid inappropriate uses of the expression « rate of return on capital ». This short appendix aims at clarifying the meaning of « rate of return on capital », as distinct from the rental rate of capital.

The rental rate of capital in PEP-1-1 is

$R_{k,j}$: Rental rate of type *k* capital in industry *j*

This is the price received by owners for allowing the use of one unit of type *k* capital in industry *j* for one period. It enters the calculation of the capital income of households, businesses and government (equations 12, 18, and 23):

12. $$YHK_h = \sum_k \lambda^{RK}_{h,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$$

18. $$YFK_f = \sum_k \lambda^{RK}_{f,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$$

23. $$YGK = \sum_k \lambda^{RK}_{gvt,k} \left(\sum_j R_{k,j} KD_{k,j} \right)$$

In the case where capital is perfectly mobile, owners will allocate their capital to the most advantageous uses, so that the rental rate of each type of capital will be uniform across industries, equal to

RK_k : Rental rate of type *k* capital (if capital is mobile)

as described by equation 73:

73. $$R_{k,j} = RK_k, \quad if\ capital\ is\ mobile$$

The rental rate of capital $R_{k,j}$ is related to

$RTI_{k,j}$: Rental rate paid by industry *j* for type *k* capital, including capital taxes

by equation 72:

72. $$RTI_{k,j} = R_{k,j} \left(1 + ttik_{k,j}\right)$$

In turn, $RTI_{k,j}$ appears in the calculation of

RC_j : Rental rate of industry *j* composite capital

in equation 71:

$$71. \qquad RC_j = \frac{\sum_k RTI_{k,j} KD_{k,j}}{KDC_j}$$

Finally, RC_j is the rental rate of capital that enters equation 68, which determines the price of value added:

$$68. \qquad PVA_j = \frac{WC_j LDC_j + RC_j KDC_j}{VA_j}$$

Now, the ***rate of return*** on capital is a different concept. A rate of return is the ratio of income received on an asset to the value of that asset. In order to compute the rate of return on capital, our model would need a ***price of capital***, which does not appear in the static model PEP-1-1. So let

PK_k : Price of private investment in type *k* capital

PK_k is the replacement cost of capital. The rate of return on type *k* capital used in industry *j* is

$$Rho_{k,j} = \frac{R_{k,j} KD_{k,j}}{PK_k KD_{k,j}} = \frac{R_{k,j}}{PK_k}$$

Therefore, one must be careful to use the expression « return rate on capital » only when appropriate, that is, when the variable refered to is the ratio of capital income over the value of the asset.

APPENDIX E: WALRAS' LAW, REDUNDANT EQUATIONS, AND SLACK VARIABLES (LEON)

E1. Walras' Law and the *LEON* slack variable

Walras' Law states that, in a closed *n*-commodity system of supply and demand equilibrium, there is one redundant equation, due to the income-expenditure accounting identity. A CGE is such a closed system: basically, income generated in production is used to pay for the purchase of commodities. Therefore, in a CGE, it is necessary to eliminate one of the commodity supply-demand equilibrium conditions, to avoid creating a model with more equations than free variables (when counting equations and variables, GAMS does not distinguish redundant from non-redundant equations). The choice of the discarded equation is arbitrary. It is customary – at least in the PEP tradition – to introduce a slack variable, called *LEON* (in honor of Leon Walras), whose value is the imbalance in the discarded equation. This adds one equation and one variable, and so maintains the equality between number of variables and equations. Naturally, in a well-specified model, the equilibrium value of the slack variable is zero. Otherwise, a non-zero *LEON* signals an error in the model.

In PEP-1-1, supply-demand equilibrium conditions are represented by equation 84, of which there are as many as there are commodities, minus 1. *LEON* is the excess supply on the last commodity market, whose value is computed in the equation called *WALRAS* in the GAMS code.

E2. Demand for labor by category and the price of composite labor (redundant equation 69)

There are, however, other redundant equations that are discarded from the model. For instance, equation 69 is inserted in the GAMS code as a mere comment, with the statement that « Given the way equation 6 is written, equation 69 is redundant ». Now, in Appendix C2, the following has been demonstrated:

- equations 5 and C036 (the latter derived from the first-order cost-minimization conditions) together imply equation C041;
- equations C041 and 69 together imply equation 6.

We shall now see that

- equation C041 implies C036;
- equation 6 implies C036;
- equation C041 implies 5;

- equations 5 and 6 together imply 69.

To summarize, equations 5 and 6 together make equation 69 redundant.

E2.1 EQUATION C041 IMPLIES EQUATIONS C036 AND 5

To begin, we demonstrate that equation C041 implies equations C036 and 5. It is straightforward to take the ratio of equation C041 for $LD_{li,j}$ over the same equation for $LD_{lj,j}$:

$$\text{E001.}\quad \frac{LD_{li,j}}{LD_{lj,j}} = \frac{\frac{LDC_j}{B_j^{LD}}\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}\right]^{\frac{1}{\rho_j^{LD}}} \left(\frac{WTI_{li,j}}{\beta_{li,j}^{LD}}\right)^{-\frac{1}{\rho_j^{LD}+1}}}{\frac{LDC_j}{B_j^{LD}}\left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}\right]^{\frac{1}{\rho_j^{LD}}} \left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}}\right)^{-\frac{1}{\rho_j^{LD}+1}}}$$

$$\text{E002.}\quad \frac{LD_{li,j}}{LD_{lj,j}} = \frac{\left(\frac{WTI_{li,j}}{\beta_{li,j}^{LD}}\right)^{-\frac{1}{\rho_j^{LD}+1}}}{\left(\frac{WTI_{lj,j}}{\beta_{lj,j}^{LD}}\right)^{-\frac{1}{\rho_j^{LD}+1}}}$$

which, given $\sigma_j^{LD} = \frac{1}{\rho_j^{LD}+1}$, is equivalent to equation C036:

$$\text{C036.}\quad LD_{li,j} = \left(\frac{\beta_{li,j}^{LD}\, WTI_{lj,j}}{\beta_{lj,j}^{LD}\, WTI_{li,j}}\right)^{\sigma_j^{LD}} LD_{lj,j}$$

It is equally straightforward to verify in the same manner that equation 6 also implies equation C036.

Next, the development in Appendix C2 from equations C037 to C041 can be reversed, so that equations C037 and C041 are equivalent (each one implies the other). Finally, substituting for $\left(\frac{\beta_{l,j}^{LD}\ WTI_{lj,j}}{\beta_{lj,j}^{LD}\ WTI_{l,j}}\right)^{\frac{1}{\rho_j^{LD}+1}}$ $LD_{lj,j}$ from equation C036 into equation C037, equation 5 follows.

E2.2 EQUATION 69 REDUNDANT GIVEN EQUATIONS 5 AND 6

Second, we prove that, given equations 5 and 6, equation 69 is redundant.

E2.2.1 Equations 5 and 6 together imply equation C051

The first step in the demonstration is to show that 5 and 6 together imply C046. Substitute 6 into 5, and there results:

E003. $$LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\left\{\left[\frac{\beta_{l,j}^{LD}\ WC_j}{WTI_{l,j}}\right]^{\sigma_j^{LD}}\left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j\right\}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

Given $\sigma_j^{LD} = \frac{1}{\rho_j^{LD}+1}$,

E004. $$LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD}\left\{\left[\frac{\beta_{l,j}^{LD}\ WC_j}{WTI_{l,j}}\right]^{\frac{1}{\rho_j^{LD}+1}}\left(B_j^{LD}\right)^{-\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} LDC_j\right\}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

E005. $$LDC_j = WC_j^{\frac{1}{\rho_j^{LD}+1}} \; LDC_j \; B_j^{LD} \left(B_j^{LD}\right)^{-\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} \left[\sum_l \beta_{l,j}^{LD} \left\{\left[\frac{\beta_{l,j}^{LD}}{WTI_{l,j}}\right]^{\frac{1}{\rho_j^{LD}+1}}\right\}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$$

E006. $$1 = WC_j^{\frac{1}{\rho_j^{LD}+1}} \left(B_j^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left[\sum_l \beta_{l,j}^{LD} \left\{\left[\frac{\beta_{l,j}^{LD}}{WTI_{l,j}}\right]^{\frac{-\rho_j^{LD}}{\rho_j^{LD}+1}}\right\}\right]^{-\frac{1}{\rho_j^{LD}}}$$

E007. $$WC_j^{\frac{1}{\rho_j^{LD}+1}} \left(B_j^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} = \left[\sum_l \beta_{l,j}^{LD} \left\{\left[\frac{\beta_{l,j}^{LD}}{WTI_{l,j}}\right]^{\frac{-\rho_j^{LD}}{\rho_j^{LD}+1}}\right\}\right]^{\frac{1}{\rho_j^{LD}}}$$

E008. $$WC_j \; B_j^{LD} = \left[\sum_l \beta_{l,j}^{LD} \left\{\left[\frac{\beta_{l,j}^{LD}}{WTI_{l,j}}\right]^{\frac{-\rho_j^{LD}}{\rho_j^{LD}+1}}\right\}\right]^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}$$

And equation C046 follows:

C046. $$WC_j = \frac{1}{B_j^{LD}} \left[\sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} \left(WTI_{l,j}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}\right]^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}$$

E2.2.2 Equations 6 and C046 together imply equation 69

Next, from equation 6, it follows that

E009. $$\sum_l WTI_{l,j}\ LD_{l,j} = \sum_l WTI_{l,j} \left[\frac{\beta_{l,j}^{LD}\ WC_j}{WTI_{l,j}}\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j$$

E010. $$\sum_l WTI_{l,j}\ LD_{l,j} = \sum_l WTI_{l,j}^{1-\sigma_j^{LD}} \left[\beta_{l,j}^{LD}\ WC_j\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j$$

E011. $$\sum_l WTI_{l,j}\ LD_{l,j} = \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_j\ WC_j^{\sigma_j^{LD}} \sum_l \left(\beta_{l,j}^{LD}\right)^{\sigma_j^{LD}} WTI_{l,j}^{1-\sigma_j^{LD}}$$

E012. $$\left(B_j^{LD}\right)^{1-\sigma_j^{LD}} LDC_j^{-1}\ WC_j^{-\sigma_j^{LD}} \sum_l WTI_{l,j}\ LD_{l,j} = \sum_l \left(\beta_{l,j}^{LD}\right)^{\sigma_j^{LD}} WTI_{l,j}^{1-\sigma_j^{LD}}$$

Since $\sigma_j^{LD} = \dfrac{1}{\rho_j^{LD}+1}$, we have

E013. $$\left(B_j^{LD}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} LDC_j^{-1}\ WC_j^{-\frac{1}{\rho_j^{LD}+1}} \sum_l WTI_{l,j}\ LD_{l,j} = \sum_l \left(\beta_{l,j}^{LD}\right)^{\frac{1}{\rho_j^{LD}+1}} WTI_{l,j}^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}}$$

Substitute into equation C046, and find

E014. $$WC_j = \frac{1}{B_j^{LD}} \left[\left(B_j^{LD}\right)^{\frac{\rho_j^{LD}}{\rho_j^{LD}+1}} LDC_j^{-1}\ WC_j^{-\frac{1}{\rho_j^{LD}+1}} \sum_l WTI_{l,j}\ LD_{l,j}\right]^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}$$

E015. $$WC_j = WC_j^{-\frac{1}{\rho_j^{LD}}}\ LDC_j^{-\frac{\rho_j^{LD}+1}{\rho_j^{LD}}} \left[\sum_l WTI_{l,j}\ LD_{l,j}\right]^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}$$

E016. $$WC_j^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}\ LDC_j^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}} = \left[\sum_l WTI_{l,j}\ LD_{l,j}\right]^{\frac{\rho_j^{LD}+1}{\rho_j^{LD}}}$$

which is equivalent to equation 69.

E2.3 SUMMARY OF THE LOGICAL STRUCTURE

The logical developments just presented are summarized in Figures E1 and E2[16]. Figure E1 illustrates the following relationships:

- equations 5 and C036 together imply C041;
- equation C041 implies C036;
- equation C041 is equivalent to C037;
- equations C041 and 69 together imply 6;
- equation 6 implies C036;
- equations C036 and C037 together imply 5;
- equations 5 and 6 together imply C046;
- equations 6 and C046 together imply 69.

Figure E2 is more compact, because intermediate equations C037 and C046 are kept implicit. Figure E2 illustrates the following relationships:

- equations 5 and C036 together imply C041;
- equation C041 implies C036;
- equation C041 implies 5;
- equations C041 and 69 together imply 6;
- equation 6 implies C036;
- equations 5 and 6 together imply 69.

16 Logical implication (« If *A* then *B* ») is represented by solid arrows (⇨). Logical equivalence (« If *A* then *B* **and** If *B* then *A* ») is represented by double-headed solid arrows (⇦⇨) Braces indicate that an implication follows from the combination of two or more equations.

Figure E1: Logical structure of labor demand by category

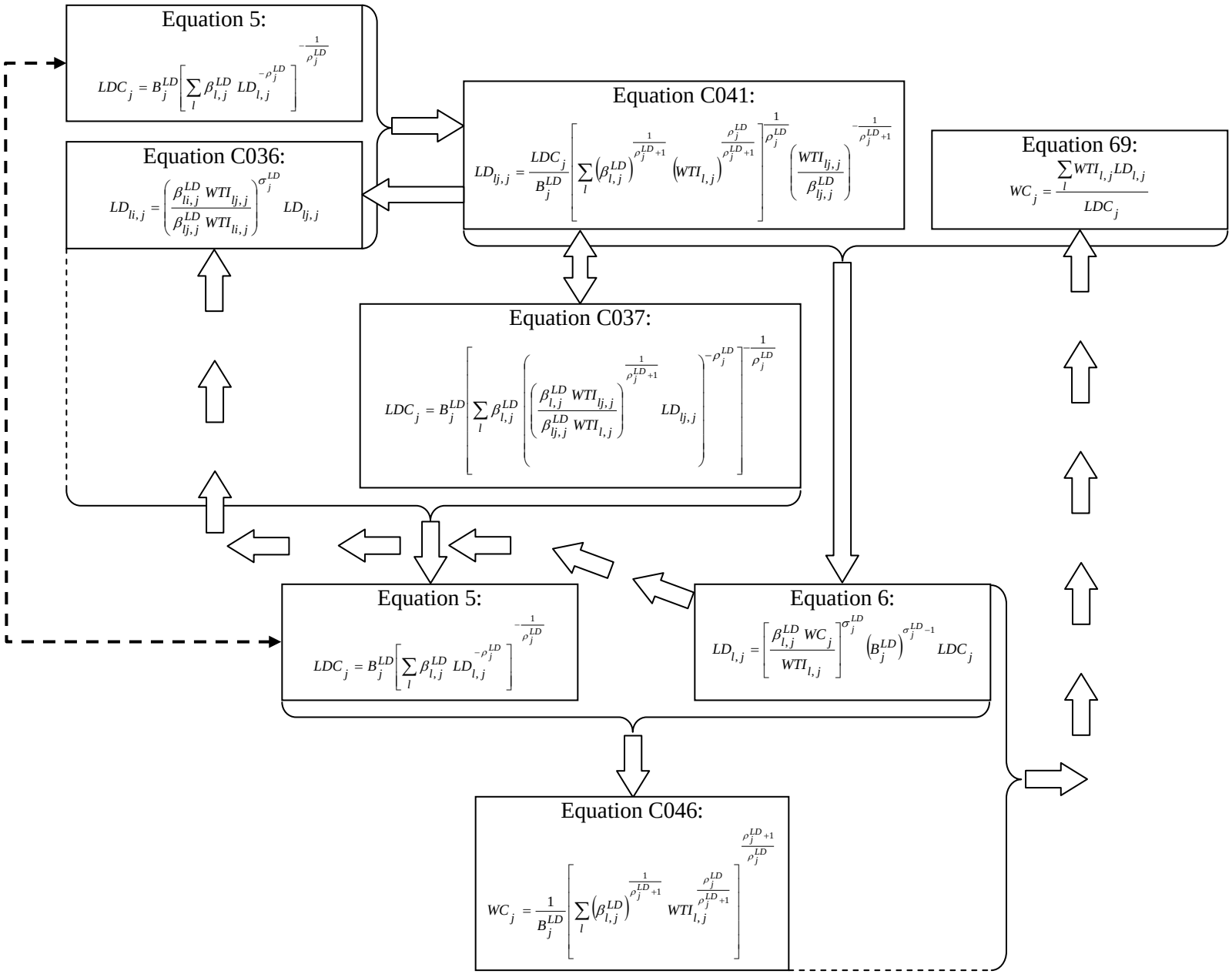
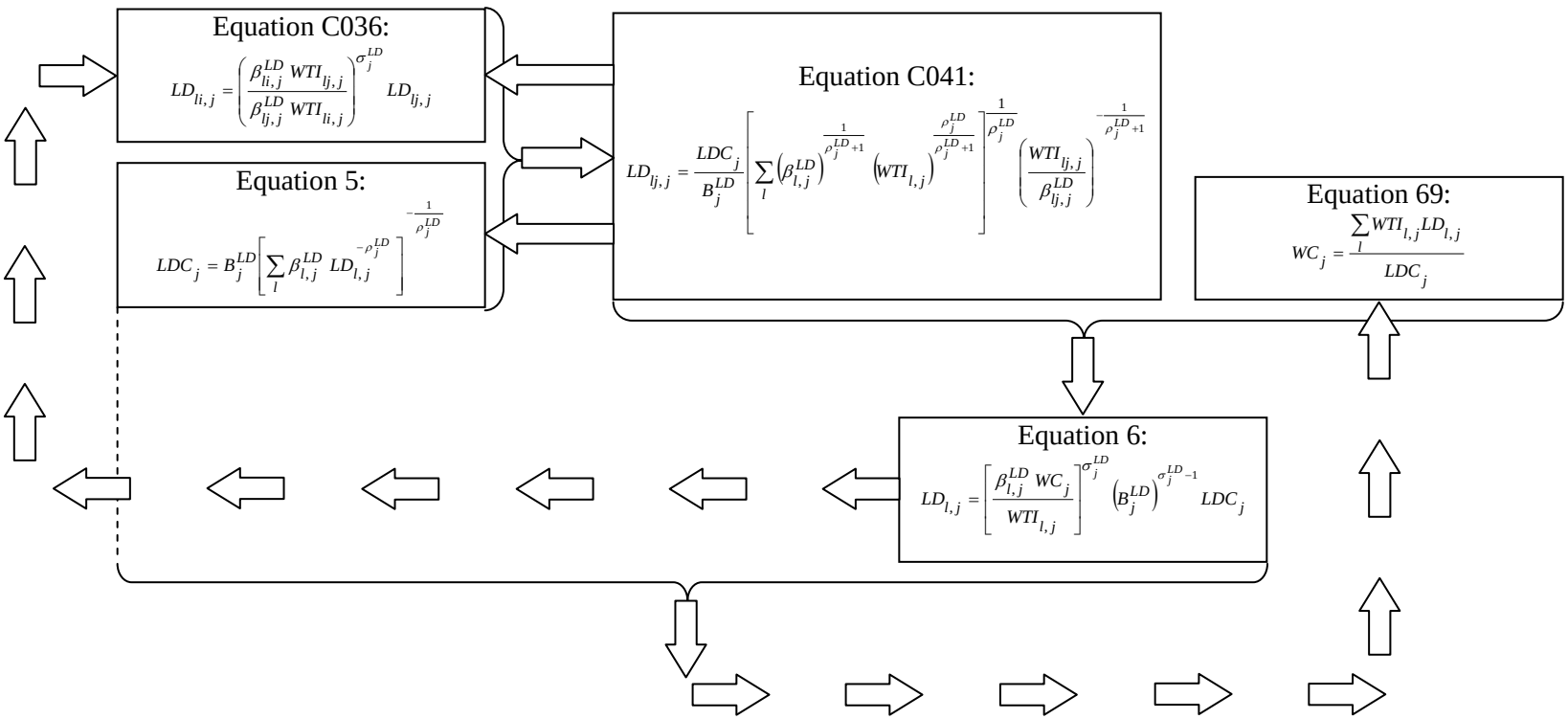


Figure E2: Logical structure of labor demand by category (compact form)



To summarize, given the logical structure described in Figures E1 and E2, the set of equations relating to labor demand by category and the price of composite labor may be formulated in three combinations:

- equations 5, C036, and 69;
- equations C041 and 69;
- equations 5 and 6.

The latter configuration is the one chosen in PEP-1-1, which implies that equation 69 is redundant. The number of equations is the same in all configurations. Let N_J be the number of industries, and N_L, the number of labor categories. Then

- equations 5 and 69 are families of N_J equations each;
- equations C041 and 6 are families of $N_J \times N_L$ equations each;
- but equation C036 is a family of $N_J \times (N_L - 1)$ equations.

In the case of equation C036, the equation with $LD_{lj,j}$ on the left hand side is a tautology:

$$\text{C036.}\quad LD_{li,j} = \left(\frac{\beta_{li,j}^{LD}\, WTI_{lj,j}}{\beta_{lj,j}^{LD}\, WTI_{li,j}} \right)^{\sigma_j^{LD}} LD_{lj,j}$$

So there are only $N_J \times (N_L - 1)$ independent equations C037.

The same configuration of equations that represents labor demand by category was also chosen to represent the demand for capital by category and the allocation of aggregate output to product supplies. The equations involved are, in the first case, equations 7, 8, and 71, and in the second case, equations 58, 59, and 74. Just as equation 69 is redundant given 5 and 6, so are 71 given 7 and 8, and 74 given 58 and 59. The underlying logical structure is similar to the one underlying the redundancy of equation 69.

On the other hand, when there are only two products or commodities involved, the configuration chosen in PEP-1-1 is analogous to the combination of equations 5, 69, and C037. The cases in point are: value added production (equations 3, 4, and 68), the allocation of production between domestic sales and exports (equations 60, 61, and 75), and the Armington demand for local products and imports (equations 63, 64, and 79). Of course, in these three cases, it would have been possible to apply the same configuration as for labor demand by category.

E3. Demand for capital by category and the price of composite capital (redundant equation 71)

We now prove that, given equations 7 and 8,

7. $$KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD}\ KD_{k,j}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$$

8. $$KD_{k,j} = \left[\frac{\beta_{k,j}^{KD}\ RC_j}{RTI_{k,j}}\right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j$$

equation 71

71. $$RC_j = \frac{\sum_k RTI_{k,j} KD_{k,j}}{KDC_j}$$

is redundant.

E3.1 Step 1

Substitute 8 into 7, and there results:

E017. $$KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD}\left\{\left[\frac{\beta_{k,j}^{KD}\ RC_j}{RTI_{k,j}}\right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j\right\}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$$

Given $\rho_j^{KD} = \frac{1-\sigma_j^{KD}}{\sigma_j^{KD}}$, $\sigma_j^{KD} = \frac{1}{\rho_j^{KD}+1}$, and

E018. $$KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD}\left\{\left[\frac{\beta_{k,j}^{KD}\ RC_j}{RTI_{k,j}}\right]^{\frac{1}{\rho_j^{KD}+1}}\left(B_j^{KD}\right)^{-\frac{\rho_j^{KD}}{\rho_j^{KD}+1}} KDC_j\right\}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$$

E019. $$KDC_j = \left(RC_j\right)^{\frac{1}{\rho_j^{KD}+1}} KDC_j B_j^{KD}\left(B_j^{KD}\right)^{-\frac{\rho_j^{KD}}{\rho_j^{KD}+1}}\left[\sum_k \beta_{k,j}^{KD}\left\{\left[\frac{\beta_{k,j}^{KD}}{RTI_{k,j}}\right]^{\frac{1}{\rho_j^{KD}+1}}\right\}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}$$

E020. $$1 = \left(RC_j\right)^{\frac{1}{\rho_j^{KD}+1}}\left(B_j^{KD}\right)^{\frac{1}{\rho_j^{KD}+1}}\left[\sum_k \beta_{k,j}^{KD}\left\{\left[\frac{\beta_{k,j}^{KD}}{RTI_{k,j}}\right]^{-\frac{\rho_j^{KD}}{\rho_j^{KD}+1}}\right\}\right]^{-\frac{1}{\rho_j^{KD}}}$$

E021. $$\left(RC_j\right)^{\frac{1}{\rho_j^{KD}+1}}\left(B_j^{KD}\right)^{\frac{1}{\rho_j^{KD}+1}} = \left[\sum_k \beta_{k,j}^{KD}\left\{\left[\frac{\beta_{k,j}^{KD}}{RTI_{k,j}}\right]^{-\frac{\rho_j^{KD}}{\rho_j^{KD}+1}}\right\}\right]^{\frac{1}{\rho_j^{KD}}}$$

E022. $$RC_j B_j^{KD} = \left[\sum_k \beta_{k,j}^{KD} \left\{ \left[\frac{\beta_{k,j}^{KD}}{RTI_{k,j}} \right]^{-\frac{\rho_j^{KD}}{\rho_j^{KD}+1}} \right\} \right]^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}}$$

E023. $$RC_j = \frac{1}{B_j^{KD}} \left[\sum_k \beta_{k,j}^{KD} \left\{ \left[\frac{\beta_{k,j}^{KD}}{RTI_{k,j}} \right]^{-\frac{\rho_j^{KD}}{\rho_j^{KD}+1}} \right\} \right]^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}}$$

E024. $$RC_j = \frac{1}{B_j^{KD}} \left[\sum_k \left(\beta_{k,j}^{KD}\right)^{\frac{1}{\rho_j^{KD}+1}} \left(RTI_{k,j}\right)^{\frac{\rho_j^{KD}}{\rho_j^{KD}+1}} \right]^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}}$$

E3.2 Step 2

Next, from equation 8, it follows that

E025. $$\sum_k RTI_{k,j} KD_{k,j} = \sum_k RTI_{k,j} \left[\frac{\beta_{k,j}^{KD}\ RC_j}{RTI_{k,j}} \right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j$$

E026. $$\sum_k RTI_{k,j} KD_{k,j} = \sum_k \left(RTI_{k,j}\right)^{1-\sigma_j^{KD}} \left(\beta_{k,j}^{KD}\ RC_j\right)^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j$$

E027. $$\sum_k RTI_{k,j} KD_{k,j} = \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_j \left(RC_j\right)^{\sigma_j^{KD}} \sum_k \left(\beta_{k,j}^{KD}\right)^{\sigma_j^{KD}} \left(RTI_{k,j}\right)^{1-\sigma_j^{KD}}$$

E028. $$\left(B_j^{KD}\right)^{1-\sigma_j^{KD}} KDC_j^{-1}\left(RC_j\right)^{-\sigma_j^{KD}} \sum_k RTI_{k,j} KD_{k,j} = \sum_k \left(\beta_{k,j}^{KD}\right)^{\sigma_j^{KD}} \left(RTI_{k,j}\right)^{1-\sigma_j^{KD}}$$

Since $\sigma_j^{KD} = \dfrac{1}{\rho_j^{KD}+1}$, we have

E029. $$\left(B_j^{KD}\right)^{\frac{\rho_j^{KD}}{\rho_j^{KD}+1}} KDC_j^{-1}\left(RC_j\right)^{-\frac{1}{\rho_j^{KD}+1}} \sum_k RTI_{k,j} KD_{k,j} = \sum_k \left(\beta_{k,j}^{KD}\right)^{\frac{1}{\rho_j^{KD}+1}} \left(RTI_{k,j}\right)^{\frac{\rho_j^{KD}}{\rho_j^{KD}+1}}$$

Substitute into equation E024, and find

E030. $$RC_j = \frac{1}{B_j^{KD}} \left[\left(B_j^{KD}\right)^{\frac{\rho_j^{KD}}{\rho_j^{KD}+1}} KDC_j^{-1}\left(RC_j\right)^{-\frac{1}{\rho_j^{KD}+1}} \sum_k RTI_{k,j} KD_{k,j} \right]^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}}$$

E031. $$RC_j = \left(KDC_j\right)^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}} \left(RC_j\right)^{-\frac{1}{\rho_j^{KD}}} \left[\sum_k RTI_{k,j} KD_{k,j} \right]^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}}$$

E032. $$\left(RC_j\right)^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}} \left(KDC_j\right)^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}} = \left[\sum_k RTI_{k,j} KD_{k,j} \right]^{\frac{\rho_j^{KD}+1}{\rho_j^{KD}}}$$

Equation 71 follows directly :

71. $$RC_j = \frac{\sum_k RTI_{k,j} KD_{k,j}}{KDC_j}$$

E4. Allocation of industry output among goods and the aggregate price of production (redundant equation 74)

We now prove that, given equations 58 and 59,

58. $$XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

59. $$XS_{j,i} = \frac{XST_j}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}}\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}\ PT_j}\right]^{\sigma_j^{XT}}$$

equation 74

74. $$PT_j = \frac{\sum_i P_{j,i}\ XS_{j,i}}{XST_j}$$

is redundant.

E4.1 Step 1

Substitute 59 into 58, and there results:

E033. $$XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\left\{\frac{XST_j}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}}\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}\ PT_j}\right]^{\sigma_j^{XT}}\right\}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

Given $\rho_j^{XT} = \frac{1+\sigma_j^{XT}}{\sigma_j^{XT}}$, $\sigma_j^{XT} = \frac{1}{\rho_j^{XT}-1}$, and

E034. $$XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\left\{\frac{XST_j}{\left(B_j^{XT}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}}\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}\ PT_j}\right]^{\frac{1}{\rho_j^{XT}-1}}\right\}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

E035. $$XST_j = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT}\left\{XST_j\left(B_j^{XT}\right)^{-\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}\ PT_j}\right]^{\frac{1}{\rho_j^{XT}-1}}\right\}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

E036. $$XST_j = \left(PT_j\right)^{-\frac{1}{\rho_j^{XT}-1}} XST_j\, B_j^{XT}\left(B_j^{XT}\right)^{-\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\left[\sum_i \beta_{j,i}^{XT}\left\{\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}}\right]^{\frac{1}{\rho_j^{XT}-1}}\right\}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

E037. $$1 = \left(PT_j\right)^{-\frac{1}{\rho_j^{XT}-1}}\left(B_j^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}}\left[\sum_i \beta_{j,i}^{XT}\left\{\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}}\right]^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\right\}\right]^{\frac{1}{\rho_j^{XT}}}$$

E038. $$\left(PT_j\right)^{\frac{1}{\rho_j^{XT}-1}}\left(B_j^{XT}\right)^{\frac{1}{\rho_j^{XT}-1}} = \left[\sum_i \beta_{j,i}^{XT}\left\{\left[\frac{P_{j,i}}{\beta_{j,i}^{XT}}\right]^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}\right\}\right]^{\frac{1}{\rho_j^{XT}}}$$

E039. $$PT_j B_j^{XT} = \left[\sum_i \beta_{j,i}^{XT} \left\{ \left[\frac{P_{j,i}}{\beta_{j,i}^{XT}} \right]^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right\} \right]^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}}$$

E040. $$PT_j = \frac{1}{B_j^{XT}} \left[\sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} \right]^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}}$$

E4.2 Step 2

Next, from equation 59, it follows that

E041. $$\sum_i P_{j,i} XS_{j,i} = \sum_i P_{j,i} \frac{XST_j}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i}}{\beta_{j,i}^{XT}\ PT_j} \right]^{\sigma_j^{XT}}$$

E042. $$\sum_i P_{j,i} XS_{j,i} = \sum_i \left(P_{j,i}\right)^{1+\sigma_j^{XT}} \left(\beta_{j,i}^{XT}\ PT_j\right)^{-\sigma_j^{XT}} \left(B_j^{XT}\right)^{-1-\sigma_j^{XT}}\ XST_j$$

E043. $$\sum_i P_{j,i} XS_{j,i} = \left(B_j^{XT}\right)^{-1-\sigma_j^{XT}}\ XST_j \left(PT_j\right)^{-\sigma_j^{XT}} \sum_i \left(\beta_{j,i}^{XT}\right)^{-\sigma_j^{XT}} \left(P_{j,i}\right)^{1+\sigma_j^{XT}}$$

E044. $$\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}\ XST_j^{-1} \left(PT_j\right)^{\sigma_j^{XT}} \sum_i P_{j,i} XS_{j,i} = \sum_i \left(\beta_{j,i}^{XT}\right)^{-\sigma_j^{XT}} \left(P_{j,i}\right)^{1+\sigma_j^{XT}}$$

Since $\sigma_j^{XT} = \frac{1}{\rho_j^{XT}-1}$, we have

E045. $$\left(B_j^{XT}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} XST_j^{-1}\left(PT_j\right)^{\frac{1}{\rho_j^{XT}-1}} \sum_i P_{j,i} XS_{j,i} = \sum_i \left(\beta_{j,i}^{XT}\right)^{-\frac{1}{\rho_j^{XT}-1}} \left(P_{j,i}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}}$$

Substitute into equation E040, and find

E046. $$PT_j = \frac{1}{B_j^{XT}} \left[\left(B_j^{XT}\right)^{\frac{\rho_j^{XT}}{\rho_j^{XT}-1}} XST_j^{-1}\left(PT_j\right)^{\frac{1}{\rho_j^{XT}-1}} \sum_i P_{j,i} XS_{j,i} \right]^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}}$$

E047. $$PT_j = \left(XST_j\right)^{-\frac{\rho_j^{XT}-1}{\rho_j^{XT}}} \left(PT_j\right)^{\frac{1}{\rho_j^{XT}}} \left[\sum_i P_{j,i} XS_{j,i} \right]^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}}$$

E048. $$\left(PT_j\right)^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}} \left(XST_j\right)^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}} = \left[\sum_i P_{j,i} XS_{j,i} \right]^{\frac{\rho_j^{XT}-1}{\rho_j^{XT}}}$$

Equation 74 follows directly:

74. $$PT_j = \frac{\sum_i P_{j,i}\ XS_{j,i}}{XST_j}$$

E5. Other slack variables

Just as the *LEON* variable was introduced as the imbalance of the equation chosen as redundant according to Walras's Law, other slack variables could be introduced for each redundant equation that was discarded. In complex models, this device may be useful to verify that redundant equations are satisfied. It is illustrated in the variant *PEP-1-1.v2_1_slack.gms* of the PEP-1-1 GAMS code.

APPENDIX F: MODEL PARAMETRIZATION

F1. What is model parametrization?

To implement a CGE model, values must be assigned to its parameters and exogenous variables. This process comprises two aspects: calibration of the parameters that can be determined from the information contained in the underlying social accounting matrix (SAM), and assignment of values to the so-called free parameters that remain.

Calibration can be considered a form of estimation. Unlike econometric estimation, however, calibration is not based on statistical inference procedures. Rather, it consists in determining parameter values on the basis of a detailed « snapshot » of the economy. Calibration goes back at least as far as the « structural analysis » approach of Leontief (1941, 1951, 1953) and Stone (1951, 1953, who coined the expression « social accounting matrix »). Indeed, Leontief input-output coefficients are computed from an input-output table as the ratios of input purchases over the value of production. And, given the extremely restrictive form of the Leontief fixed-proportions production function, all the parameters of the input-output model can be determined in that manner.

CGE models can be viewed as generalizations of input-output models. Of course, the latter are usually confined to the production system as represented by an input-output table, whereas CGE models are based on a SAM encompassing the whole of the economy. But the major difference lies in the fact that CGE models are, as their name indicates, models of economy-wide supply-and-demand equilibria regulated by the price system. In order for economic agents to be responsive to price changes, at least some of the functional forms which represent their behavior in CGE models have to be more flexible than simple fixed-proportions Leontief functions. However, more flexible functional forms have more parameters. Consequently, the information contained in the SAM is not sufficient to uniquely determine the values of all parameters.

The parameters that cannot be « calibrated » (that is, determined from the SAM) are called « free », and they must be assigned values by other methods. These include ad hoc econometric estimation, or, more frequently, a search of the empirical literature to find plausible values for the free parameters. In the demonstration version of PEP-1-1, the free parameters are assigned arbitrary values which, in the experience of the authors, are reasonable ballpark figures.

The parametrization strategy involves, first, determining which parameters are to be calibrated, and which are to be determined otherwise (in some cases, modelers have a choice of which of a given pair of

parameters is to be calibrated). Secondly, it involves specifying adequate formulae to compute calibrated parameters from SAM values, together with the order in which the formulae are to be applied in the calibration procedure, which is sometimes critical.

The following pages describe the calibration procedure in the demonstration version of PEP-1-1.

F2. Assignments from SAM data

Figure F1 below reproduces the file *SAM-V2_0.xls*, which contains the SAM data that is read into the GAMS program. The gray parts of the SAM are supposed to be empty[17]. Superimposed cartoon balloons describe the content of the non-empty cells of the SAM.

F2.1 NOTATION

In what follows, values retrieved from the SAM are denoted *SAM*{ }; inside the curly parentheses is a mathematical expression which corresponds to the description of a cell or group of cells in the SAM found in Figure F1. The initial values, or base values, of variables are identified by a superscript *O*. In the GAMS code, this is done by adding the letter « O » to the variable name. In the GAMS language, these initial values are parameters.

In order to economize on the number of symbols, some parameters or variables are given temporary values. Such temporary values are topped by a horizontal stroke. Some of these temporary values are revised more than once, so that some of the equations below are of the form $\bar{x} = f(\bar{x})$ (for example, F094 and F095); this way of writing assignments is often used in programming, but in mathematics, the two $\bar{x}$ should be represented by different symbols, because the left-hand side $\bar{x}$ is different from the right-hand side $\bar{x}$.

F2.2 ASSIGNMENT OF TEMPORARY BASE VALUES TO VOLUME VARIABLES

Once the SAM has been read into the GAMS program, the following base values of volume variables are assigned temporary values. These assignments are provisional, because SAM data are not volumes (quantities); they are nominal values.

F001. $\overline{C^O_{i,h}} = SAM\left\{ PC_i \; C_{i,h} \right\}$

[17] Cells in the SAM that are assumed to be empty in PEP-1-1 are not necessarily so according to the SNA 2008. For instance, in the SNA 2008, there may be non-resident workers, which means that the ROW (Rest-of-the-World) account receives labor income; or there may be re-exports. If a user wishes to take such flows into account, then s/he will need to adapt PEP-1-1 for that purpose.

F002. $\overline{CG_i^O} = SAM\left\{ PC_i \; CG_i \right\}$

F003. $\overline{DS_{j,i}^O} = SAM\left\{ PL_i \; DS_{j,i} \right\}$

F004. $\overline{DD_i^O} = \sum_j \overline{DS_{j,i}^O}$

F005. $\overline{DI_{i,j}^O} = SAM\left\{ PC_i \; DI_{i,j} \right\}$

F006. $\overline{EX_{j,i}^O} = SAM\left\{ PE_i \; EX_{j,i} \right\}$

F007. $\overline{EXD_i^O} = SAM\left\{ PE_i^{FOB} \; EXD_i \right\}$

F008. $\overline{INV_i^O} = SAM\left\{ PC_i \; INV_i \right\}$

F009. $\overline{VSTK_i^O} = SAM\left\{ PC_i \; VSTK_i \right\}$

F010. $\overline{IM_i^O} = SAM\left\{ e \; PWM_i \; IM_i \right\}$

F011. $\overline{KD_{k,j}^O} = SAM\left\{ R_{k,j} KD_{k,j} \right\}$

F012. $\overline{LD_{l,j}^O} = SAM\left\{ W_l LD_{l,j} \right\}$

F2.3 Assignment of base values to nominal variables

Next, base values are assigned to the following nominal variables (variables defined in terms of value).

F013. $SF_f^O = SAM\left\{ SF_f \right\}$

F014. $SG^O = SAM\{ SG\}$

F015. $SH_h^O = SAM\left\{ SH_h \right\}$

F016. $SROW^O = SAM\{ SROW\}$

F017. $TDF_f^O = SAM\left\{ TDF_f \right\}$

F018. $TDH_h^O = SAM\left\{ TDH_h \right\}$

F019. $TIC_i^O = SAM\left\{ TIC_i \right\}$

F020. $TIK_{k,j}^O = SAM\left\{ TIK_{k,j} \right\}$

F021. $TIM_i^O = SAM\left\{ TIM_i \right\}$

F022. $TIP_j^O = SAM\left\{ TIP_j \right\}$

F023. $TIX_i^O = SAM\left\{ TIX_i \right\}$

F024. $TIW_{l,j}^O = SAM\left\{ TIW_{l,j} \right\}$

F025. $TR_{ag,agj}^O = SAM\left\{ TR_{ag,agj} \right\}$

It should be noted that $TR_{agd,ROW}$ and $TR_{agng,GVT}$ are indexed transfers, and their base value is revised below (F4.4) given the base value of the consumer price index. However, in the present calibration procedure of PEP-1-1, the base value of the consumer price index is 1 and the revised value of the indexed transfers is equal to their temporary value.

F2.4 ASSIGNMENT OF TEMPORARY VALUES TO PARAMETERS

Finally, some parameters are assigned temporary values from SAM data.

F026. $\overline{\lambda^{RK}_{ag,k}} = SAM\left\{\lambda^{RK}_{ag,k}\left(\sum_j R_{k,j} KD_{k,j}\right)\right\}$

F027. $\overline{\lambda^{WL}_{h,l}} = SAM\left\{\lambda^{WL}_{h,l}\left(W_l \sum_j LD_{l,j}\right)\right\}$

F028. $\overline{tmrg_{i,ij}} = SAM\left\{PC_i\ tmrg_{i,ij}\left(DD_{ij} + IM_{ij}\right)\right\}$

F029. $\overline{tmrg^{X}_{i,ij}} = SAM\left\{PC_i\ tmrg^{X}_{i,ij}\ EXD_{ij}\right\}$

F3. Free parameters

In the demonstration version of PEP-1-1, free parameters are assigned the following values.

F3.1 PRICE ELASTICITY OF INDEXED VALUES

The price elasticity of indexed values should be set equal to one when verifying model homogeneity.

F030. $\eta = 1$

F3.2 CES AND CET ELASTICITIES

The following parameters are read from external file *VAL_PAR.xls*.

F031. $\sigma^{KD}_j = 0.8$

F032. $\sigma^{LD}_j = 0.8$

F033. $\sigma^{M}_i = 2$

F034. $\sigma^{VA}_j = 1.5$

F035. $\sigma^{X}_{j,i} = 2$

F036. $\sigma^{XT}_j = 2$

F3.3 ELASTICITY OF INTERNATIONAL DEMAND FOR EXPORTED COMMODITY I

This parameter is read from external file *VAL_PAR.xls*.

F037. $\sigma_i^{XD} = 2$

F3.4 LES PARAMETERS

The following parameters are read from external file *VAL_PAR.xls.*

F038. $Frisch_h = -1.5$

F039. $\overline{\sigma^Y_{AGR,h}} = 0.7$

F040. $\overline{\sigma^Y_{FOOD,h}} = 1.1$

F041. $\overline{\sigma^Y_{OTHIND,h}} = 1.1$

F042. $\overline{\sigma^Y_{SER,h}} = 1.05$

F043. $\overline{\sigma^Y_{ADM,h}} = 1.05$

F3.5 INTERCEPTS OF TRANSFERS, DIRECT TAXES AND SAVINGS

In household savings and transfers-to-government functions, and in income-tax functions, one can choose to assign a value to the intercept and calibrate the slope accordingly, or the other way around. This type of modelling can be useful to take into account known marginal savings or taxation rates or to deal with negative average saving rates in cases where savings are negative for some household groups. When no specific information is available, one can simply set the intercepts to zero and calibrate an average rate: this is what we do here.

F044. $sh0_h = 0$

F045. $tr0_h = 0$

F046. $ttdf0_f = 0$

F047. $ttdh0_h = 0$

These parameters are read from external file *VAL_PAR.xls*. It should be noted that these intercepts are indexed, and their value is revised below (F4.4) given the base value of the consumer price index. However, in the present calibration procedure of PEP-1-1, the base value of the consumer price index is 1 and the revised value of the indexed intercepts is equal to their temporary value.

F3.6 EXOGENOUS PRICES

The base value of some prices is arbitrary, insofar as it is constrained only by the price × quantity product. In such cases, the arbitrary value assigned to the price implicitely determines the measurement unit of the quantity. The most convenient arbitrary price is obviously 1.

F048. $PL_i^O = 1$

F049. $PE_i^O = 1$

F050. $e^O = 1$

F051. $PWM_i^O = 1$

F052. $W_l^O = 1$

F053. $RK_k^O = 1$

F054. $R_{k,j}^O = R_k^O$

F4. Calibration

F4.1 NOMINAL VARIABLES

The base values of nominal variables determined in equations 10-15 are computed in the following sequence:

F055. $YHK_h^O = \sum_k \overline{\lambda_{h,k}^{RK}}$

F056. $YHL_h^O = \sum_l \overline{\lambda_{h,l}^{WL}}$

F057. $YHTR_h^O = \sum_{ag} TR_{h,ag}^O$

F058. $YH_h^O = YHL_h^O + YHK_h^O + YHTR_h^O$

F059. $YDH_h^O = YH_h^O - TDH_h^O - TR_{gvt,h}^O$

F060. $CTH_h^O = YDH_h^O - SH_h^O - \sum_{agng} TR_{agng,h}^O$

The base values of nominal variables determined in equations 17-20 are computed in the following sequence:

F061. $YFK_f^O = \sum_k \overline{\lambda_{f,k}^{RK}}$

F062. $YFTR_f^O = \sum_{ag} TR_{f,ag}^O$

F063. $YF_f^O = YFK_f^O + YFTR_f^O$

F064. $YDF_f^O = YF_f^O - TDF_f^O$

The base values of nominal variables determined in equations 23-34 are computed in the following sequence:

F065. $YGK^O = \sum_k \overline{\lambda_{gvt,k}^{RK}}$

F066. $TDHT^O = \sum_h TDH_h^O$

F067. $TDFT^O = \sum_f TDF_f^O$

F068. $TICT^O = \sum_i TIC_i^O$

F069. $TIMT^O = \sum_i TIM_i^O$

F070. $TIXT^O = \sum_i TIX_i^O$

F071. $TIWT^O = \sum_{l,j} TIW_{l,j}^O$

F072. $TIKT^O = \sum_{k,j} TIK_{k,j}^O$

F073. $TIPT^O = \sum_j TIP_j^O$

F074. $TPRODN^O = TIWT^O + TIKT^O + TIPT^O$

F075. $TPRCTS^O = TICT^O + TIMT^O + TIXT^O$

F076. $YGTR^O = \sum_{agng} TR_{gvt,agng}^O$

F077. $YG^O = YGK^O + TDHT^O + TDFT^O + TPRODN^O + TPRCTS^O + YGTR^O$

From equations 44 and 46:

F078. $$YROW^{O} = \sum_{i} IM_{i}^{O} + \sum_{k} \overline{\lambda_{row,k}^{RK}} + \sum_{agd} TR_{row,agd}^{O}$$

F070. $$CAB^{O} = -SROW^{O}$$

Equation 87 yields

F080. $$IT^{O} = \sum_{h} SH_{h}^{O} + \sum_{f} SF_{f}^{O} + SG^{O} + SROW^{O}$$

F4.2 REVISED PARAMETER ASSIGNMENTS

Revised values are assigned to some parameters which had been assigned temporary values.

F081. $$\lambda_{ag,k}^{RK} = \frac{\overline{\lambda_{ag,k}^{RK}}}{\sum_{j} KD_{k,j}^{O}}$$

F082. $$\lambda_{h,l}^{WL} = \frac{\overline{\lambda_{h,l}^{WL}}}{\sum_{j} LD_{l,j}^{O}}$$

F4.3 PARAMETERS

F4.3.1 Miscelaneous

F083. $$\lambda_{agng,h}^{TR} = \frac{TR_{agng,h}^{O}}{YDH_{h}^{O}}$$

F084. $$\lambda_{ag,f}^{TR} = \frac{TR_{ag,f}^{O}}{YDF_{f}^{O}}$$

F085. $$sh1_{h} = \frac{SH_{h}^{O} - \overline{sh0_{h}}}{YDH_{h}^{O}}$$

F086. $$tr1_{h} = \frac{TR_{GVT,h}^{O} - \overline{tr0_{h}}}{YH_{h}^{O}}$$

F4.3.2 Investment and government expenditure shares

F087. $$\gamma_i^{GVT} = \frac{\overline{CG_i^O}}{\sum_{ij} CG_{ij}^O}$$

F088. $$\gamma_i^{INV} = \frac{\overline{INV_i^O}}{\sum_{ij} INV_{ij}^O}$$

F4.3.3 Margin rates, tax rates, prices and volumes

F089. $$ttdf1_f = \frac{TDF_f^O - \overline{ttdf0_f}}{YFK_f^O}$$

F090. $$ttdh1_h = \frac{TDH_h^O - \overline{ttdh0_h}}{YH_h^O}$$

F091. $$PC_i^O = \frac{\overline{DD_i^O} + \overline{IM_i^O} + \sum_{ij} \overline{tmrg_{ij,i}} + TIC_i^O + TIM_i^O}{\overline{DD_i^O} + \overline{IM_i^O}}$$

F092. $$\overline{tmrg_{i,ij}} = \frac{\overline{tmrg_{i,ij}}}{PC_i^O}$$

F093. $$\overline{tmrg_{i,ij}^X} = \frac{\overline{tmrg_{i,ij}^X}}{PC_i^O}$$

F094. $$DD_i^O = \frac{\overline{DD_i^O}}{PL_i^O}$$

F095. $$IM_i^O = \frac{\overline{IM_i^O}}{e^O\ PWM_i^O}$$

F096. $$tmrg_{i,ij} = \frac{\overline{tmrg_{i,ij}}}{DD_{ij}^O + IM_{ij}^O}$$

F097. $$ttic_i^O = \frac{TIC_i^O}{\left(PL_i^O + \sum_{ij} PC_{ij}^O tmrg_{ij,i}\right) DD_i^O + \left(e^O PWM_i^O + \sum_{ij} PC_{ij}^O tmrg_{ij,i}\right) IM_i^O}$$

F098. $$PD_i^O = \left(1 + ttic_i\right)\left(PL_i^O + \sum_{ij} PC_{ij}^O \; tmrg_{ij,i} \right)$$

F099. $$ttim_i = \frac{TIM_i^O}{e^O PWM_i^O IM_i^O}$$

From equation 78:

F100. $$PM_i^O = \left(1 + ttic_i\right)\left(\left(1 + ttim_i\right) e^O \; PWM_i^O + \sum_{ij} PC_{ij}^O tmrg_{ij,i} \right)$$

F101. $$EX_{j,i}^O = \frac{\overline{EX_{j,i}^O}}{PE_i^O}$$

F102. $$tmrg_i^X = \frac{\overline{tmrg_i^X}}{\sum_j EX_{j,i}^O}$$

F103. $$ttix_i = \frac{TIX_i^O}{\overline{\overline{EXD_i^O}} - TIX_i^O}$$

From equation 76, compute the FOB price of exports:

F104. $$PE_i^{FOB\_O} = \left(1 + ttix_i\right)\left(PE_i^O + \sum_{ij} PC_{ij}^O tmrg_{ij,i}^X \right)$$

Next, in order that the base value of EXD_x be consistent with equation 62, set

F105. $$PWX_i^O = \frac{PE_i^{FOB\_O}}{e^O}$$

And then revise the temporary values of the following:

F106. $$EXD_i^O = \frac{\overline{EXD_i^O}}{e^O \; PWX_i^O}$$

F107. $$DS_i^O = \frac{\overline{DS_i^O}}{PL_i^O}$$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of $XS_{j,i}$, the base value of its price given PL_i^O and PE_i^O, and the parameter $B_{j,i}^X$ given the aggregator function of equation 60.

F108. $XS_{j,i}^O = DS_{j,i}^O + EX_{j,i}^O$

From equation 75:

F109. $P_{j,i}^O = \frac{PL_i^O DS_{j,i}^O + PE_i^O EX_{j,i}^O}{XS_{j,i}^O}$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of XST_j, the base value of its price given the $P_{j,i}^O$, and the parameter $B_{j,i}^{XT}$ given the aggregator function of equation 58.

F110. $XST_j^O = \sum_i XS_{j,i}^O$

From equation 74:

F111. $PT_j^O = \frac{\sum_i P_{j,i}^O XS_{j,i}^O}{XST_j^O}$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of Q_i, the base value of its price given PM_i^O and PD_i^O, and the parameter B_i^M given the aggregator function of equation 63.

F112. $Q_i^O = \frac{PM_i^O IM_i^O + PD_i^O DD_i^O}{PC_i^O}$

From equation 57:

F113. $MRGN_i^O = \sum_{ij} tmrg_{i,ij} DD_{ij}^O + \sum_{ij} tmrg_{i,ij}\ IM_{ij}^O + \sum_{j,ij} tmrg_{i,ij}^X\ EX_{j,ij}^O$

Conversion of other temporary base values of volume variables into true volumes:

F114. $C_i^O = \frac{\overline{C_i^O}}{PC_i^O}$

F115. $CG_i^O = \overline{\frac{CG_i^O}{PC_i^O}}$

F116. $DI_{i,j}^O = \overline{\frac{DI_{i,j}^O}{PC_i^O}}$

F117. $INV_i^O = \overline{\frac{INV_i^O}{PC_i^O}}$

F118. $VSTK_i^O = \overline{\frac{VSTK_i^O}{PC_i^O}}$

From equation 53:

F119. $GFCF^O = IT^O - \sum_i PC_i^O \; VSTK_i^O$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of CI_j (the aggregate intermediate demand of industry *j*), and, hence, the base value of its price given the PC_i^O, and also, given equation 9, implicitely scales the $aij_{i,j}$ input-output coefficients so that their sum is equal to 1.

F120. $CI_j^O = \sum_i DI_{i,j}^O$

From equation 56:

F121. $DIT_i^O = \sum_j DI_{i,j}^O$

Applying the definition of total government expenditures on goods and services yields

F122. $G^O = \sum_i PC_i^O \; CG_i^O$

The price of industry *j*'s aggregate intermediate input, given the PC_i^O, is given by

F123. $PCI_j^O = \frac{\sum_i PC_i^O \; DI_{i,j}^O}{CI_j^O}$

From equations 37, 38, 70 and 72:

F124. $$ttiw_{l,j} = \frac{TIW^O_{l,j}}{\overline{LD^O_{l,j}}}$$

F125. $$WTI^O_{l,j} = W^O_l \left(1 + ttiw_{l,j}\right)$$

F126. $$ttik_{k,j} = \frac{TIK^O_{k,j}}{\overline{KD^O_{k,j}}}$$

F127. $$RTI^O_{k,j} = R^O_{k,j} \left(1 + ttik_{k,j}\right)$$

Conversion of temporary base values of labor volume variables into true volumes, given wage rates W^O_l:

F128. $$LD^O_{l,j} = \frac{\overline{LD^O_{l,j}}}{W^O_l}$$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of LDC_j (the aggregate labor demand of industry *j*), and, hence, the base value of aggregate wage rate WC_j given the $WTI^O_{l,j}$, and the parameter B^{LD}_j given the aggregator function of equation 5.

F129. $$LDC^O_j = \sum_l LD^O_{l,j}$$

From equation 85:

F130. $$LS^O_l = \sum_j LD^O_{l,j}$$

From equation 69:

F131. $$WC^O_j = \frac{\sum_l WTI^O_{l,j} LD^O_{l,j}}{LDC^O_j}$$

Conversion of temporary base values of capital volume variables into true volumes, given rental rates $R^O_{k,j}$:

F132. $$KD^O_{k,j} = \frac{\overline{KD^O_{k,j}}}{R^O_{k,j}}$$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of KDC_j (the aggregate capital demand of industry j), and, hence, the base value of aggregate rental rate RC_j given the $RTI^O_{k,j}$, and the parameter B^{KD}_j given the aggregator function of equation 7.

F133. $KDC^O_j = \sum_k KD^O_{k,j}$

From equation 86:

F134. $KS^O_k = \sum_j KD^O_{k,j}$

From equation 71, the base value of aggregate rental rate RC_j given the $RTI^O_{k,j}$ is computed to be consistent with the normalization rule applied above:

F135. $RC^O_j = \frac{\sum_k RTI^O_{k,j} KD^O_{k,j}}{KDC^O_j}$

The following assignment may be seen as a normalization rule which implicitely defines the measurement unit of VA_j (the aggregate value added of industry j), and, hence, the base value of its price PVA_j given WC^O_j and RC^O_j, and the parameter B^{VA}_j given the aggregator function of equation 3.

F136. $VA^O_j = LDC^O_j + KDC^O_j$

Then, from equation 68:

F137. $PVA^O_j = \frac{WC^O_j LDC^O_j + RC^O_j KDC^O_j}{VA^O_j}$

F138. $ttip_j = \frac{TIP^O_j}{PVA^O_j VA^O_j + \sum_i PC^O_i DIO^O_{i,j}}$

F139. $PP^O_j = \frac{PT^O_j}{\left(1 + ttip_j\right)}$

The base values of price indexes are computed from equations 80-83. It is easily verified that they are all equal to 1.

F140. $$PIXGDP^O = \sqrt{\frac{\sum_j PVA_j^O VA_j^O}{\sum_j PVA_j^O VA_j^O} \frac{\sum_j PVA_j^O VA_j^O}{\sum_j PVA_j^O VA_j^O}}$$

F141. $$PIXCON^O = \frac{\sum_i PC_i^O \sum_h C_{i,h}^O}{\sum_i PC_i^O \sum_h C_{i,h}^O}$$

F142. $$PIXGVT^O = \prod_i \left(\frac{PC_i^O}{PC_i^O} \right)^{\gamma_i^{GVT}}$$

F143. $$PIXINV^O = \prod_i \left(\frac{PC_i^O}{PC_i^O} \right)^{\gamma_i^{INV}}$$

F4.4 INDEXED TRANSFERS AND INTERCEPTS

Indexed transfers and intercepts are now revised in accordance with the base value of the consumer price index. Given that the base value of the consumer price index is 1, the revised values are equal to the original ones: these assignments are executed merely as a matter of caution, so that the calibration remains consistent in the case of changes in the calibration procedure.

F144. $$TR_{agd,ROW}^O = \frac{\overline{TR_{agd,ROW}^O}}{\left(PIXCON^O\right)^\eta}$$

F145. $$TR_{agng,GVT}^O = \frac{\overline{TR_{agng,GVT}^O}}{\left(PIXCON^O\right)^\eta}$$

F146. $$ttdf0_f = \frac{\overline{ttdf0_f}}{\left(PIXCON^O\right)^\eta}$$

F147. $$ttdh0_h = \frac{\overline{ttdh0_h}}{\left(PIXCON^O\right)^\eta}$$

F148. $$sh0_h = \frac{\overline{sh0_h}}{\left(PIXCON^O\right)^\eta}$$

F149. $tr0_h = \frac{\overline{tr0_h}}{\left(PIXCON^O\right)^{\eta}}$

F4.5 LEONTIEF INPUT COEFFICIENTS

Leontief input coefficients are calibrated as volume ratios:

F150. $io_j = \frac{CI_j^O}{XST_j^O}$

F151. $v_j = \frac{VA_j^O}{XST_j^O}$

F152. $aij_{i,j} = \frac{DI_{i,j}^O}{CI_j^O}$

F4.6 CET PARAMETERS

F4.6.1 CET between commodities

In accordance with the algebra of the CET transformation function (Appendix C5),

F153. $\rho_j^{XT} = \frac{1+\sigma_j^{XT}}{\sigma_j^{XT}}$

Next comes the calibration of the $\beta_{j,i}^{XT}$ .First, note that these are defined only up to a factor of proportionality. Indeed, let

F154. $\beta_{j,i}^{XT*} = \mu\beta_{j,i}^{XT}$

and

F155. $\left[\sum_i \beta_{j,i}^{XT*} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}} = \left[\sum_i \mu\beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}} = \mu^{\frac{1}{\rho_j^{XT}}}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$

Now let

F156. $B_j^{XT*} = \mu^{-\frac{1}{\rho_j^{XT}}} B_j^{XT}$

and it follows that

F157. $$XST_j = B_j^{XT*}\left[\sum_i \beta_{j,i}^{XT*} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}} = \mu^{-\frac{1}{\rho_j^{XT}}} B_j^{XT} \mu^{\frac{1}{\rho_j^{XT}}}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

F158. $$XST_j = B_j^{XT*}\left[\sum_i \beta_{j,i}^{XT*} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}} = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$$

With that in mind, develop equation 59 to obtain relative commodity supply:

F159. $$\frac{XS_{j,i}}{XS_{j,ij}} = \left[\frac{P_{j,i}}{\beta_{j,i}^{XT}} \frac{\beta_{j,ij}^{XT}}{P_{j,ij}}\right]^{\sigma_j^{XT}}$$

F160. $$\frac{XS_{j,i}}{XS_{j,ij}} = \left[\frac{P_{j,i}}{\beta_{j,i}^{XT}} \frac{\beta_{j,ij}^{XT}}{P_{j,ij}}\right]^{\frac{1}{\rho_j^{XT}-1}}$$

F161. $$\frac{XS_{j,i}}{XS_{j,ij}} = \left[\frac{\beta_{j,i}^{XT}}{P_{j,i}} \frac{P_{j,ij}}{\beta_{j,ij}^{XT}}\right]^{\frac{1}{1-\rho_j^{XT}}}$$

F162. $$\left(\frac{XS_{j,i}}{XS_{j,ij}}\right)^{1-\rho_j^{XT}} = \frac{\beta_{j,i}^{XT}}{P_{j,i}} \frac{P_{j,ij}}{\beta_{j,ij}^{XT}}$$

F163. $$\beta_{j,ij}^{XT} P_{j,i} XS_{j,i}^{1-\rho_j^{XT}} = \beta_{j,i}^{XT} P_{j,ij} XS_{j,ij}^{1-\rho_j^{XT}}$$

F164. $$\sum_{ij} \beta_{j,ij}^{XT} P_{j,i} XS_{j,i}^{1-\rho_j^{XT}} = \sum_{ij} \beta_{j,i}^{XT} P_{j,ij} XS_{j,ij}^{1-\rho_j^{XT}}$$

F165. $$P_{j,i} XS_{j,i}^{1-\rho_j^{XT}} \sum_{ij} \beta_{j,ij}^{XT} = \beta_{j,i}^{XT} \sum_{ij} P_{j,ij} XS_{j,ij}^{1-\rho_j^{XT}}$$

We have shown that the $\beta_{j,i}^{XT}$ are defined only up to a factor of proportionality. Therefore, we can, without loss of generality, impose the normalization rule $\sum_{ij} \beta_{j,ij}^{XT} = 1$. It then follows that

F166. $$P_{j,i} XS_{j,i}^{1-\rho_j^{XT}} = \beta_{j,i}^{XT} \sum_{ij} P_{j,ij} XS_{j,ij}^{1-\rho_j^{XT}}$$

Whence

F167. $$\beta_{j,i}^{XT} = \frac{P_{j,i}^{O} \; XS_{j,i}^{O}{}^{1-\rho_j^{XT}}}{\sum_{ij} P_{j,ij}^{O} XS_{j,ij}^{O}{}^{1-\rho_j^{XT}}}$$

Then, from equation 58

F168. $$B_j^{XT} = \frac{XST_j^{O}}{\left[\sum_i \beta_{j,i}^{XT} \left(XS_{j,i}^{O}\right)^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}}$$

F4.6.2 CET between exports and local production

In accordance with the algebra of the CET transformation function (Appendix C6),

F169F169. $$\rho_{j,i}^{X} = \frac{1+\sigma_{j,i}^{X}}{\sigma_{j,i}^{X}}$$

Following the same calibration strategy as for the CET between commodities, develop equation 61:

F170. $$\frac{EX_{j,i}}{DS_{j,i}} = \left[\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}} \frac{PE_i}{PL_i}\right]^{\sigma_{j,i}^{X}}$$

F171. $$\frac{EX_{j,i}}{DS_{j,i}} = \left[\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}} \frac{PE_i}{PL_i}\right]^{\frac{1}{\rho_{j,i}^{X}-1}}$$

F172. $$\frac{EX_{j,i}}{DS_{j,i}} = \left[\frac{\beta_{j,i}^{X}}{1-\beta_{j,i}^{X}} \frac{PL_i}{PE_i}\right]^{\frac{1}{1-\rho_{j,i}^{X}}}$$

F173. $$\left(\frac{EX_{j,i}}{DS_{j,i}}\right)^{1-\rho_{j,i}^{X}} = \frac{\beta_{j,i}^{X}}{1-\beta_{j,i}^{X}} \frac{PL_i}{PE_i}$$

F174. $$\beta_{j,i}^{X} \; PL_i \; DS_{j,i}^{1-\rho_{j,i}^{X}} = \left(1-\beta_{j,i}^{X}\right) PE_i \; EX_{j,i}^{1-\rho_{j,i}^{X}}$$

F175. $$\beta^X_{j,i}\, PL_i\, DS_{j,i}^{1-\rho^X_{j,i}} = PE_i\, EX_{j,i}^{1-\rho^X_{j,i}} - \beta^X_{j,i}\, PE_i\, EX_{j,i}^{1-\rho^X_{j,i}}$$

F176. $$\beta^X_{j,i}\left(PL_i\, DS_{j,i}^{1-\rho^X_{j,i}} + PE_i\, EX_{j,i}^{1-\rho^X_{j,i}} \right) = PE_i\, EX_{j,i}^{1-\rho^X_{j,i}}$$

Whence

F177. $$\beta^X_{j,i} = \frac{PE^O_i\, EX^O_{j,i}^{1-\rho^X_{j,i}}}{PL^O_i\, DS^O_{j,i}^{1-\rho^X_{j,x}} + PE^O_i\, EX^O_{j,i}^{1-\rho^X_{j,i}}}$$

And from equation 60

F178. $$B^X_{j,i} = \frac{XS^O_{j,i}}{\left[\beta^X_{j,i}\left(EX^O_{j,i}\right)^{\rho^X_{j,x}} + \left(1-\beta^X_{j,i}\right)\left(DS^O_{j,i}\right)^{\rho^X_{j,i}} \right]^{\frac{1}{\rho^X_{j,i}}}}$$

F4.7 CES PARAMETERS

F4.7.1 Composite good

In accordance with the algebra of CES aggregator functions (Appendix C7),

F179. $$\rho^M_i = \frac{1-\sigma^M_i}{\sigma^M_i}$$

Develop equation 64:

F180. $$\frac{IM_i}{DD_i} = \left[\frac{\beta^M_i}{1-\beta^M_i} \frac{PD_i}{PM_i} \right]^{\sigma^M_i}$$

F181. $$\frac{IM_i}{DD_i} = \left[\frac{\beta^M_i}{1-\beta^M_i} \frac{PD_i}{PM_i} \right]^{\frac{1}{\rho^M_i+1}}$$

F182. $$\left(\frac{IM_i}{DD_i} \right)^{\rho^M_i+1} = \frac{\beta^M_i}{1-\beta^M_i} \frac{PD_i}{PM_i}$$

F183. $\beta_i^M PD_i \; DD_i^{\rho_i^M+1} = \left(1-\beta_i^M\right) PM_i \; IM_i^{\rho_i^M+1}$

F184. $\beta_i^M \left(PD_i \; DD_i^{\rho_i^M+1} + PM_i \; IM_i^{\rho_i^M+1} \right) = PM_i \; IM_i^{\rho_i^M+1}$

Whence

F185. $\beta_i^M = \dfrac{PM_i^O \left(IM_i^O\right)^{\rho_i^M+1}}{PD_i^O \left(DD_i^O\right)^{\rho_i^M+1} + PM_i^O \left(IM_i^O\right)^{\rho_i^M+1}}$

From equation 63

F186.. $B_i^M = \dfrac{Q_i^O}{\left[\beta_i^M \left(IM_i^O\right)^{-\rho_i^M} + \left(1-\beta_i^M\right)\left(DD_i^O\right)^{-\rho_i^M} \right]^{-\frac{1}{\rho_i^M}}}$

F4.7.2 Composite capital

In accordance with the algebra of the CES production function (Appendix C2),

F187. $\rho_j^{KD} = \dfrac{1-\sigma_j^{KD}}{\sigma_j^{KD}}$

The calibration of the $\beta_{k,j}^{KD}$ follows the same strategy as that of the $\beta_{j,i}^{XT}$.

Develop equation 8 to obtain relative demand:

F188. $\dfrac{KD_{k,j}}{KD_{kj,j}} = \left[\dfrac{\beta_{k,j}^{KD}}{\beta_{kj,j}^{KD}} \dfrac{RTI_{kj,j}}{RTI_{k,j}} \right]^{\sigma_j^{KD}}$

F189. $\dfrac{KD_{k,j}}{KD_{kj,j}} = \left[\dfrac{\beta_{k,j}^{KD}}{\beta_{kj,j}^{KD}} \dfrac{RTI_{kj,j}}{RTI_{k,j}} \right]^{\frac{1}{\rho_j^{KD}+1}}$

F190. $\left(\dfrac{KD_{k,j}}{KD_{kj,j}} \right)^{\rho_j^{KD}+1} = \dfrac{\beta_{k,j}^{KD}}{\beta_{kj,j}^{KD}} \dfrac{RTI_{kj,j}}{RTI_{k,j}}$

F191. $\beta_{kj,j}^{KD} RTI_{k,j} KD_{k,j}^{\rho_j^{KD}+1} = \beta_{k,j}^{KD} RTI_{kj,j} KD_{kj,j}^{\rho_j^{KD}+1}$

F192. $$\sum_{kj} \beta_{kj,j}^{KD} RTI_{k,j} KD_{k,j}^{\rho_j^{KD}+1} = \sum_{kj} \beta_{k,j}^{KD} RTI_{kj,j} KD_{kj,j}^{\rho_j^{KD}+1}$$

F193. $$RTI_{k,j} KD_{k,j}^{\rho_j^{KD}+1} \sum_{kj} \beta_{kj,j}^{KD} = \beta_{k,j}^{KD} \sum_{kj} RTI_{kj,j} KD_{kj,j}^{\rho_j^{KD}+1}$$

We know that the $\beta_{k,j}^{KD}$, like the $\beta_{j,i}^{XT}$, are defined only up to a factor of proportionality. Therefore, we can, without loss of generality, impose the normalization rule $\sum_{kj} \beta_{kj,j}^{KD} = 1$. It then follows that

F194. $$RTI_{k,j} KD_{k,j}^{\rho_j^{KD}+1} = \beta_{k,j}^{KD} \sum_{kj} RTI_{kj,j} KD_{kj,j}^{\rho_j^{KD}+1}$$

Whence

F195. $$\beta_{k,j}^{KD} = \frac{RTI_{k,j}^{O} \left(KD_{k,j}^{O}\right)^{\rho_j^{KD}+1}}{\sum_{kj} RTI_{kj,j}^{O} \left(KD_{kj,j}^{O}\right)^{\rho_j^{KD}+1}}$$

Then, from equation 7

F196. $$B_j^{KD} = \frac{KDC_j^{O}}{\left[\sum_k \beta_{k,j}^{KD} \left(KD_{k,j}^{O}\right)^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}}}$$

F4.7.3 Composite labor

In accordance with the algebra of the CES production function (Appendix C2),

F197. $$\rho_j^{LD} = \frac{1-\sigma_j^{LD}}{\sigma_j^{LD}}$$

The calibration of the $\beta_{l,j}^{LD}$ follows the same strategy as that of the $\beta_{j,i}^{XT}$.

Develop equation 5 to obtain relative demand:

F198. $$\frac{LD_{l,j}}{LD_{lj,j}} = \left[\frac{\beta_{l,j}^{LD}}{\beta_{lj,j}^{LD}} \frac{WTI_{lj,j}}{WTI_{l,j}}\right]^{\sigma_j^{LD}}$$

F199. $$\frac{LD_{l,j}}{LD_{lj,j}} = \left[\frac{\beta^{LD}_{l,j}}{\beta^{LD}_{lj,j}} \frac{WTI_{lj,j}}{WTI_{l,j}} \right]^{\frac{1}{\rho^{LD}_j + 1}}$$

F200. $$\left(\frac{LD_{l,j}}{LD_{lj,j}} \right)^{\rho^{LD}_j + 1} = \frac{\beta^{LD}_{l,j}}{\beta^{LD}_{lj,j}} \frac{WTI_{lj,j}}{WTI_{l,j}}$$

F201. $$WTI_{l,j} \left(\frac{LD_{l,j}}{LD_{lj,j}} \right)^{\rho^{LD}_j + 1} = WTI_{lj,j} \frac{\beta^{LD}_{l,j}}{\beta^{LD}_{lj,j}}$$

F202. $$\beta^{LD}_{lj,j} WTI_{l,j} LD^{\rho^{LD}_j + 1}_{l,j} = \beta^{LD}_{l,j} WTI_{lj,j} LD^{\rho^{LD}_j + 1}_{lj,j}$$

F203. $$\sum_{lj} \beta^{LD}_{lj,j} WTI_{l,j} LD^{\rho^{LD}_j + 1}_{l,j} = \sum_{lj} \beta^{LD}_{l,j} WTI_{lj,j} LD^{\rho^{LD}_j + 1}_{lj,j}$$

F204. $$WTI_{l,j} LD^{\rho^{LD}_j + 1}_{l,j} \sum_{lj} \beta^{LD}_{lj,j} = \beta^{LD}_{l,j} \sum_{lj} WTI_{lj,j} LD^{\rho^{LD}_j + 1}_{lj,j}$$

We know that the $\beta^{LD}_{l,j}$, like the $\beta^{XT}_{j,i}$, are defined only up to a factor of proportionality. Therefore, we can, without loss of generality, impose the normalization rule $\sum_{lj} \beta^{LD}_{lj,j} = 1$. It then follows that

F205. $$WTI_{l,j} LD^{\rho^{LD}_j + 1}_{l,j} = \beta^{LD}_{l,j} \sum_{lj} WTI_{lj,j} LD^{\rho^{LD}_j + 1}_{lj,j}$$

Whence

F206. $$\beta^{LD}_{l,j} == \frac{WTI^{O}_{l,j} \left(LD^{O}_{l,j} \right)^{\rho^{LD}_j + 1}}{\sum_{lj} WTI^{O}_{lj,j} \left(LD^{O}_{lj,j} \right)^{\rho^{LD}_j + 1}}$$

Then, from equation 5

F207. $$B^{LD}_j = \frac{LDC^{O}_j}{\left[\sum_{l} \beta^{LD}_{l,j} \left(LD^{O}_{l,j} \right)^{-\rho^{LD}_j} \right]^{-\frac{1}{\rho^{LD}_j}}}$$

F4.7.4 Value added

In accordance with the algebra of CES aggregator functions (Appendix C1),

F208. $$\rho_j^{VA} = \frac{1-\sigma_j^{VA}}{\sigma_j^{VA}}$$

Develop equation 4:

F209. $$\frac{LDC_j}{KDC_j} = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}}\frac{RC_j}{WC_j}\right]^{\sigma_j^{VA}}$$

F210. $$\frac{LDC_j}{KDC_j} = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}}\frac{RC_j}{WC_j}\right]^{\frac{1}{\rho_j^{VA}+1}}$$

F211. $$\left(\frac{LDC_j}{KDC_j}\right)^{\rho_j^{VA}+1} = \frac{\beta_j^{VA}}{1-\beta_j^{VA}}\frac{RC_j}{WC_j}$$

F212. $$\beta_j^{VA} RC_j KDC_j^{\rho_j^{VA}+1} = \left(1-\beta_j^{VA}\right) WC_j LDC_j^{\rho_j^{VA}+1}$$

Whence

F213. $$\beta_j^{VA} = \frac{WC_j^O \left(LDC_j^O\right)^{\rho_j^{VA}+1}}{WC_j^O \left(LDC_j^O\right)^{\rho_j^{VA}+1} + RC_j^O \left(KDC_j^O\right)^{\rho_j^{VA}+1}}$$

From equation 3

F214. $$B_j^{VA} = \frac{VA_j^O}{\left[\beta_j^{VA}\left(LDC_j^O\right)^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right)\left(KDC_j^O\right)^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}}$$

F4.8 LES PARAMETERS

We refer to the elasticity of consumption demand for commodity *i* with respect to household *h*'s total consumption budget CTH_h as the « income elasticity » of the consumption of commodity *i* by household *h*[18]. From equation 52, the income elasticity is given by

F215. $$\sigma^Y_{i,h} = \frac{\partial \ln C_{i,h}}{\partial \ln CTH_h} = \frac{CTH_h}{C_{i,h}} \frac{\partial C_{i,h}}{\partial CTH_h} = \frac{CTH_h}{C_{i,h}} \frac{\partial}{\partial CTH_h} \left[C^{MIN}_{i,h} + \frac{\gamma^{LES}_{i,h}}{PC_i} \left(CTH_h - \sum_{ij} C^{MIN}_{ij,h} PC_{ij} \right) \right]$$

F216. $$\sigma^Y_{i,h} = \frac{CTH_h}{C_{i,h}} \frac{\gamma^{LES}_{i,h}}{PC_i} \frac{\partial CTH_h}{\partial CTH_h} = \gamma^{LES}_{i,h} \frac{CTH_h}{PC_i\, C_{i,h}}$$

This implies

F217. $$\gamma^{LES}_{i,h} = \frac{\sigma^Y_{i,h} PC_i\, C_{i,h}}{CTH_h}$$

Now it is readily verified from equation 52 that the household budget constraint $\sum_i PC_i\, C_{i,h} = CTH_h$ implies $\sum_i \gamma^{LES}_{i,h} = 1$. Given equation F216, this requires the elasticities to fulfill the condition

F218. $$\frac{\sum_i \sigma^Y_{i,h} PC_i\, C_{i,h}}{CTH_h} = \sum_i \gamma^{LES}_{i,h} = 1$$

As the assigned values of income elasticities may not satisfy this condition *a priori*, the elasticities are adjusted proportionnally as follows:

F219. $$\sigma^Y_{i,h} = \frac{\overline{\sigma^Y_{i,h}}\, CTH^O_h}{\sum_{ij} \overline{\sigma^Y_{ij,h}}\, PC^O_{ij}\, C^O_{ij,h}}$$

Then, from equation F216

F220. $$\gamma^{LES}_{i,h} = \frac{\sigma^Y_{i,h} PC^O_i\, C^O_{i,h}}{CTH^O_h}$$

[18] If income taxes, transfers and savings were a constant proportion of income, then so would total consumption expenditure, and the elasticity of consumption demand for commodity *i* with respect to household *h*'s total consumption budget would indeed be identical to its income-elasticity.

The Frisch parameter is (Appendix C4)

F221. $$Frisch = -\lambda\, CTH_h = -\frac{CTH_h}{CTH_h - \sum_i PC_i C_{i,h}^{MIN}}$$

So, from equation 52

F222. $$C_{i,h}PC_i = C_{i,h}^{MIN}PC_i + \gamma_{i,h}^{LES}\frac{CTH_h}{-Frisch} = C_{i,h}^{MIN}PC_i - \gamma_{i,h}^{LES}\frac{CTH_h}{Frisch}$$

F223. $$C_{i,h}^{MIN}PC_i = C_{i,h}PC_i + \gamma_{i,h}^{LES}\frac{CTH_h}{Frisch}$$

The calibration formula is then

F224. $$C_{i,h}^{MIN\_O} = C_{i,h}^{O} + \gamma_{i,h}^{LES}\frac{CTH_h^O}{PC_i^O Frisch}$$

F5. Calibration of gross domestic products

From equations 90-93,

F225. $$GDP^{BP\_O} = \sum_j PVA_j^O VA_j^O + TIPT^O$$

F226. $$GDP^{MP\_O} = GDP^{BP\_O} + TPRCTS^O$$

F227. $$GDP^{IB\_O} = \sum_{l,j} W_l^O LD_{l,j}^O + \sum_{k,j} R_{k,j}^O KD_{k,j}^O + TPRODN^O + TPRCTS^O$$

F228. $$GDP^{FD\_O} = \sum_i PC_i^O\left[\sum_h C_{i,h}^O + CG_i^O + INV_i^O + VSTK_i^O\right] + \sum_i PE_i^{FOB\_O}EX_i^O - \sum_i e^O PWM_i^O IM_i^O$$

F6. Calibration of real (volume) variables computed from price indices

From equations 94-98

F229. $$CTH_h^{REAL\_O} = \frac{CTH_h^O}{PIXCON^O}$$

F230. $$G^{REAL\_O} = \frac{G^O}{PIXGVT^O}$$

F231. $$GDP^{BP\_REAL\_O} = \frac{GDP^{BP\_O}}{PIXGDP^O}$$

F232. $GDP^{MP\_REAL\_O} = \frac{GDP^{MP\_O}}{PIXCON^{O}}$

F233. $GFCF^{REAL\_O} = \frac{GFCF^{O}}{PIXINV^{O}}$

References for Appendix F

ANNABI, Nabil, Bernard DECALUWÉ and John COCKBURN (2006) *Functional Forms and Parametrization of CGE Models*, PEP-MPIA Working Paper 2006-04, Politiques économiques et pauvreté / Poverty and Economic Policies, Université Laval, Québec.

LEONTIEF, Wassily W. (1941), *The structure of American economy 1919-1929*, New York, Oxford University Press.

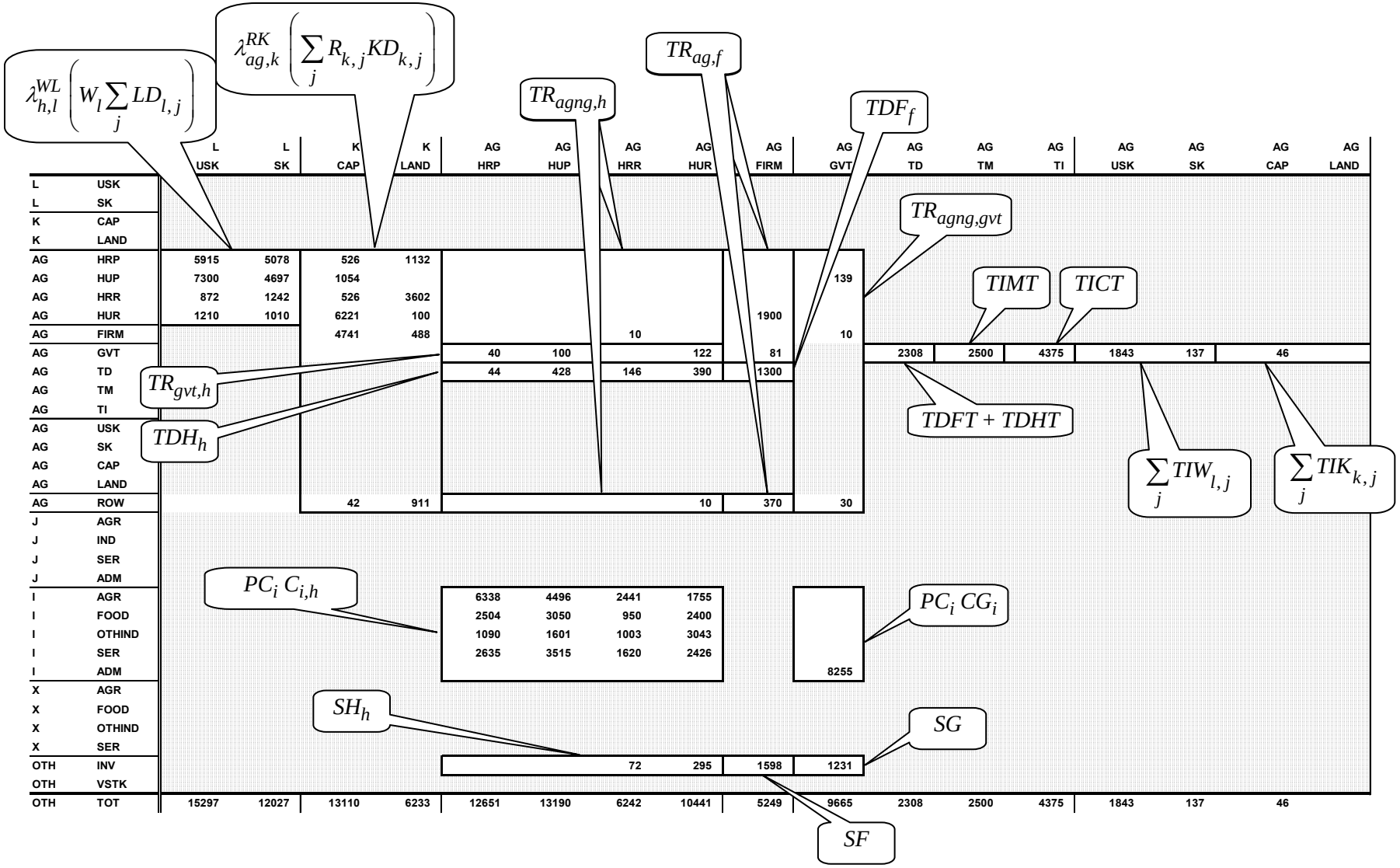
LEONTIEF, Wassily W. (1951), *The structure of American economy 1919-1939*, New York, Oxford University Press.

LEONTIEF, Wassily W. et al. (1953), *Studies in the structure of the American economy*, New York, Oxford University Press.

STONE, J.R.N. (1951), «Simple transaction models, information and computing», *Review of Economic Studies*, 19.

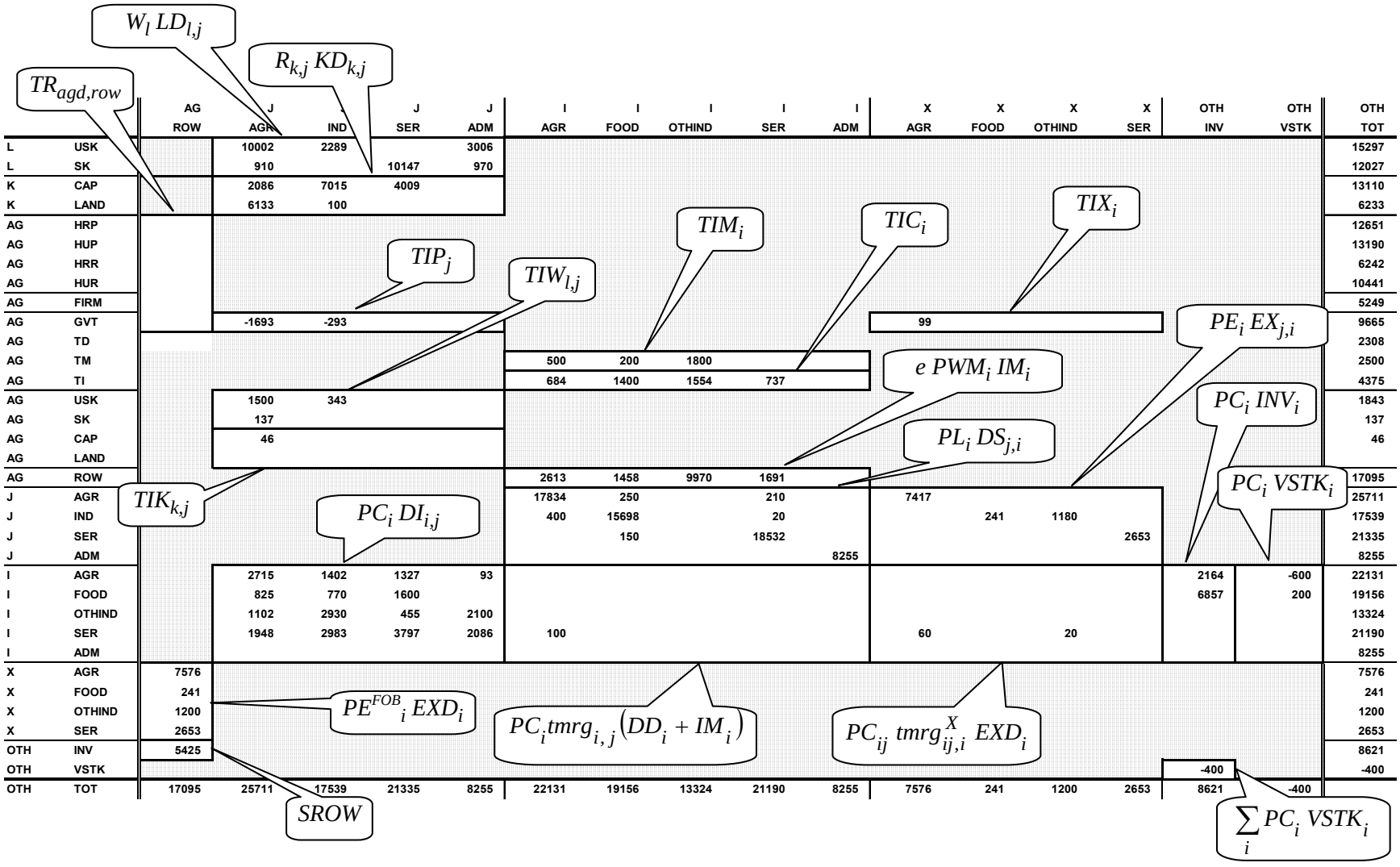
STONE, J.R.N. et UTTING, J.E.G. (1953), «The relationship between input-output analysis and national accounting», in NETHERLANDS ECONOMIC INSTITUTE (1953), *Input-Output Relations*, Proceedings of a conference on inter-industrial relations held at Driebergen, Holland, 1953; Leyden, H.E. Stenfort Kroese N.V.

Figure F1 – Structure of the SAM (part I)



		L USK	L SK	K CAP	K LAND	AG HRP	AG HUP	AG HRR	AG HUR	AG FIRM	AG GVT	AG TD	AG TM	AG TI	AG USK	AG SK	AG CAP	AG LAND
L	USK																	
L	SK																	
K	CAP																	
K	LAND																	
AG	HRP	5915	5078	526	1132						139							
AG	HUP	7300	4697	1054														
AG	HRR	872	1242	526	3602													
AG	HUR	1210	1010	6221	100					1900								
AG	FIRM			4741	488			10			10							
AG	GVT					40	100		122	81		2308	2500	4375	1843	137	46	
AG	TD					44	428	146	390	1300								
AG	TM																	
AG	TI																	
AG	USK																	
AG	SK																	
AG	CAP																	
AG	LAND																	
AG	ROW			42	911				10	370	30							
J	AGR																	
J	IND																	
J	SER																	
J	ADM																	
I	AGR					6338	4496	2441	1755									
I	FOOD					2504	3050	950	2400									
I	OTHIND					1090	1601	1003	3043									
I	SER					2635	3515	1620	2426									
I	ADM										8255							
X	AGR																	
X	FOOD																	
X	OTHIND																	
X	SER																	
OTH	INV							72	295	1598	1231							
OTH	VSTK																	
OTH	TOT	15297	12027	13110	6233	12651	13190	6242	10441	5249	9665	2308	2500	4375	1843	137	46	

Figure F1 – Structure of the SAM (part II)



		AG	J	J	J	J	I	I	I	I	I	X	X	X	X	OTH	OTH	OTH
		ROW	AGR	IND	SER	ADM	AGR	FOOD	OTHIND	SER	ADM	AGR	FOOD	OTHIND	SER	INV	VSTK	TOT
L	USK		10002	2289		3006												15297
L	SK		910		10147	970												12027
K	CAP		2086	7015	4009													13110
K	LAND		6133	100														6233
AG	HRP																	12651
AG	HUP																	13190
AG	HRR																	6242
AG	HUR																	10441
AG	FIRM																	5249
AG	GVT		-1693	-293								99						9665
AG	TD																	2308
AG	TM						500	200	1800									2500
AG	TI						684	1400	1554	737								4375
AG	USK		1500	343														1843
AG	SK		137															137
AG	CAP		46															46
AG	LAND																	
AG	ROW						2613	1458	9970	1691								17095
J	AGR						17834	250		210		7417						25711
J	IND						400	15698		20			241	1180				17539
J	SER							150		18532					2653			21335
J	ADM										8255							8255
I	AGR		2715	1402	1327	93										2164	-600	22131
I	FOOD		825	770	1600											6857	200	19156
I	OTHIND		1102	2930	455	2100												13324
I	SER		1948	2983	3797	2086	100					60		20				21190
I	ADM																	8255
X	AGR	7576																7576
X	FOOD	241																241
X	OTHIND	1200																1200
X	SER	2653																2653
OTH	INV	5425																8621
OTH	VSTK															-400		-400
OTH	TOT	17095	25711	17539	21335	8255	22131	19156	13324	21190	8255	7576	241	1200	2653	8621	-400	

APPENDIX G: CLOSURES, THE NUMERAIRE, AND MODEL HOMOGENEITY

G1. Default closure

The default PEP-1-1 model closure defines the exchange rate e as the numeraire, with government expenditures G[19] and the current account balance CAB fixed. Regarding capital, there are two possibilities. Either capital is mobile between industries ($kmob$ = 1), in which case KS_k is fixed, or capital is not mobile ($kmob$ = 0), and $KD_{k,j}$ is fixed.

Some variables are generally considered to be exogenous, and they are routinely fixed. They are: minimum consumption $C_{i,h}^{MIN}$:, labor supply LS_l, the volume of inventory changes $VSTK_i$ [20], and world prices of imports (PWM_i) and exports (PWX_i).

G2. Homogeneity

The PEP-1-1 model is homogenous. In CGE models, only relative prices matter. Therefore, changing the value of the numeraire shouldn't affect volume variable levels, and should change all prices and nominal values in the same proportion as the numeraire. Of course, in order to test for homogeneity, nominal variables and prices that are fixed in the closure must be changed in the same proportion as the numeraire. In the PEP-1-1 default closure, these are: government expenditures G, the current account balances CAB, and world prices of imports (PWM_i) and exports (PWX_i).

19 Depending on the context, the user may prefer to fix *real* government expenditures.

20 Inventory changes may be positive or negative in the SAM. They are made exogenous in PEP-1-1 to avoid the complications of modeling negative inventory stock variations as endogenous.

Model Structure for Policy Simulations

*** Number of equations corresponds to
GAMS code line numbers of each Simulation***

Appendix B. Equations of Simulations

Equations of Simulation Report 1

A1.1 Production

1. $VA_{j,t} = v_j XST_{j,t}$
2. $CI_{j,t} = io_j XST_{j,t}$
3. $VA_{j1,t} = B_{j1}^{VA}\left[\beta_{j1}^{VA}(X_{j1,t}LDC_{j1,t})^{-\rho^{VA}} + (1-\beta_{j1}^{VA})KDC_{j1,t}^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_{j1}^{VA}}\right)}$
4. $VA_{min,t} = B_{min}^{VA}\left[\beta_{min}^{VA}(X_{min,t}LDC_{min,t})^{-\rho^{VA}} + (1-\beta_{min}^{VA})KDC_{min,t}^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_{min}^{VA}}\right)}$
5. $X_{j,t}LDC_{j,t} = \left[\frac{\beta^{VA}}{1-\beta_j^{VA}}\frac{RC_{j,t}}{WC_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t}$
6. $LDC_{j,t} = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j,t}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$
7. $LD_{l,j,t} = \left[\frac{\beta_{l,j}^{LD} WC_{j,t}}{WTI_{l,j,t}}\right]^{\sigma_{LD}^{j}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_{j,t}$
8. $LD_{l,j,t} = B_{l,j}^{LDG}\left\{\left[\beta_{l,j}^{LDG} LDM_{l,j,t}^{-\rho_j^{LDG}}\right] + \left[(1-\beta_{l,j}^{LDG})LDF_{l,j,t}^{-\rho_j^{LDG}}\right]\right\}^{-\frac{1}{\rho_j^{LDG}}}$
9. $LDM_{l,j,t} = \left\{\left[\frac{\beta_{l,j}^{LDG}}{1-\beta_{l,j}^{LDG}}\right]\left[\frac{WF_{l,t}}{WM_{l,t}}\right]\right\}^{\sigma_j^{LDG}} LDF_{l,j,t}$
10. $KDC_{j,t} = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j,t}^{-\rho_j^{KD}}\right]^{-\left(\frac{1}{\rho_j^{KD}}\right)}$
11. $KD_{k,j,t} = \left[\frac{\beta_{k,j}^{KD} RC_{j,t}}{RTI_{k,j,t}}\right]^{\rho_j^{KD}} \left(B_j^{KD}\right)^{\rho_j^{KD}-1} KDC_{j,t}$
12. $DI_{i,j,t} = aij_{i,j} C\ I_{j,t}$

A1.2 Households

13. $YH_{h,t} = YHL_{h,t} + YHK_{h,t} + YHTR_{h,t}$
14. $YHL_{h,t} = \sum_l \lambda_{h,l}^{WL}\left(W_{l,t}\sum_j LD_{l,j,t}\right)$
15. $YHK_{h,t} = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j,t}KD_{k,j,t}\right) + CAPROW_t$
16. $YHTR_{h,t} = \sum_{ag} TR_{h,ag,t}$
17. $YDH_{h,t} = YH_{h,t} - TDH_{h,t} - TR_{gvt,h,t}$
18. $CTH_{h,t} = YDH_{h,t} - SH_{h,t} - \sum_{agng} TR_{agng,h,t}$
19. $SH_{h,t} = PIXCON_t^{\eta} sh0_{h,t} + sh1_{h,t} YDH_{h,t} zzz_t$

A1.2.3 Government

20. $YG_t = YGK_t + TDHT_t + TPRODN_t + TPRCTS_t + YGTR_t$
21. $YGK_t = \sum_k \lambda_{gvt,k}^{RK} \left(\sum_j R_{k,j,t} KD_{k,j,t}\right)$
22. $TDHT_t = \sum_h TDH_{h,t}$
23. $TPRODN_t = TIWT_t + TIKT_t + TIPT_t$
24. $TIKT_t = \sum_{k,j} TIK_{k,j,t}$
25. $TIPT_t = \sum_j TIP_{j,t}$
26. $TPRCTS_t = TICT_t + TIMT_t + TIXT_t$
27. $TICT_t = \sum_i TIC_{i,t}$
28. $TIMT_t = \sum_i TIM_{i,t}$
29. $TIXT_t = \sum_i TIX_{i,t}$
30. $YGTR_t = \sum_{agng} TR_{gvt,agng,t}$
31. $TDH_{h,t} = PIXCON_t^{\eta} ttdh0_{h,t} + ttdh1_{h,t} YH_{h,t}$
32. $TIK_{k,j,t} = ttik_{k,j,t} R_{k,j,t} KD_{k,j,t}$
33. $TIP_{j,t} = ttip_{j,t} PP_{j,t} XST_{j,t}$
34. $TIC_{i,t} = ttic_{i,t}\left[(PL_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) DD_{i,t} + ((1 + ttim_{i,t}) PWM_{i,t} e_t + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) IM_{i,t}\right]$
35. $TIM_{i,t} = ttim_{i,t} PWM_{i,t} e_t IM_{i,t}$
36. $TIX_{i,t} = ttix_{i,t}\left(PE_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}^{x}\right) EXD_{i,t}$
37. $SG_t = YG_t - \sum_{agng} TR_{agng,gvt,t} - G_t$

A1.2.4 Rest of the world

38. $YROW_t = e_t \sum_i PWM_{i,t} IM_{i,t} + \sum_k \lambda_{row,k}^{RK} \left(\sum_j R_{k,t,t}\ KD_{k,j,t}\right) + CAPROW_t + \sum_{agd} TR_{row,agd,t}$
39. $SROW_t = YROW_t - \sum_i PE_{i,t}^{FOB} EXD_{i,t} - \sum_{agd} TR_{agd,row,t} - CAPROW_t$
40. $SROW_t = -CAB_t$

A1.2.5 Transfers

41. $TR_{agng,h,t} = \lambda_{agng,h}^{TR} YDH_{h,t} zz_{agng,h,t}$
42. $TR_{gvt,h,t} = PIXCON_t^{\eta} tr0_{h,t} + tr1_{h,t} YH_{h,t} zz_{gvt,h,t}$
43. $TR_{agng,gvt,t} = PIXCON_t^{\eta} TR_{agng,gvt}^{O} zz_{agng,gvt,t}$
44. $TR_{agd,row,t} = PIXCON_t^{\eta} TR_{agd,row}^{O} zz_{agd,row,t}$

Demand

45. $PC_{i,t}C_{i,h,t} = PC_{i,t}C_{i,h,t}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h,t} - \sum_{ij} PC_{ij,t}C_{ij,h,t}^{MIN}\right)$
46. $GFCF_t = IT_t - \sum_i PC_{i,t}VSTK_{i,t}$
47. $PC_{i,t}INV_{i,t}^{PRI} = \gamma_i^{INVPRI} IT_t^{PRI}$
48. $PC_{i,t}INV_{i,t}^{PUB} = \gamma_i^{INVPUB} IT_t^{PUB}$
49. $INV_{i,t} = INV_{i,t}^{PRI} + INV_{i,t}^{PUB}$
50. $PC_{i,t}CG_{i,t} = g1_{i,t}\gamma_i^{GVT} G_t$
51. $DIT_{i,t} = \sum_j DI_{i,j,t}$
52. $MRGN_{i,t} = \sum_{ij} tmrg_{i,ij}DD_{ij,t} + \sum_{ij} tmrg_{i,ij}IM_{ij,t} + \sum_{ij} tmrg_{i,ij}^{X}EXD_{ij,t}$

International trade

53. $XST_{j,t} = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i,t}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$
54. $XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}}\left[\frac{P_{j,i,t}}{\beta_{j,i}^{XT} PT_{j,t}}\right]^{\sigma_j^{XT}}$
55. $XS_{j,i,t} = B_{j,i}^{X}\left[\beta_{j,i}^{X} EX_{j,i,t}^{\rho_{j,i}^{X}} + \left(1-\beta_{j,i}^{X}\right)DS_{j,i,t}^{\rho_{j,x}^{X}}\right]^{\frac{1}{\rho_{j,i}^{X}}}$
56. $EX_{j,i,t} = \left[\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\frac{PE_{i,t}}{PL_{i,t}}\right]^{\sigma_{j,i}^{X}} DS_{j,i,t}$
57. $EXD_{i,t} = EXD_i^{O} pop_t \left(\frac{e_t PWX_{i,t}}{PE_{i,t}^{FOB}}\right)^{\sigma_i^{XD}}$
58. $Q_{i,t} = B_i^{M}\left[\beta_i^{M} IM_{i,t}^{-\rho_i^{M}} + \left(1-\beta_i^{M}\right)DD_{i,t}^{-\rho_i^{M}}\right]^{-\frac{1}{\rho_i^{M}}}$
59. $IM_{i,t} = \left[\frac{\beta_i^{M}}{1-\beta_i^{M}}\frac{PD_{i,t}}{PM_{i,t}}\right]^{\sigma_i^{M}} DD_{i,t}$

Prices

60. $PP_{j,t} = \frac{PVA_{j,t}VA_{j,t} + PCI_{j,t}CI_{j,t}}{XST_{j,t}}$
61. $PT_{j,t} = \left(1 + ttip_{j,t}\right)PP_{j,t}$
62. $PCI_{j,t} = \frac{\sum_i PC_{i,t}DI_{i,j,t}}{CI_{j,t}}$
63. $PVA_{j,t} = \frac{WC_{j,t}LDC_{j,t} + RC_{j,t}KDC_{j,t}}{VA_{j,t}}$
64. $LD_{l,j,t}WTI_{l,j,t} = WM_{l,t}LDM_{l,j,t} + WF_{l,t}LDF_{l,j,t}$
65. $RTI_{k,j,t} = R_{k,j,t}(1 + ttik_{k,j,t})$
66. $P_{j,i,t} = PT_{j,t}$
67. $P_{j,i,t} = \frac{PE_{i,t}EX_{j,i,t} + PL_{i,t}DS_{j,i,t}}{XS_{j,i,t}}$
68. $PE_{i,t}^{FOB} = \left(PE_{i,t} + \sum_{ij} PC_{ij,t}tmrg_{ij,i}^{X}\right)\left(1 + ttix_{i,t}\right)$
69. $PD_{i,t} = \left(1 + ttic_{i,t}\right)\left(PL_{i,t} + \sum_{ij} PC_{ij,t}tmrg_{ij,i}\right)$
70. $PM_{i,t} = \left(1 + ttic_{i,t}\right)\left(\left(1 + ttim_{i,t}\right)e_t PWM_{i,t} + \sum_{ij} PC_{ij,t}tmrg_{ij,i}\right)$
71. $PC_{i,t} = \frac{PM_{i,t}IM_{i,t} + PD_{i,t}DD_{i,t}}{Q_{i,t}}$
72. $PIXGDP_t = \sqrt{\frac{\sum_j\left(PVA_{j,t} + \frac{TIP_{j,t}}{VA_{j,t}}\right)VA_j^{O}\sum_j\left(PVA_{j,t}VA_{j,t} + TIP_{j,t}\right)}{\sum_j\left(PVA_j^{O}VA_j^{O} + TIP_j^{O}\right)\sum_j\left(PVA_j^{O} + \frac{TIP_j^{O}}{VA_j^{O}}\right)VA_{j,t}}}$

73. $PIXCON_t = \frac{\sum_i PC_{i,t} \sum_h C^O_{i,h}}{\sum_{ij} PC^O_{ij} \sum_h C^O_{ij,h}}$
74. $PIXINV^{PRI}_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma_i^{INVPRI}}$
75. $PIXINV^{PUB}_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma_i^{INVPUB}}$
76. $PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma_i^{GVT}}$

Equilibrium

77. $Q_{i1,t} = \sum_h C_{i1,h,t} + CG_{i1,t} + INV_{i1,t} + VSTK_{i1,t} + DIT_{i1,t} + MRGN_{i1,t}$
78. $\sum_j LDM_{l,j,t} = LSM_{l,t}$
79. $\sum_j LDF_{l,j,t} = LSF_{l,t}$
80. $\sum_j KD_{k,j,t} = KS_{k,t}$
81. $IT_t = \sum_h SH_{h,t} + SG_t + SROW_t$
82. $IT^{PRI}_t = IT_t - IT^{PUB}_t - \sum_i PC_{i,t} VSTK_{i,t}$
83. $\sum_j DS_{j,i,t} = DD_{i,t}$
84. $\sum_j EX_{j,i,t} = EXD_{i,t}$

Gross Domestic Product

85. $GDP^{BP}_t = \sum_j PVA_{j,t} VA_{j,t} + TIPT_t$
86. $GDP^{MP}_t = GDP^{BP}_t + TPRCTS_t$
87. $GDP^{IB}_t = \sum_{l,j} WTI_{l,j,t} LD_{l,j,t} + \sum_{k,j} R_{k,j,t} KD_{k,j,t} + TPRODN_t + TPRCTS_t$
88. $GDP^{FD}_t = \sum_i PC_{i,t}\left[\sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t}\right] + \sum_i PE^{POB}_{i,t} EXD_{i,t} - \sum_i e_t PWM_{i,t} IM_{i,t}$
89. $EX^T_t = \sum_i PE^{FOB}_{i,t} EXD_{i,t}$
90. $IM^T_t = \sum_i PWM_{i,t} e_t IM_{i,t}$

Real variables

91. $CTH^{REAL}_{h,t} = \frac{CTH_{h,t}}{PIXCON_t}$
92. $G^{REAL}_t = \frac{G_t}{PIXGVT_t}$
93. $GDP^{BP\_REAL}_t = \frac{GDP^{BP}_t}{PIXGDP_t}$
94. $GDP^{MP\_REAL}_t = \frac{GDP^{MP}_t}{PIXCON_t}$
95. $GFCF^{PRI\_REAL}_t = \frac{IT^{PRI}_t}{PIXINV^{PRI}_t}$
96. $GFCF^{PUB\_REAL}_t = \frac{IT^{PUB}_t}{PIXINV^{PUB}_t}$

Dynamic equations

97. $KD_{k,j,t+1} = KD_{k,j,t}(1 - \delta_{k,j}) + IND_{k,j,t}$
98. $IT^{PUB}_t = PK^{PUB}_t \sum_{k,pub} IND_{k,pub,t}$
99. $IT^{PRI}_t = PK^{PRI}_t \sum_{k,bus} IND_{k,bus,t}$
100. $PK^{PRI}_t = \frac{1}{A^{K\_PRI}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right]^{\gamma_i^{INVPRI}}$

101. $PK_t^{PUB} = \frac{1}{A^{K\_PUB}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right]^{\gamma_i^{INVPUB}}$

102. $IND_{k,bus,t} = \phi_{k,bus} \left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma_{k,bus}^{INV}} KD_{k,bus,t}$

103. $U_{k,bus,t} = PK_t^{PRI}(\delta_{k,bus} + IR_t)$

104. $U_{k,pub,t} = PK_t^{PUB}(\delta_{k,pub} + IR_t)$

Other equations

105. $LEON_t = Q_{agr,t} - \sum_h C_{agr,h,t} - CG_{agr,t} - INV_{agr,t} - VSTK_{agr,t} - DIT_{agr,t} - MRGN_{agr,t}$

106. $LSM_{l,t} = LSM_{l,t}^P(1 - unempl_{l,t}^M)$

107. $LSF_{l,t} = LSF_{l,t}^P(1 - unempl_{l,t}^F)$

108. $\frac{WM_{l,t}}{PIXCON_t} = \frac{WM_l^O}{PIXCONO}\left[\frac{0.11}{unempl_{l,t}^M}\right]^{0.2}$

109. $\frac{WF_{l,t}}{PIXCON_t} = \frac{WF_l^O}{PIXCONO}\left[\frac{0.09}{unempl_{l,t}^F}\right]^{0.2}$

110. $buddef_t = G_t + \sum_{agng} TR_{agng,gvt,t} + Capexp_t - YG_t$

111. $defGDPr_t = \frac{buddef_t}{GDP_t^{MP}} * 100$

112. $EXRT_t = 1993 * e_t F_t^{EXRT}$

113. $debt_{t+1}^{row} = debt_t^{row} + GFF_t/EXRT_t$

114. $debt_{t+1}^{dom} = debt_t^{dom} + GDF_t$

115. $debt_t = debt_t^{dom} + debt_t^{row} EXRT_t$

116. $debttoGDP_{t+1} = \frac{debt_{t+1}}{GDP_t^{MP}} * 100$

117. $TR_{h,gvt,t} = TR_{h,gvt,t}^i + 0.11 * debt_t^{dom}$

118. $TR_{row,gvt,t} = TR_{row,gvt,t}^i + (0.04 - F_t^{IRrow}) debt_t^{row} EXRT_t$

119. $TR_{row,h,t} = TR_{row,h,t}^i$

120. $TR_{h,row,t} = TR_{h,row,t}^i$

121. $TR_{gvt,h,t} = TR_{gvt,h,t}^i$

122. $TR_{gvt,row,t} = TR_{gvt,row,t}^i$

123. $GFF_t = 0.8 * buddef_t + F_t^{GFF}$

124. $GDF_t = 0.2 * buddef_t + F_t^{GDF}$

125. $Unemp_t = \left(1 - \frac{\sum_l LSM_{l,t} + LSF_{l,t})}{\sum_l LSM_{l,t}^P + LSF_{l,t}^P}\right) * 100$

126. $Unemp_t^M = \left(1 - \frac{\sum_l LSM_{l,t})}{\sum_l LSM_{l,t}^P}\right) * 100$

127. $Unemp_t^F = \left(1 - \frac{\sum_l LSF_{l,t})}{\sum_l LSF_{l,t}^P}\right) * 100$

Equations of Simulation Report 2

A1.1 Production

128. $VA_{j,t} = v_j XST_{j,t}$

129. $CI_{j,t} = io_j XST_{j,t}$

130. $VA_{j,t} = B_j^{VA}\left[\beta_j^{VA}(TFP1_t TFP_{j,t} LDC_{j,t})^{-\rho^{VA}} + (1-\beta_j^{VA})KDC_{j,t}^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_j^{VA}}\right)}$

131. $TFP1_t TFP_{j,t} LDC_{j,t} = \left[\frac{\beta^{VA}}{1-\beta_j^{VA}}\frac{RC_{j,t}}{WC_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t}$

132. $LDC_{j,t} = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j,t}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$

133. $LD_{l,j,t} = \left[\frac{\beta_{l,j}^{LD} WC_{j,t}}{WTI_{l,j,t}}\right]^{\sigma_{LD}^{j}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_{j,t}$

134. $KDC_{j,t} = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j,t}^{-\rho_j^{KD}}\right]^{-\left(\frac{1}{\rho_j^{KD}}\right)}$

135. $KD_{k,j,t} = \left[\frac{\beta_{k,j}^{KD} RC_{j,t}}{RTI_{k,j,t}}\right]^{\rho_j^{KD}} \left(B_j^{KD}\right)^{\rho_j^{KD}-1} KDC_{j,t}$

136. $DI_{i,j,t} = aij_{i,j} C\ I_{j,t}$

A1.2 Households

137. $YH_{h,t} = YHL_{h,t} + YHK_{h,t} + YHTR_{h,t} + avilga_t$

138. $YHL_{h,t} = \sum_l \lambda_{h,l}^{WL}\left(W_{l,t}\sum_j LD_{l,j,t} Wdist_{l,j}\right) + LABROW_t$

139. $YHK_{h,t} = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j,t} KD_{k,j,t}\right) + CAPROW_t$

140. $YHTR_{h,t} = \sum_{ag} TR_{h,ag,t}$

141. $YDH_{h,t} = YH_{h,t} - TDH_{h,t} - TR_{gvt,h,t} - Offshore_t$

142. $CTH_{h,t} = YDH_{h,t} - SH_{h,t} - \sum_{agng} TR_{agng,h,t}$

143. $SH_{h,t} = PIXCON_t^{\eta} sh0_{h,t} + sh1_{h,t} YDH_{h,t}$

A1.2.3 Government

144. $YG_t = YGK_t + TDHT_t + TPRODN_t + TPRCTS_t + YGTR_t$

145. $YGK_t = \sum_k \lambda_{gvt,k}^{RK}\left(\sum_j R_{k,j,t} KD_{k,j,t}\right)$

146. $TDHT_t = \sum_h TDH_{h,t}$

147. $TPRODN_t = TIWT_t + TIKT_t + TIPT_t$

148. $TIWT_t = \sum_{l,j} TIW_{l,j,t}$

149. $TIKT_t = \sum_{k,j} TIK_{k,j,t}$

150. $TIPT_t = \sum_j TIP_{j,t}$

151. $TPRCTS_t = TICT_t + TIMT_t + TIXT_t$

152. $TICT_t = \sum_i TIC_{i,t}$

153. $TIMT_t = \sum_i TIM_{i,t}$

154. $TIXT_t = \sum_i TIX_{i,t}$

155. $YGTR_t = \sum_{agng} TR_{gvt,agng,t}$

156. $TDH_{h,t} = PIXCON_t^{\eta} ttdh0_{h,t} + ttdh1_{h,t}(YH_{h,t} - avilga_t)$

157. $TIW_{l,j,t} = ttiw_{l,j,t} W_{l,t} Wdist_{l,j} LD_{l,j,t}$

158. $TIK_{k,j,t} = ttik_{k,j,t} R_{k,j,t} KD_{k,j,t}$

159. $TIP_{j,t} = ttip_{j,t} PP_{j,t} XST_{j,t}$

160. $TIC_{i,t} = ttic_{i,t}\left[(PL_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) DD_{i,t} + ((1 + ttim_{i,t}) PWM_{i,t} e_t + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) IM_{i,t}\right]$

161. $TIM_{i,t} = ttim_{i,t} PWM_{i,t} e_t IM_{i,t}$

162. $TIX_{i,t} = ttix_{i,t}\left(PE_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}^{x}) EXD_{i,t}\right)$

163. $SG_t = YG_t - GTR_t - G_t$

164. $GTR_t = \sum_{agng} TR_{agng,gvt,t}$

A1.2.4 Rest of the world

165. $YROW_t = e_t \sum_i PWM_{i,t} IM_{i,t} + \sum_k \lambda_{row,k}^{RK}\left(\sum_j R_{k,j,t}\ KD_{k,j,t}\right) + \sum_{agd} TR_{row,agd,t} + \sum_l lambda_{row,l}^{WL} \sum_j WTI_{l,j,t} LD_{l,j,t} + Offshore_t$

166. $CAB_t = -[YROW_t - \sum_i PE_{i,t}^{FOB} EXD_{i,t} - \sum_{agd} TR_{agd,row,t} - CAPROW_t - LABROW_t]$

167. $CAB_t = -[SROW_t + FDI_t^{coal} + FDI_t^{metal} + CBI_t]$

A1.2.5 Transfers

168. $TR_{agng,h,t} = \lambda_{agng,h}^{TR} YDH_{h,t}$

169. $TR_{gvt,h,t} = PIXCON_t^{\eta} tr0_{h,t} + tr1_{h,t}(YH_{h,t} - avilga_t)$

170. $TR_{agng,gvt,t} = PIXCON_t^{\eta} TR_{agng,gvt}^{O} TFP1_t pop_t$

171. $TR_{agd,row,t} = PIXCON_t^{\eta} TR_{agd,row}^{O} pop_t aindex_t$

Demand

172. $PC_{i,t} C_{i,h,t} = PC_{i,t} C_{i,h,t}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h,t} - \sum_{ij} PC_{ij,t} C_{ij,h,t}^{MIN}\right)$

173. $GFCF_t = IT_t - \sum_i PC_{i,t} VSTK_{i,t}$

174. $PC_{i,t} INV_{i,t}^{PRI} = \gamma_i^{INVPRI} IT_t^{PRI} + \gamma_i^{INVMIN} IT_t^{MIN}$

175. $PC_{i,t}INV_{i,t}^{PUB} = \gamma_i^{INVPUB} IT_t^{PUB}(1 - avilgarate_t)$
176. $INV_{i,t} = INV_{i,t}^{PRI} + INV_{i,t}^{PUB}$
177. $PC_{i,t}CG_{i,t} = \gamma_i^{GVT} G_t$
178. $DIT_{i,t} = \sum_j DI_{i,j,t}$
179. $MRGN_{i,t} = \sum_{ij} tmrg_{i,ij} DD_{ij,t} + \sum_{ij} tmrg_{i,ij} IM_{ij,t} + \sum_{ij} tmrg_{i,ij}^X EXD_{ij,t}$

International trade

180. $XST_{j,t} = B_j^{XT} \left[\sum_i \beta_{j,i}^{XT} XS_{j,i,t}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$
181. $XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i,t}}{\beta_{j,i}^{XT} PT_{j,t}}\right]^{\sigma_j^{XT}}$
182. $XS_{j,i,t} = B_{j,i}^X \left[\beta_{j,i}^X EX_{j,i,t}^{\rho_{j,i}^X} + \left(1 - \beta_{j,i}^X\right) DS_{j,i,t}^{\rho_{j,x}^X}\right]^{\frac{1}{\rho_{j,i}^X}}$
183. $EX_{j,i,t} = \left[\frac{1-\beta_{j,i}^X}{\beta_{j,i}^X} \frac{PE_{i,t}}{PL_{i,t}}\right]^{\sigma_{j,i}^X} DS_{j,i,t}$
184. $EXD_{i,t} = TFP1_t pop_t EXD_i^O pop_t \left(\frac{e_t PWX_{i,t}}{PE_{i,t}^{FOB}}\right)^{\sigma_i^{XD}}$
185. $Q_{i,t} = B_i^M \left[\beta_i^M IM_{i,t}^{-\rho_i^M} + \left(1 - \beta_i^M\right) DD_{i,t}^{-\rho_i^M}\right]^{-\frac{1}{\rho_i^M}}$
186. $IM_{i,t} = \left[\frac{\beta_i^M}{1-\beta_i^M} \frac{PD_{i,t}}{PM_{i,t}}\right]^{\sigma_i^M} DD_{i,t}$

Prices

187. $PP_{j,t} = \frac{PVA_{j,t}VA_{j,t} + PCI_{j,t}CI_{j,t}}{XST_{j,t}}$
188. $PT_{j,t} = \left(1 + ttip_{j,t}\right) PP_{j,t}$
189. $PCI_{j,t} = \frac{\sum_i PC_{i,t} DI_{i,j,t}}{CI_{j,t}}$
190. $PVA_{j,t} = \frac{WC_{j,t}LDC_{j,t} + RC_{j,t}KDC_{j,t}}{VA_{j,t}}$
191. $WTI_{l,j,t} = W_{l,t}(1 + ttiw_{l,j,t})$
192. $RTI_{k,j,t} = R_{k,j,t}(1 + ttik_{k,j,t})$
193. $P_{j,i,t} = PT_{j,t}$
194. $P_{j,i,t} = \frac{PE_{i,t}EX_{j,i,t} + PL_{i,t}DS_{j,i,t}}{XS_{j,i,t}}$
195. $PE_{i,t}^{FOB} = \left(PE_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}^X\right)\left(1 + ttix_{i,t}\right)$
196. $PD_{i,t} = \left(1 + ttic_{i,t}\right)\left(PL_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}\right)$
197. $PM_{i,t} = \left(1 + ttic_{i,t}\right)\left(\left(1 + ttim_{i,t}\right) e_t PWM_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}\right)$
198. $PC_{i,t} = \frac{PM_{i,t}IM_{i,t} + PD_{i,t}DD_{i,t}}{Q_{i,t}}$
199. $PIXGDP_t = \sqrt{\frac{\sum_j \left(PVA_{j,t} + \frac{TIP_{j,t}}{VA_{j,t}}\right) VA_j^O \sum_j \left(PVA_{j,t}VA_{j,t} + TIP_{j,t}\right)}{\sum_j \left(PVA_j^O VA_j^O + TIP_j^O\right) \sum_j \left(PVA_j^O + \frac{TIP_j^O}{VA_j^O}\right) VA_{j,t}}}$
200. $PIXCON_t = \frac{\sum_i PC_{i,t} \sum_h C_{i,h}^O}{\sum_{ij} PC_{ij}^O \sum_h C_{ij,h}^O}$

201. $PIXINV_t^{PRI} = \prod_i \left(\frac{PC_{i,t}}{PC_i^O}\right)^{\gamma_i^{INVPRI}}$

202. $PIXINV_t^{PUB} = \prod_i \left(\frac{PC_{i,t}}{PC_i^O}\right)^{\gamma_i^{INVPUB}}$

203. $PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PC_i^O}\right)^{\gamma_i^{GVT}}$

Equilibrium

204. $Q_{i1,t} = \sum_h C_{i1,h,t} + CG_{i1,t} + INV_{i1,t} + VSTK_{i1,t} + DIT_{i1,t} + MRGN_{i1,t}$
205. $\sum_j LD_{l,j,t} = LS_{l,t}$
206. $\sum_j KD_{k,j,t} = KS_{k,t}$
207. $IT_t = \sum_h SH_{h,t} + SG_t + SROW_t + CBI_t + FDI_t^{metal} + FDI_t^{coal}$
208. $IT_t^{PRI} = IT_t - IT_t^{PUB} - IT_t^{MIN} - \sum_i PC_{i,t} VSTK_{i,t}$
209. $\sum_j DS_{j,i,t} = DD_{i,t}$
210. $\sum_j EX_{j,i,t} = EXD_{i,t}$

Gross Domestic Product

211. $GDP_t^{BP} = \sum_j PVA_{j,t} VA_{j,t} + TIPT_t$
212. $GDP_t^{MP} = GDP_t^{BP} + TPRCTS_t$
213. $GDP_t^{IB} = \sum_{l,j} WTI_{l,j,t} LD_{l,j,t} + \sum_{k,j} R_{k,j,t} KD_{k,j,t} + TPRODN_t + TPRCTS_t$
214. $GDP_t^{FD} = \sum_i PC_{i,t}\left[\sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t}\right] + \sum_i PE_{i,t}^{POB} EXD_{i,t} - \sum_i e_t PWM_{i,t} IM_{i,t}$
215. $EX_t^T = \sum_i PE_{i,t}^{FOB} EXD_{i,t}$
216. $IM_t^T = \sum_i PWM_{i,t} e_t IM_{i,t}$

Real variables

217. $CTH_{h,t}^{REAL} = \frac{CTH_{h,t}}{PIXCON_t}$
218. $G_t^{REAL} = \frac{G_t}{PIXGVT_t}$
219. $GDP_t^{BP\_REAL} = \frac{GDP_t^{BP}}{PIXGDP_t}$
220. $GDP_t^{MP\_REAL} = \frac{GDP_t^{MP}}{PIXCON_t}$

Dynamic equations

221. $KD_{k,j,t+1} = \left[KD_{k,j,t}(1 - \delta_{k,j}) + IND_{k,j,t}\right] * capadj_t$
222. $IT_t^{PUB}(1 - avilgarate_t) = PK_t^{PUB} \sum_{k,pub} IND_{k,pub,t} + ITtrans_t$
223. $IT_t^{MIN} = PK_t^{PRI} \sum_{k,min} IND_{k,min,t}$
224. $IT_t^{PRI} + ITtrans_t = PK_t^{PRI} \sum_{k,bus} IND_{k,bus,t}$
225. $PK_t^{PRI} = \frac{1}{A^{K\_PRI}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right]^{\gamma_i^{INVPRI}}$
226. $PK_t^{PUB} = \frac{1}{A^{K\_PUB}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right]^{\gamma_i^{INVPUB}}$
227. $IND_{k,bus,t} = \phi_{k,bus} \left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma_{k,bus}^{INV}} KD_{k,bus,t}$
228. $U_{k,bus,t} = PK_t^{PRI}(\delta_{k,bus} + IR_t)$
229. $U_{k,pub,t} = PK_t^{PUB}(\delta_{k,pub} + IR_t)$

230. $U_{k,min,t} = PK_t^{PRI}(\delta_{k,min} + IR_t)$

Other equations

231. $LEON_t = Q_{agr,t} - \sum_h C_{agr,h,t} - CG_{agr,t} - INV_{agr,t} - VSTK_{agr,t} - DIT_{agr,t} - MRGN_{agr,t}$

232. $LS_{l,t} = LS_{l,t}^P(1 - unemp_{l,t})$

233. $buddef_t = G_t + GTR_t + IT_t^{PUB} - YG_t$

234. $defGDPr_t = \frac{buddef_t}{GDP_t^{MP}} * 100$

235. $growth_t = 100 * [\frac{GDP_t^{MP\_REAL}}{GDP_{t-1}^{MP\_REAL}} - 1]$

236. $growth_t = 100 * [\frac{GDP_t^{MP\_REAL}}{GDP^{MP\_REALO}} - 1]$ (only for first period)

237. $GDP_{j,t}^{IND} = PVA_{j,t}VA_{j,t} + TIP_{j,t}$

238. $GDP_{j,t}^{SHR} = \frac{GDP_{j,t}^{IND}}{GDP_t^{BP}} * 100$

239. $realwage_{l,t} = \frac{W_{l,t}}{PIXCON_t}$

240. $Avilga_t = avilgarate_t IT_t^{PUB}$

241. $Offshore_t = 0.8 * Avilga_t$

242. $TFP2_t = \prod_j TFP1_t TFP_{j,t}^{\frac{GDP_j^{SHRO}}{100}}$

Equations of Simulation Report 3

A1.1 Production

243. $VA_j = v_j XST_j$

244. $CI_j = io_j XST_j$

245. $VA_j = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho^{VA}} + (1-\beta_j^{VA}) KDC_j^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_j^{VA}}\right)}$

246. $LDC_j = \left[\frac{\beta^{VA}}{1-\beta_j^{VA}}\frac{RC_j}{WC_j}\right]^{\sigma_j^{VA}} KDC_j$

247. $LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$

248. $LD_{l,j} = \left[\frac{\beta_{l,j}^{LD} WC_j}{WTI_{l,j}}\right]^{\rho_j^{LD}} \left(B_j^{LD}\right)^{\rho_j^{LD}-1} LDC_j$

249. $KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j}^{-\rho_j^{KD}}\right]^{-\left(\frac{1}{\rho_j^{KD}}\right)}$

250. $KD_{k,j} = \left[\frac{\beta_{k,j}^{KD} RC_j}{RTI_{k,j}}\right]^{\rho_j^{KD}} \left(B_j^{KD}\right)^{\rho_j^{KD}-1} KDC_j$

251. $DI_{i,j} = aij_{i,j} C\ I_j$

A1.2 Income and savings

252. $YH_h = YHL_h + YHK_h + YHTR_h$

253. $YHL_h = \sum_l \lambda_{h,l}^{WL}\left(W_l \sum_j LD_{l,j}\right)$

254. $YHK_h = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j} KD_{k,j}\right)$

255. $YHTR_h = \sum_{ag} TR_{h,ag}$

256. $YDH_h = YH_h - TDH_h - TR_{gvt,h}$

257. $CTH_h = YDH_h - SH_h - \sum_{agng} TR_{agng,h}$

258. $SH_h = PIXCON^{\eta} sh0_h + sh1_h YDH_h$

A1.2.3 Government

259. $YG = YGK + TDHT + TDFT + TPRODN + TPRCTS + YGTR$

260. $YGK = \sum_k \lambda_{gvt,k}^{RK}\left(\sum_j R_{k,j} KD_{k,j}\right)$

261. $TDHT = \sum_h TDH_h$

262. $TPRODN = TIWT + TIKT + TIPT$

263. $TIWT = \sum_{l,j} TIW_{l,j}$

264. $TIKT = \sum_{k,j} TIKT_{k,j}$

265. $TIPT = \sum_{j} TIP_{j}$

266. $TPRCTS = TICT + TIMT + TIXT$

267. $TICT = \sum_{i} TIC_{i}$

268. $TIMT = \sum_{i} TIM_{i}$

269. $TIXT = \sum_{i} TIX_{i}$

270. $YGTR = \sum_{agng} TR_{gvt,agng}$

271. $TDH_{h} = PIXCON^{\eta} ttdh0_{h} + ttdh1_{h} YH_{h}$

272. $TIW_{l,j} = ttiw_{l,j} W_{l} LD_{l,j}$

273. $TIK_{k,j} = ttik_{k,j} R_{k,j} KD_{k,j}$

274. $TIP_{j} = ttip_{j} PP_{j} XST_{j}$

275. $TIC_{i} = ttic_{i}\left[(PL_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i}) DD_{i} + ((1 + ttim_{i})\, PWM_{i} e + \sum_{ij} PC_{ij} tmrg_{ij,i}) IM_{i}\right]$

276. $TIM_{i} = ttim_{i} PWM_{i} eIM_{i}$

277. $TIX_{i} = ttix_{i}\left(PE_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i}^{x}\right) EXD_{i}\right)$

278. $SG = YG - \sum_{agng} TR_{agng,gvt} - G$

A1.2.4 Rest of the world

279. $YROW = e \sum_{i} PWM_{i} IM_{i} + \sum_{k} \lambda_{row,k}^{RK}\left(\sum_{j} R_{k,j}\ KD_{k,j}\right) + \sum_{agd} TR_{row,agd}$

280. $SROW = YROW - \sum_{i} PE_{i}^{FOB} EXD_{i} - \sum_{agd} TR_{agd,row}$

281. $SROW = -CAB$

A1.2.5 Transfers

282. $TR_{agng,h} = \lambda_{agng,h}^{TR} YDH_{h}$

283. $TR_{gvt,h} = PIXCON^{\eta} tr0_{h} + tr1_{h} YH_{h}$

284. $TR_{row,gvt} = PIXCON^{\eta} TR_{row,gvt}^{O}$

285. $TR_{agd,row} = PIXCON^{\eta} TR_{agd,row}^{O}$

Demand

286. $PC_{i}C_{i,h} = PC_{i}C_{i,h}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h} - \sum_{ij} PC_{ij} C_{ij,h}^{MIN}\right)$

287. $PC_{i}INV_{i}^{PRI} = \gamma_{i}^{INV} IT^{PRI}$

288. $PC_{i}INV_{i}^{PUB} = \gamma_{i}^{INV} IT^{PUB}$

289. $INV_{i} = INV_{i}^{PRI} + INV_{i}^{PUB}$

290. $IT^{PRI} = IT - IT^{PUB} - \sum_{i} PC_{i} VSTK_{i}$

291. $PC_{i}CG_{i} = \gamma_{i}^{GVT} G$

292. $DIT_{i} = \sum_{j} DI_{i,j}$

293. $MRGN_i = \sum_{ij} tmrg_{i,ij} DD_{ij} + \sum_{ij} tmrg_{i,ij} IM_{ij} + \sum_{ij} tmrg^X_{i,ij} EXD_{ij}$

International trade

294. $XST_j = B^{XT}_j \left[\sum_i \beta^{XT}_{j,i} XS^{\rho^{XT}_j}_{j,i}\right]^{\frac{1}{\rho^{XT}_j}}$

295. $XS_{j,i} = \frac{XST_j}{\left(B^{XT}_j\right)^{1+\sigma^{XT}_j}} \left[\frac{P_{j,i}}{\beta^{XT}_{j,i} PT_j}\right]^{\sigma^{XT}_j}$

296. $XS_{j,i} = B^X_{j,i} \left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,x}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}}$

297. $EX_{j,i} = \left[\frac{1-\beta^X_{j,i}}{\beta^X_{j,i}} \frac{PE_i}{PL_i}\right]^{\sigma^X_{j,i}} DS_{j,i}$

298. $EXD_i = EXD^O_i pop_t \left(\frac{e_t PWX_i}{PE^{FOB}_i}\right)^{\sigma^{XD}_i}$

299. $Q_i = B^M_i \left[\beta^M_i IM_i^{-\rho^M_i} + \left(1-\beta^M_i\right) DD_i^{-\rho^M_i}\right]^{-\frac{1}{\rho^M_i}}$

300. $IM_i = \left[\frac{\beta^M_i}{1-\beta^M_i} \frac{PD_i}{PM_i}\right]^{\sigma^M_i} DD_i$

Prices

301. $PP_j = \frac{PVA_j VA_j + PCI_j CI_j}{XST_j}$

302. $PT_j = \left(1 + ttip_j\right) PP_j$

303. $PCI_j = \frac{\sum_i PC_i DI_{i,j}}{CI_j}$

304. $PVA_j = \frac{WC_j LDC_j + RC_j KDC_j}{VA_j}$

305. $WTI_{l,j} = W_l (1 + ttiw_{l,j})$

306. $RTI_{k,j} = R_{k,j} (1 + ttik_{k,j})$

307. $R_{k,j} = RK_k$ (Relevant only if capital is mobile)

308. $P_{j,i} = PT_j$

309. $P_{j,i} = \frac{PE_i EX_{j,i} + PL_i DS_{j,i}}{XS_{j,i}}$

310. $PE^{FOB}_i = \left(PE_i + \sum_{ij} PC_{ij} tmrg^X_{ij,i}\right)(1 + ttix_i)$

311. $PD_i = (1 + ttic_i)\left(PL_i + \sum_{ij} PC_{ij} tmrg_{ij,i}\right)$

312. $PM_i = (1 + ttic_i)\left((1 + ttim_i) ePWM_i + \sum_{ij} PC_{ij} tmrg_{ij,i}\right)$

313. $PC_i = \frac{PM_i IM_i + PD_i DD_i}{Q_i}$

314. $PIXGDP = \sqrt{\frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j}\right) VA^O_j \sum_j \left(PVA_j VA_j + TIP_j\right)}{\sum_j \left(PVA^O_j VA^O_j + TIP^O_j\right) \sum_j \left(PVA^O_j + \frac{TIP^O_j}{VA^O_j}\right) VA_j}}$

315. $PIXCON_t = \frac{\sum_i PC_i \sum_h C^O_{i,h}}{\sum_{ij} PC^O_{ij} \sum_h C^O_{ij,h}}$

316. $PIXINV = \prod_i \left(\frac{PC_i}{PC^O_i}\right)^{\gamma^{INV}_i}$

317. $PIXGVT = \prod_i \left(\frac{PC_i}{PC^O_i}\right)^{\gamma^{GVT}_i}$

318. $PIXEX = \prod_i \left(\frac{PE_i}{PE_i^O}\right)^{\gamma_i^{EX}}$

319. $PIXIM = \prod_i \left(\frac{PM_i}{PM_i^O}\right)^{\gamma_i^{IM}}$

Equilibrium

320. $Q_{i1} = \sum_h C_{i1,h} + CG_{i1} + INV_{i1} + VSTK_{i1} + DIT_{i1} + MRGN_{i1}$
321. $\sum_j LD_{l,j} = LS_l$
322. $\sum_j KD_{k,j} = KS_k$
323. $IT = \sum_h SH_h + SG + SROW$
324. $\sum_j DS_{j,i} = DD_i$
325. $\sum_j EX_{j,i} = EXD_i$

Gross Domestic Product

326. $GDP^{BP} = \sum_j PVA_j VA_j + TIPT$
327. $GDP^{MP} = GDP^{BP} + TPRCTS$
328. $GDP^{IB} = \sum_{l,j} W_l LD_{l,j} + \sum_{k,j} R_{k,j} KD_{k,j} + TPRODN + TPRCTS$
329. $GDP^{FD} = \sum_i PC_i\left[\sum_h C_{i,h} + CG_i + INV_i + VSTK_i\right] + \sum_i PE_i^{POB} EXD_i - \sum_i ePWM_i IM_i$

Real variables

330. $CTH_h^{REAL} = \frac{CTH_h}{PIXCON}$
331. $G^{REAL} = \frac{G}{PIXGVT}$
332. $GDP^{BP\_REAL} = \frac{GDP^{BP}}{PIXGDP}$
333. $GDP^{MP\_REAL} = \frac{GDP^{MP}}{PIXCON}$

Additional equations

334. $EXPT = \sum_i PE_i^{FOB} EXD_i$
335. $IMPT = \sum_i PWM_i eIM_i$
336. $EX^{REAL} = EXPT/PIXEX$
337. $IM^{REAL} = IMPT/PIXIM$
338. $Capexp = capexp^{gdp} GDP^{FD}$
339. $GovBdef = YG - \left\{\sum_{agng} TR_{agng,'gvt'} + G\right\} - capexp^{gdp} GDP^{FD}$
340. $LEON = Q_{c-agr} - \sum_h C_{c-agr,h} - CG_{c-agr} - INV_{c-agr} - VSTK_{c-agr} - DIT_{c-agr} - MRGN_{c-agr}$
341. $\frac{W_l}{PIXCON} = \frac{W_l^O}{PIXCONO}\left[\frac{unemp_l^O}{unemp_l}\right]^{0.25}$
342. $LS_l = LS_l^P[1 - unemp_l]$

Appendix B. Equations of Simulations

Equations of Simulation Report 1

A1.1 Production

1. $VA_{j,t} = v_j XST_{j,t}$
2. $CI_{j,t} = io_j XST_{j,t}$
3. $VA_{j1,t} = B_{j1}^{VA}\left[\beta_{j1}^{VA}(X_{j1,t}LDC_{j1,t})^{-\rho^{VA}} + (1-\beta_{j1}^{VA})KDC_{j1,t}^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_{j1}^{VA}}\right)}$
4. $VA_{min,t} = B_{min}^{VA}\left[\beta_{min}^{VA}(X_{min,t}LDC_{min,t})^{-\rho^{VA}} + (1-\beta_{min}^{VA})KDC_{min,t}^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_{min}^{VA}}\right)}$
5. $X_{j,t}LDC_{j,t} = \left[\frac{\beta^{VA}}{1-\beta_j^{VA}}\frac{RC_{j,t}}{WC_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t}$
6. $LDC_{j,t} = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j,t}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$
7. $LD_{l,j,t} = \left[\frac{\beta_{l,j}^{LD} WC_{j,t}}{WTI_{l,j,t}}\right]^{\sigma_{LD}^{j}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_{j,t}$
8. $LD_{l,j,t} = B_{l,j}^{LDG}\left\{\left[\beta_{l,j}^{LDG} LDM_{l,j,t}^{-\rho_j^{LDG}}\right] + \left[(1-\beta_{l,j}^{LDG})LDF_{l,j,t}^{-\rho_j^{LDG}}\right]\right\}^{-\frac{1}{\rho_j^{LDG}}}$
9. $LDM_{l,j,t} = \left\{\left[\frac{\beta_{l,j}^{LDG}}{1-\beta_{l,j}^{LDG}}\right]\left[\frac{WF_{l,t}}{WM_{l,t}}\right]\right\}^{\sigma_j^{LDG}} LDF_{l,j,t}$
10. $KDC_{j,t} = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j,t}^{-\rho_j^{KD}}\right]^{-\left(\frac{1}{\rho_j^{KD}}\right)}$
11. $KD_{k,j,t} = \left[\frac{\beta_{k,j}^{KD} RC_{j,t}}{RTI_{k,j,t}}\right]^{\rho_j^{KD}} \left(B_j^{KD}\right)^{\rho_j^{KD}-1} KDC_{j,t}$
12. $DI_{i,j,t} = aij_{i,j} C\ I_{j,t}$

A1.2 Households

13. $YH_{h,t} = YHL_{h,t} + YHK_{h,t} + YHTR_{h,t}$
14. $YHL_{h,t} = \sum_l \lambda_{h,l}^{WL}\left(W_{l,t}\sum_j LD_{l,j,t}\right)$
15. $YHK_{h,t} = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j,t}KD_{k,j,t}\right) + CAPROW_t$
16. $YHTR_{h,t} = \sum_{ag} TR_{h,ag,t}$
17. $YDH_{h,t} = YH_{h,t} - TDH_{h,t} - TR_{gvt,h,t}$
18. $CTH_{h,t} = YDH_{h,t} - SH_{h,t} - \sum_{agng} TR_{agng,h,t}$
19. $SH_{h,t} = PIXCON_t^{\eta} sh0_{h,t} + sh1_{h,t} YDH_{h,t} zzz_t$

A1.2.3 Government

20. $YG_t = YGK_t + TDHT_t + TPRODN_t + TPRCTS_t + YGTR_t$
21. $YGK_t = \sum_k \lambda_{gvt,k}^{RK} \left(\sum_j R_{k,j,t} KD_{k,j,t}\right)$
22. $TDHT_t = \sum_h TDH_{h,t}$
23. $TPRODN_t = TIWT_t + TIKT_t + TIPT_t$
24. $TIKT_t = \sum_{k,j} TIK_{k,j,t}$
25. $TIPT_t = \sum_j TIP_{j,t}$
26. $TPRCTS_t = TICT_t + TIMT_t + TIXT_t$
27. $TICT_t = \sum_i TIC_{i,t}$
28. $TIMT_t = \sum_i TIM_{i,t}$
29. $TIXT_t = \sum_i TIX_{i,t}$
30. $YGTR_t = \sum_{agng} TR_{gvt,agng,t}$
31. $TDH_{h,t} = PIXCON_t^{\eta} ttdh0_{h,t} + ttdh1_{h,t} YH_{h,t}$
32. $TIK_{k,j,t} = ttik_{k,j,t} R_{k,j,t} KD_{k,j,t}$
33. $TIP_{j,t} = ttip_{j,t} PP_{j,t} XST_{j,t}$
34. $TIC_{i,t} = ttic_{i,t}\left[(PL_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) DD_{i,t} + ((1 + ttim_{i,t}) PWM_{i,t} e_t + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) IM_{i,t}\right]$
35. $TIM_{i,t} = ttim_{i,t} PWM_{i,t} e_t IM_{i,t}$
36. $TIX_{i,t} = ttix_{i,t}\left(PE_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}^{x}\right) EXD_{i,t}$
37. $SG_t = YG_t - \sum_{agng} TR_{agng,gvt,t} - G_t$

A1.2.4 Rest of the world

38. $YROW_t = e_t \sum_i PWM_{i,t} IM_{i,t} + \sum_k \lambda_{row,k}^{RK} \left(\sum_j R_{k,t,t}\ KD_{k,j,t}\right) + CAPROW_t + \sum_{agd} TR_{row,agd,t}$
39. $SROW_t = YROW_t - \sum_i PE_{i,t}^{FOB} EXD_{i,t} - \sum_{agd} TR_{agd,row,t} - CAPROW_t$
40. $SROW_t = -CAB_t$

A1.2.5 Transfers

41. $TR_{agng,h,t} = \lambda_{agng,h}^{TR} YDH_{h,t} zz_{agng,h,t}$
42. $TR_{gvt,h,t} = PIXCON_t^{\eta} tr0_{h,t} + tr1_{h,t} YH_{h,t} zz_{gvt,h,t}$
43. $TR_{agng,gvt,t} = PIXCON_t^{\eta} TR_{agng,gvt}^{O} zz_{agng,gvt,t}$
44. $TR_{agd,row,t} = PIXCON_t^{\eta} TR_{agd,row}^{O} zz_{agd,row,t}$

Demand

45. $PC_{i,t}C_{i,h,t} = PC_{i,t}C_{i,h,t}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h,t} - \sum_{ij} PC_{ij,t}C_{ij,h,t}^{MIN}\right)$
46. $GFCF_t = IT_t - \sum_i PC_{i,t}VSTK_{i,t}$
47. $PC_{i,t}INV_{i,t}^{PRI} = \gamma_i^{INVPRI} IT_t^{PRI}$
48. $PC_{i,t}INV_{i,t}^{PUB} = \gamma_i^{INVPUB} IT_t^{PUB}$
49. $INV_{i,t} = INV_{i,t}^{PRI} + INV_{i,t}^{PUB}$
50. $PC_{i,t}CG_{i,t} = g1_{i,t}\gamma_i^{GVT} G_t$
51. $DIT_{i,t} = \sum_j DI_{i,j,t}$
52. $MRGN_{i,t} = \sum_{ij} tmrg_{i,ij}DD_{ij,t} + \sum_{ij} tmrg_{i,ij}IM_{ij,t} + \sum_{ij} tmrg_{i,ij}^{X}EXD_{ij,t}$

International trade

53. $XST_{j,t} = B_j^{XT}\left[\sum_i \beta_{j,i}^{XT} XS_{j,i,t}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$
54. $XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}}\left[\frac{P_{j,i,t}}{\beta_{j,i}^{XT} PT_{j,t}}\right]^{\sigma_j^{XT}}$
55. $XS_{j,i,t} = B_{j,i}^{X}\left[\beta_{j,i}^{X} EX_{j,i,t}^{\rho_{j,i}^{X}} + \left(1-\beta_{j,i}^{X}\right)DS_{j,i,t}^{\rho_{j,x}^{X}}\right]^{\frac{1}{\rho_{j,i}^{X}}}$
56. $EX_{j,i,t} = \left[\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}}\frac{PE_{i,t}}{PL_{i,t}}\right]^{\sigma_{j,i}^{X}} DS_{j,i,t}$
57. $EXD_{i,t} = EXD_i^{O} pop_t \left(\frac{e_t PWX_{i,t}}{PE_{i,t}^{FOB}}\right)^{\sigma_i^{XD}}$
58. $Q_{i,t} = B_i^{M}\left[\beta_i^{M} IM_{i,t}^{-\rho_i^{M}} + \left(1-\beta_i^{M}\right)DD_{i,t}^{-\rho_i^{M}}\right]^{-\frac{1}{\rho_i^{M}}}$
59. $IM_{i,t} = \left[\frac{\beta_i^{M}}{1-\beta_i^{M}}\frac{PD_{i,t}}{PM_{i,t}}\right]^{\sigma_i^{M}} DD_{i,t}$

Prices

60. $PP_{j,t} = \frac{PVA_{j,t}VA_{j,t} + PCI_{j,t}CI_{j,t}}{XST_{j,t}}$
61. $PT_{j,t} = \left(1 + ttip_{j,t}\right)PP_{j,t}$
62. $PCI_{j,t} = \frac{\sum_i PC_{i,t}DI_{i,j,t}}{CI_{j,t}}$
63. $PVA_{j,t} = \frac{WC_{j,t}LDC_{j,t} + RC_{j,t}KDC_{j,t}}{VA_{j,t}}$
64. $LD_{l,j,t}WTI_{l,j,t} = WM_{l,t}LDM_{l,j,t} + WF_{l,t}LDF_{l,j,t}$
65. $RTI_{k,j,t} = R_{k,j,t}(1 + ttik_{k,j,t})$
66. $P_{j,i,t} = PT_{j,t}$
67. $P_{j,i,t} = \frac{PE_{i,t}EX_{j,i,t} + PL_{i,t}DS_{j,i,t}}{XS_{j,i,t}}$
68. $PE_{i,t}^{FOB} = \left(PE_{i,t} + \sum_{ij} PC_{ij,t}tmrg_{ij,i}^{X}\right)\left(1 + ttix_{i,t}\right)$
69. $PD_{i,t} = \left(1 + ttic_{i,t}\right)\left(PL_{i,t} + \sum_{ij} PC_{ij,t}tmrg_{ij,i}\right)$
70. $PM_{i,t} = \left(1 + ttic_{i,t}\right)\left(\left(1 + ttim_{i,t}\right)e_t PWM_{i,t} + \sum_{ij} PC_{ij,t}tmrg_{ij,i}\right)$
71. $PC_{i,t} = \frac{PM_{i,t}IM_{i,t} + PD_{i,t}DD_{i,t}}{Q_{i,t}}$
72. $PIXGDP_t = \sqrt{\frac{\sum_j\left(PVA_{j,t} + \frac{TIP_{j,t}}{VA_{j,t}}\right)VA_j^{O}\sum_j\left(PVA_{j,t}VA_{j,t} + TIP_{j,t}\right)}{\sum_j\left(PVA_j^{O}VA_j^{O} + TIP_j^{O}\right)\sum_j\left(PVA_j^{O} + \frac{TIP_j^{O}}{VA_j^{O}}\right)VA_{j,t}}}$

73. $PIXCON_t = \frac{\sum_i PC_{i,t} \sum_h C^O_{i,h}}{\sum_{ij} PC^O_{ij} \sum_h C^O_{ij,h}}$
74. $PIXINV^{PRI}_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma_i^{INVPRI}}$
75. $PIXINV^{PUB}_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma_i^{INVPUB}}$
76. $PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PC^O_i}\right)^{\gamma_i^{GVT}}$

Equilibrium

77. $Q_{i1,t} = \sum_h C_{i1,h,t} + CG_{i1,t} + INV_{i1,t} + VSTK_{i1,t} + DIT_{i1,t} + MRGN_{i1,t}$
78. $\sum_j LDM_{l,j,t} = LSM_{l,t}$
79. $\sum_j LDF_{l,j,t} = LSF_{l,t}$
80. $\sum_j KD_{k,j,t} = KS_{k,t}$
81. $IT_t = \sum_h SH_{h,t} + SG_t + SROW_t$
82. $IT^{PRI}_t = IT_t - IT^{PUB}_t - \sum_i PC_{i,t} VSTK_{i,t}$
83. $\sum_j DS_{j,i,t} = DD_{i,t}$
84. $\sum_j EX_{j,i,t} = EXD_{i,t}$

Gross Domestic Product

85. $GDP^{BP}_t = \sum_j PVA_{j,t} VA_{j,t} + TIPT_t$
86. $GDP^{MP}_t = GDP^{BP}_t + TPRCTS_t$
87. $GDP^{IB}_t = \sum_{l,j} WTI_{l,j,t} LD_{l,j,t} + \sum_{k,j} R_{k,j,t} KD_{k,j,t} + TPRODN_t + TPRCTS_t$
88. $GDP^{FD}_t = \sum_i PC_{i,t}\left[\sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t}\right] + \sum_i PE^{POB}_{i,t} EXD_{i,t} - \sum_i e_t PWM_{i,t} IM_{i,t}$
89. $EX^T_t = \sum_i PE^{FOB}_{i,t} EXD_{i,t}$
90. $IM^T_t = \sum_i PWM_{i,t} e_t IM_{i,t}$

Real variables

91. $CTH^{REAL}_{h,t} = \frac{CTH_{h,t}}{PIXCON_t}$
92. $G^{REAL}_t = \frac{G_t}{PIXGVT_t}$
93. $GDP^{BP\_REAL}_t = \frac{GDP^{BP}_t}{PIXGDP_t}$
94. $GDP^{MP\_REAL}_t = \frac{GDP^{MP}_t}{PIXCON_t}$
95. $GFCF^{PRI\_REAL}_t = \frac{IT^{PRI}_t}{PIXINV^{PRI}_t}$
96. $GFCF^{PUB\_REAL}_t = \frac{IT^{PUB}_t}{PIXINV^{PUB}_t}$

Dynamic equations

97. $KD_{k,j,t+1} = KD_{k,j,t}(1 - \delta_{k,j}) + IND_{k,j,t}$
98. $IT^{PUB}_t = PK^{PUB}_t \sum_{k,pub} IND_{k,pub,t}$
99. $IT^{PRI}_t = PK^{PRI}_t \sum_{k,bus} IND_{k,bus,t}$
100. $PK^{PRI}_t = \frac{1}{A^{K\_PRI}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right]^{\gamma_i^{INVPRI}}$

101. $PK_t^{PUB} = \frac{1}{A^{K\_PUB}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right]^{\gamma_i^{INVPUB}}$

102. $IND_{k,bus,t} = \phi_{k,bus} \left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma_{k,bus}^{INV}} KD_{k,bus,t}$

103. $U_{k,bus,t} = PK_t^{PRI}(\delta_{k,bus} + IR_t)$

104. $U_{k,pub,t} = PK_t^{PUB}(\delta_{k,pub} + IR_t)$

Other equations

105. $LEON_t = Q_{agr,t} - \sum_h C_{agr,h,t} - CG_{agr,t} - INV_{agr,t} - VSTK_{agr,t} - DIT_{agr,t} - MRGN_{agr,t}$

106. $LSM_{l,t} = LSM_{l,t}^P(1 - unempl_{l,t}^M)$

107. $LSF_{l,t} = LSF_{l,t}^P(1 - unempl_{l,t}^F)$

108. $\frac{WM_{l,t}}{PIXCON_t} = \frac{WM_l^O}{PIXCONO}\left[\frac{0.11}{unempl_{l,t}^M}\right]^{0.2}$

109. $\frac{WF_{l,t}}{PIXCON_t} = \frac{WF_l^O}{PIXCONO}\left[\frac{0.09}{unempl_{l,t}^F}\right]^{0.2}$

110. $buddef_t = G_t + \sum_{agng} TR_{agng,gvt,t} + Capexp_t - YG_t$

111. $defGDPr_t = \frac{buddef_t}{GDP_t^{MP}} * 100$

112. $EXRT_t = 1993 * e_t F_t^{EXRT}$

113. $debt_{t+1}^{row} = debt_t^{row} + GFF_t/EXRT_t$

114. $debt_{t+1}^{dom} = debt_t^{dom} + GDF_t$

115. $debt_t = debt_t^{dom} + debt_t^{row} EXRT_t$

116. $debttoGDP_{t+1} = \frac{debt_{t+1}}{GDP_t^{MP}} * 100$

117. $TR_{h,gvt,t} = TR_{h,gvt,t}^i + 0.11 * debt_t^{dom}$

118. $TR_{row,gvt,t} = TR_{row,gvt,t}^i + (0.04 - F_t^{IRrow}) debt_t^{row} EXRT_t$

119. $TR_{row,h,t} = TR_{row,h,t}^i$

120. $TR_{h,row,t} = TR_{h,row,t}^i$

121. $TR_{gvt,h,t} = TR_{gvt,h,t}^i$

122. $TR_{gvt,row,t} = TR_{gvt,row,t}^i$

123. $GFF_t = 0.8 * buddef_t + F_t^{GFF}$

124. $GDF_t = 0.2 * buddef_t + F_t^{GDF}$

125. $Unemp_t = \left(1 - \frac{\sum_l LSM_{l,t} + LSF_{l,t})}{\sum_l LSM_{l,t}^P + LSF_{l,t}^P}\right) * 100$

126. $Unemp_t^M = \left(1 - \frac{\sum_l LSM_{l,t})}{\sum_l LSM_{l,t}^P}\right) * 100$

127. $Unemp_t^F = \left(1 - \frac{\sum_l LSF_{l,t})}{\sum_l LSF_{l,t}^P}\right) * 100$

Equations of Simulation Report 2

A1.1 Production

128. $VA_{j,t} = v_j XST_{j,t}$

129. $CI_{j,t} = io_j XST_{j,t}$

130. $VA_{j,t} = B_j^{VA}\left[\beta_j^{VA}(TFP1_t TFP_{j,t} LDC_{j,t})^{-\rho^{VA}} + (1-\beta_j^{VA})KDC_{j,t}^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_j^{VA}}\right)}$

131. $TFP1_t TFP_{j,t} LDC_{j,t} = \left[\frac{\beta^{VA}}{1-\beta_j^{VA}}\frac{RC_{j,t}}{WC_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t}$

132. $LDC_{j,t} = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j,t}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$

133. $LD_{l,j,t} = \left[\frac{\beta_{l,j}^{LD} WC_{j,t}}{WTI_{l,j,t}}\right]^{\sigma_{LD}^{j}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_{j,t}$

134. $KDC_{j,t} = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j,t}^{-\rho_j^{KD}}\right]^{-\left(\frac{1}{\rho_j^{KD}}\right)}$

135. $KD_{k,j,t} = \left[\frac{\beta_{k,j}^{KD} RC_{j,t}}{RTI_{k,j,t}}\right]^{\rho_j^{KD}} \left(B_j^{KD}\right)^{\rho_j^{KD}-1} KDC_{j,t}$

136. $DI_{i,j,t} = aij_{i,j} C\ I_{j,t}$

A1.2 Households

137. $YH_{h,t} = YHL_{h,t} + YHK_{h,t} + YHTR_{h,t} + avilga_t$

138. $YHL_{h,t} = \sum_l \lambda_{h,l}^{WL}\left(W_{l,t}\sum_j LD_{l,j,t} Wdist_{l,j}\right) + LABROW_t$

139. $YHK_{h,t} = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j,t} KD_{k,j,t}\right) + CAPROW_t$

140. $YHTR_{h,t} = \sum_{ag} TR_{h,ag,t}$

141. $YDH_{h,t} = YH_{h,t} - TDH_{h,t} - TR_{gvt,h,t} - Offshore_t$

142. $CTH_{h,t} = YDH_{h,t} - SH_{h,t} - \sum_{agng} TR_{agng,h,t}$

143. $SH_{h,t} = PIXCON_t^{\eta} sh0_{h,t} + sh1_{h,t} YDH_{h,t}$

A1.2.3 Government

144. $YG_t = YGK_t + TDHT_t + TPRODN_t + TPRCTS_t + YGTR_t$

145. $YGK_t = \sum_k \lambda_{gvt,k}^{RK}\left(\sum_j R_{k,j,t} KD_{k,j,t}\right)$

146. $TDHT_t = \sum_h TDH_{h,t}$

147. $TPRODN_t = TIWT_t + TIKT_t + TIPT_t$

148. $TIWT_t = \sum_{l,j} TIW_{l,j,t}$

149. $TIKT_t = \sum_{k,j} TIK_{k,j,t}$

150. $TIPT_t = \sum_j TIP_{j,t}$

151. $TPRCTS_t = TICT_t + TIMT_t + TIXT_t$

152. $TICT_t = \sum_i TIC_{i,t}$

153. $TIMT_t = \sum_i TIM_{i,t}$

154. $TIXT_t = \sum_i TIX_{i,t}$

155. $YGTR_t = \sum_{agng} TR_{gvt,agng,t}$

156. $TDH_{h,t} = PIXCON_t^{\eta} ttdh0_{h,t} + ttdh1_{h,t}(YH_{h,t} - avilga_t)$

157. $TIW_{l,j,t} = ttiw_{l,j,t} W_{l,t} Wdist_{l,j} LD_{l,j,t}$

158. $TIK_{k,j,t} = ttik_{k,j,t} R_{k,j,t} KD_{k,j,t}$

159. $TIP_{j,t} = ttip_{j,t} PP_{j,t} XST_{j,t}$

160. $TIC_{i,t} = ttic_{i,t}\left[(PL_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) DD_{i,t} + ((1 + ttim_{i,t}) PWM_{i,t} e_t + \sum_{ij} PC_{ij,t} tmrg_{ij,i}) IM_{i,t}\right]$

161. $TIM_{i,t} = ttim_{i,t} PWM_{i,t} e_t IM_{i,t}$

162. $TIX_{i,t} = ttix_{i,t}\left(PE_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}^{x}) EXD_{i,t}\right)$

163. $SG_t = YG_t - GTR_t - G_t$

164. $GTR_t = \sum_{agng} TR_{agng,gvt,t}$

A1.2.4 Rest of the world

165. $YROW_t = e_t \sum_i PWM_{i,t} IM_{i,t} + \sum_k \lambda_{row,k}^{RK}\left(\sum_j R_{k,j,t}\ KD_{k,j,t}\right) + \sum_{agd} TR_{row,agd,t} + \sum_l lambda_{row,l}^{WL} \sum_j WTI_{l,j,t} LD_{l,j,t} + Offshore_t$

166. $CAB_t = -[YROW_t - \sum_i PE_{i,t}^{FOB} EXD_{i,t} - \sum_{agd} TR_{agd,row,t} - CAPROW_t - LABROW_t]$

167. $CAB_t = -[SROW_t + FDI_t^{coal} + FDI_t^{metal} + CBI_t]$

A1.2.5 Transfers

168. $TR_{agng,h,t} = \lambda_{agng,h}^{TR} YDH_{h,t}$

169. $TR_{gvt,h,t} = PIXCON_t^{\eta} tr0_{h,t} + tr1_{h,t}(YH_{h,t} - avilga_t)$

170. $TR_{agng,gvt,t} = PIXCON_t^{\eta} TR_{agng,gvt}^{O} TFP1_t pop_t$

171. $TR_{agd,row,t} = PIXCON_t^{\eta} TR_{agd,row}^{O} pop_t aindex_t$

Demand

172. $PC_{i,t} C_{i,h,t} = PC_{i,t} C_{i,h,t}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h,t} - \sum_{ij} PC_{ij,t} C_{ij,h,t}^{MIN}\right)$

173. $GFCF_t = IT_t - \sum_i PC_{i,t} VSTK_{i,t}$

174. $PC_{i,t} INV_{i,t}^{PRI} = \gamma_i^{INVPRI} IT_t^{PRI} + \gamma_i^{INVMIN} IT_t^{MIN}$

175. $PC_{i,t}INV_{i,t}^{PUB} = \gamma_i^{INVPUB} IT_t^{PUB}(1 - avilgarate_t)$
176. $INV_{i,t} = INV_{i,t}^{PRI} + INV_{i,t}^{PUB}$
177. $PC_{i,t}CG_{i,t} = \gamma_i^{GVT} G_t$
178. $DIT_{i,t} = \sum_j DI_{i,j,t}$
179. $MRGN_{i,t} = \sum_{ij} tmrg_{i,ij} DD_{ij,t} + \sum_{ij} tmrg_{i,ij} IM_{ij,t} + \sum_{ij} tmrg_{i,ij}^X EXD_{ij,t}$

International trade

180. $XST_{j,t} = B_j^{XT} \left[\sum_i \beta_{j,i}^{XT} XS_{j,i,t}^{\rho_j^{XT}}\right]^{\frac{1}{\rho_j^{XT}}}$
181. $XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i,t}}{\beta_{j,i}^{XT} PT_{j,t}}\right]^{\sigma_j^{XT}}$
182. $XS_{j,i,t} = B_{j,i}^X \left[\beta_{j,i}^X EX_{j,i,t}^{\rho_{j,i}^X} + \left(1 - \beta_{j,i}^X\right) DS_{j,i,t}^{\rho_{j,x}^X}\right]^{\frac{1}{\rho_{j,i}^X}}$
183. $EX_{j,i,t} = \left[\frac{1-\beta_{j,i}^X}{\beta_{j,i}^X} \frac{PE_{i,t}}{PL_{i,t}}\right]^{\sigma_{j,i}^X} DS_{j,i,t}$
184. $EXD_{i,t} = TFP1_t pop_t EXD_i^O pop_t \left(\frac{e_t PWX_{i,t}}{PE_{i,t}^{FOB}}\right)^{\sigma_i^{XD}}$
185. $Q_{i,t} = B_i^M \left[\beta_i^M IM_{i,t}^{-\rho_i^M} + \left(1 - \beta_i^M\right) DD_{i,t}^{-\rho_i^M}\right]^{-\frac{1}{\rho_i^M}}$
186. $IM_{i,t} = \left[\frac{\beta_i^M}{1-\beta_i^M} \frac{PD_{i,t}}{PM_{i,t}}\right]^{\sigma_i^M} DD_{i,t}$

Prices

187. $PP_{j,t} = \frac{PVA_{j,t}VA_{j,t} + PCI_{j,t}CI_{j,t}}{XST_{j,t}}$
188. $PT_{j,t} = \left(1 + ttip_{j,t}\right) PP_{j,t}$
189. $PCI_{j,t} = \frac{\sum_i PC_{i,t} DI_{i,j,t}}{CI_{j,t}}$
190. $PVA_{j,t} = \frac{WC_{j,t}LDC_{j,t} + RC_{j,t}KDC_{j,t}}{VA_{j,t}}$
191. $WTI_{l,j,t} = W_{l,t}(1 + ttiw_{l,j,t})$
192. $RTI_{k,j,t} = R_{k,j,t}(1 + ttik_{k,j,t})$
193. $P_{j,i,t} = PT_{j,t}$
194. $P_{j,i,t} = \frac{PE_{i,t}EX_{j,i,t} + PL_{i,t}DS_{j,i,t}}{XS_{j,i,t}}$
195. $PE_{i,t}^{FOB} = \left(PE_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}^X\right)\left(1 + ttix_{i,t}\right)$
196. $PD_{i,t} = \left(1 + ttic_{i,t}\right)\left(PL_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}\right)$
197. $PM_{i,t} = \left(1 + ttic_{i,t}\right)\left(\left(1 + ttim_{i,t}\right) e_t PWM_{i,t} + \sum_{ij} PC_{ij,t} tmrg_{ij,i}\right)$
198. $PC_{i,t} = \frac{PM_{i,t}IM_{i,t} + PD_{i,t}DD_{i,t}}{Q_{i,t}}$
199. $PIXGDP_t = \sqrt{\frac{\sum_j \left(PVA_{j,t} + \frac{TIP_{j,t}}{VA_{j,t}}\right) VA_j^O \sum_j \left(PVA_{j,t}VA_{j,t} + TIP_{j,t}\right)}{\sum_j \left(PVA_j^O VA_j^O + TIP_j^O\right) \sum_j \left(PVA_j^O + \frac{TIP_j^O}{VA_j^O}\right) VA_{j,t}}}$
200. $PIXCON_t = \frac{\sum_i PC_{i,t} \sum_h C_{i,h}^O}{\sum_{ij} PC_{ij}^O \sum_h C_{ij,h}^O}$

201. $PIXINV_t^{PRI} = \prod_i \left(\frac{PC_{i,t}}{PC_i^O}\right)^{\gamma_i^{INVPRI}}$

202. $PIXINV_t^{PUB} = \prod_i \left(\frac{PC_{i,t}}{PC_i^O}\right)^{\gamma_i^{INVPUB}}$

203. $PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PC_i^O}\right)^{\gamma_i^{GVT}}$

Equilibrium

204. $Q_{i1,t} = \sum_h C_{i1,h,t} + CG_{i1,t} + INV_{i1,t} + VSTK_{i1,t} + DIT_{i1,t} + MRGN_{i1,t}$
205. $\sum_j LD_{l,j,t} = LS_{l,t}$
206. $\sum_j KD_{k,j,t} = KS_{k,t}$
207. $IT_t = \sum_h SH_{h,t} + SG_t + SROW_t + CBI_t + FDI_t^{metal} + FDI_t^{coal}$
208. $IT_t^{PRI} = IT_t - IT_t^{PUB} - IT_t^{MIN} - \sum_i PC_{i,t} VSTK_{i,t}$
209. $\sum_j DS_{j,i,t} = DD_{i,t}$
210. $\sum_j EX_{j,i,t} = EXD_{i,t}$

Gross Domestic Product

211. $GDP_t^{BP} = \sum_j PVA_{j,t} VA_{j,t} + TIPT_t$
212. $GDP_t^{MP} = GDP_t^{BP} + TPRCTS_t$
213. $GDP_t^{IB} = \sum_{l,j} WTI_{l,j,t} LD_{l,j,t} + \sum_{k,j} R_{k,j,t} KD_{k,j,t} + TPRODN_t + TPRCTS_t$
214. $GDP_t^{FD} = \sum_i PC_{i,t}\left[\sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t}\right] + \sum_i PE_{i,t}^{POB} EXD_{i,t} - \sum_i e_t PWM_{i,t} IM_{i,t}$
215. $EX_t^T = \sum_i PE_{i,t}^{FOB} EXD_{i,t}$
216. $IM_t^T = \sum_i PWM_{i,t} e_t IM_{i,t}$

Real variables

217. $CTH_{h,t}^{REAL} = \frac{CTH_{h,t}}{PIXCON_t}$
218. $G_t^{REAL} = \frac{G_t}{PIXGVT_t}$
219. $GDP_t^{BP\_REAL} = \frac{GDP_t^{BP}}{PIXGDP_t}$
220. $GDP_t^{MP\_REAL} = \frac{GDP_t^{MP}}{PIXCON_t}$

Dynamic equations

221. $KD_{k,j,t+1} = \left[KD_{k,j,t}(1 - \delta_{k,j}) + IND_{k,j,t}\right] * capadj_t$
222. $IT_t^{PUB}(1 - avilgarate_t) = PK_t^{PUB} \sum_{k,pub} IND_{k,pub,t} + ITtrans_t$
223. $IT_t^{MIN} = PK_t^{PRI} \sum_{k,min} IND_{k,min,t}$
224. $IT_t^{PRI} + ITtrans_t = PK_t^{PRI} \sum_{k,bus} IND_{k,bus,t}$
225. $PK_t^{PRI} = \frac{1}{A^{K\_PRI}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right]^{\gamma_i^{INVPRI}}$
226. $PK_t^{PUB} = \frac{1}{A^{K\_PUB}} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right]^{\gamma_i^{INVPUB}}$
227. $IND_{k,bus,t} = \phi_{k,bus} \left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma_{k,bus}^{INV}} KD_{k,bus,t}$
228. $U_{k,bus,t} = PK_t^{PRI}(\delta_{k,bus} + IR_t)$
229. $U_{k,pub,t} = PK_t^{PUB}(\delta_{k,pub} + IR_t)$

230. $U_{k,min,t} = PK_t^{PRI}(\delta_{k,min} + IR_t)$

Other equations

231. $LEON_t = Q_{agr,t} - \sum_h C_{agr,h,t} - CG_{agr,t} - INV_{agr,t} - VSTK_{agr,t} - DIT_{agr,t} - MRGN_{agr,t}$

232. $LS_{l,t} = LS_{l,t}^P(1 - unemp_{l,t})$

233. $buddef_t = G_t + GTR_t + IT_t^{PUB} - YG_t$

234. $defGDPr_t = \frac{buddef_t}{GDP_t^{MP}} * 100$

235. $growth_t = 100 * [\frac{GDP_t^{MP\_REAL}}{GDP_{t-1}^{MP\_REAL}} - 1]$

236. $growth_t = 100 * [\frac{GDP_t^{MP\_REAL}}{GDP^{MP\_REALO}} - 1]$ (only for first period)

237. $GDP_{j,t}^{IND} = PVA_{j,t}VA_{j,t} + TIP_{j,t}$

238. $GDP_{j,t}^{SHR} = \frac{GDP_{j,t}^{IND}}{GDP_t^{BP}} * 100$

239. $realwage_{l,t} = \frac{W_{l,t}}{PIXCON_t}$

240. $Avilga_t = avilgarate_t IT_t^{PUB}$

241. $Offshore_t = 0.8 * Avilga_t$

242. $TFP2_t = \prod_j TFP1_t TFP_{j,t}^{\frac{GDP_j^{SHRO}}{100}}$

Equations of Simulation Report 3

A1.1 Production

243. $VA_j = v_j XST_j$

244. $CI_j = io_j XST_j$

245. $VA_j = B_j^{VA}\left[\beta_j^{VA} LDC_j^{-\rho^{VA}} + (1-\beta_j^{VA}) KDC_j^{-\rho^{VA}}\right]^{-\left(\frac{1}{\rho_j^{VA}}\right)}$

246. $LDC_j = \left[\frac{\beta^{VA}}{1-\beta_j^{VA}}\frac{RC_j}{WC_j}\right]^{\sigma_j^{VA}} KDC_j$

247. $LDC_j = B_j^{LD}\left[\sum_l \beta_{l,j}^{LD} LD_{l,j}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}}$

248. $LD_{l,j} = \left[\frac{\beta_{l,j}^{LD} WC_j}{WTI_{l,j}}\right]^{\rho_j^{LD}} \left(B_j^{LD}\right)^{\rho_j^{LD}-1} LDC_j$

249. $KDC_j = B_j^{KD}\left[\sum_k \beta_{k,j}^{KD} KD_{k,j}^{-\rho_j^{KD}}\right]^{-\left(\frac{1}{\rho_j^{KD}}\right)}$

250. $KD_{k,j} = \left[\frac{\beta_{k,j}^{KD} RC_j}{RTI_{k,j}}\right]^{\rho_j^{KD}} \left(B_j^{KD}\right)^{\rho_j^{KD}-1} KDC_j$

251. $DI_{i,j} = aij_{i,j} C\ I_j$

A1.2 Income and savings

252. $YH_h = YHL_h + YHK_h + YHTR_h$

253. $YHL_h = \sum_l \lambda_{h,l}^{WL}\left(W_l \sum_j LD_{l,j}\right)$

254. $YHK_h = \sum_k \lambda_{h,k}^{RK}\left(\sum_j R_{k,j} KD_{k,j}\right)$

255. $YHTR_h = \sum_{ag} TR_{h,ag}$

256. $YDH_h = YH_h - TDH_h - TR_{gvt,h}$

257. $CTH_h = YDH_h - SH_h - \sum_{agng} TR_{agng,h}$

258. $SH_h = PIXCON^{\eta} sh0_h + sh1_h YDH_h$

A1.2.3 Government

259. $YG = YGK + TDHT + TDFT + TPRODN + TPRCTS + YGTR$

260. $YGK = \sum_k \lambda_{gvt,k}^{RK}\left(\sum_j R_{k,j} KD_{k,j}\right)$

261. $TDHT = \sum_h TDH_h$

262. $TPRODN = TIWT + TIKT + TIPT$

263. $TIWT = \sum_{l,j} TIW_{l,j}$

264. $TIKT = \sum_{k,j} TIKT_{k,j}$

265. $TIPT = \sum_{j} TIP_{j}$

266. $TPRCTS = TICT + TIMT + TIXT$

267. $TICT = \sum_{i} TIC_{i}$

268. $TIMT = \sum_{i} TIM_{i}$

269. $TIXT = \sum_{i} TIX_{i}$

270. $YGTR = \sum_{agng} TR_{gvt,agng}$

271. $TDH_{h} = PIXCON^{\eta} ttdh0_{h} + ttdh1_{h} YH_{h}$

272. $TIW_{l,j} = ttiw_{l,j} W_{l} LD_{l,j}$

273. $TIK_{k,j} = ttik_{k,j} R_{k,j} KD_{k,j}$

274. $TIP_{j} = ttip_{j} PP_{j} XST_{j}$

275. $TIC_{i} = ttic_{i}\left[(PL_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i}) DD_{i} + ((1 + ttim_{i})\, PWM_{i} e + \sum_{ij} PC_{ij} tmrg_{ij,i}) IM_{i}\right]$

276. $TIM_{i} = ttim_{i} PWM_{i} eIM_{i}$

277. $TIX_{i} = ttix_{i}\left(PE_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i}^{x}\right) EXD_{i}\right)$

278. $SG = YG - \sum_{agng} TR_{agng,gvt} - G$

A1.2.4 Rest of the world

279. $YROW = e \sum_{i} PWM_{i} IM_{i} + \sum_{k} \lambda_{row,k}^{RK}\left(\sum_{j} R_{k,j}\ KD_{k,j}\right) + \sum_{agd} TR_{row,agd}$

280. $SROW = YROW - \sum_{i} PE_{i}^{FOB} EXD_{i} - \sum_{agd} TR_{agd,row}$

281. $SROW = -CAB$

A1.2.5 Transfers

282. $TR_{agng,h} = \lambda_{agng,h}^{TR} YDH_{h}$

283. $TR_{gvt,h} = PIXCON^{\eta} tr0_{h} + tr1_{h} YH_{h}$

284. $TR_{row,gvt} = PIXCON^{\eta} TR_{row,gvt}^{O}$

285. $TR_{agd,row} = PIXCON^{\eta} TR_{agd,row}^{O}$

Demand

286. $PC_{i}C_{i,h} = PC_{i}C_{i,h}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h} - \sum_{ij} PC_{ij} C_{ij,h}^{MIN}\right)$

287. $PC_{i}INV_{i}^{PRI} = \gamma_{i}^{INV} IT^{PRI}$

288. $PC_{i}INV_{i}^{PUB} = \gamma_{i}^{INV} IT^{PUB}$

289. $INV_{i} = INV_{i}^{PRI} + INV_{i}^{PUB}$

290. $IT^{PRI} = IT - IT^{PUB} - \sum_{i} PC_{i} VSTK_{i}$

291. $PC_{i}CG_{i} = \gamma_{i}^{GVT} G$

292. $DIT_{i} = \sum_{j} DI_{i,j}$

293. $MRGN_i = \sum_{ij} tmrg_{i,ij} DD_{ij} + \sum_{ij} tmrg_{i,ij} IM_{ij} + \sum_{ij} tmrg^X_{i,ij} EXD_{ij}$

International trade

294. $XST_j = B^{XT}_j \left[\sum_i \beta^{XT}_{j,i} XS^{\rho^{XT}_j}_{j,i}\right]^{\frac{1}{\rho^{XT}_j}}$

295. $XS_{j,i} = \frac{XST_j}{\left(B^{XT}_j\right)^{1+\sigma^{XT}_j}} \left[\frac{P_{j,i}}{\beta^{XT}_{j,i} PT_j}\right]^{\sigma^{XT}_j}$

296. $XS_{j,i} = B^X_{j,i} \left[\beta^X_{j,i} EX^{\rho^X_{j,i}}_{j,i} + \left(1-\beta^X_{j,i}\right) DS^{\rho^X_{j,x}}_{j,i}\right]^{\frac{1}{\rho^X_{j,i}}}$

297. $EX_{j,i} = \left[\frac{1-\beta^X_{j,i}}{\beta^X_{j,i}} \frac{PE_i}{PL_i}\right]^{\sigma^X_{j,i}} DS_{j,i}$

298. $EXD_i = EXD^O_i pop_t \left(\frac{e_t PWX_i}{PE^{FOB}_i}\right)^{\sigma^{XD}_i}$

299. $Q_i = B^M_i \left[\beta^M_i IM_i^{-\rho^M_i} + \left(1-\beta^M_i\right) DD_i^{-\rho^M_i}\right]^{-\frac{1}{\rho^M_i}}$

300. $IM_i = \left[\frac{\beta^M_i}{1-\beta^M_i} \frac{PD_i}{PM_i}\right]^{\sigma^M_i} DD_i$

Prices

301. $PP_j = \frac{PVA_j VA_j + PCI_j CI_j}{XST_j}$

302. $PT_j = \left(1 + ttip_j\right) PP_j$

303. $PCI_j = \frac{\sum_i PC_i DI_{i,j}}{CI_j}$

304. $PVA_j = \frac{WC_j LDC_j + RC_j KDC_j}{VA_j}$

305. $WTI_{l,j} = W_l (1 + ttiw_{l,j})$

306. $RTI_{k,j} = R_{k,j} (1 + ttik_{k,j})$

307. $R_{k,j} = RK_k$ (Relevant only if capital is mobile)

308. $P_{j,i} = PT_j$

309. $P_{j,i} = \frac{PE_i EX_{j,i} + PL_i DS_{j,i}}{XS_{j,i}}$

310. $PE^{FOB}_i = \left(PE_i + \sum_{ij} PC_{ij} tmrg^X_{ij,i}\right)(1 + ttix_i)$

311. $PD_i = (1 + ttic_i)\left(PL_i + \sum_{ij} PC_{ij} tmrg_{ij,i}\right)$

312. $PM_i = (1 + ttic_i)\left((1 + ttim_i) ePWM_i + \sum_{ij} PC_{ij} tmrg_{ij,i}\right)$

313. $PC_i = \frac{PM_i IM_i + PD_i DD_i}{Q_i}$

314. $PIXGDP = \sqrt{\frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j}\right) VA^O_j \sum_j \left(PVA_j VA_j + TIP_j\right)}{\sum_j \left(PVA^O_j VA^O_j + TIP^O_j\right) \sum_j \left(PVA^O_j + \frac{TIP^O_j}{VA^O_j}\right) VA_j}}$

315. $PIXCON_t = \frac{\sum_i PC_i \sum_h C^O_{i,h}}{\sum_{ij} PC^O_{ij} \sum_h C^O_{ij,h}}$

316. $PIXINV = \prod_i \left(\frac{PC_i}{PC^O_i}\right)^{\gamma^{INV}_i}$

317. $PIXGVT = \prod_i \left(\frac{PC_i}{PC^O_i}\right)^{\gamma^{GVT}_i}$

318. $PIXEX = \prod_i \left(\frac{PE_i}{PE_i^O}\right)^{\gamma_i^{EX}}$

319. $PIXIM = \prod_i \left(\frac{PM_i}{PM_i^O}\right)^{\gamma_i^{IM}}$

Equilibrium

320. $Q_{i1} = \sum_h C_{i1,h} + CG_{i1} + INV_{i1} + VSTK_{i1} + DIT_{i1} + MRGN_{i1}$
321. $\sum_j LD_{l,j} = LS_l$
322. $\sum_j KD_{k,j} = KS_k$
323. $IT = \sum_h SH_h + SG + SROW$
324. $\sum_j DS_{j,i} = DD_i$
325. $\sum_j EX_{j,i} = EXD_i$

Gross Domestic Product

326. $GDP^{BP} = \sum_j PVA_j VA_j + TIPT$
327. $GDP^{MP} = GDP^{BP} + TPRCTS$
328. $GDP^{IB} = \sum_{l,j} W_l LD_{l,j} + \sum_{k,j} R_{k,j} KD_{k,j} + TPRODN + TPRCTS$
329. $GDP^{FD} = \sum_i PC_i\left[\sum_h C_{i,h} + CG_i + INV_i + VSTK_i\right] + \sum_i PE_i^{POB} EXD_i - \sum_i ePWM_i IM_i$

Real variables

330. $CTH_h^{REAL} = \frac{CTH_h}{PIXCON}$
331. $G^{REAL} = \frac{G}{PIXGVT}$
332. $GDP^{BP\_REAL} = \frac{GDP^{BP}}{PIXGDP}$
333. $GDP^{MP\_REAL} = \frac{GDP^{MP}}{PIXCON}$

Additional equations

334. $EXPT = \sum_i PE_i^{FOB} EXD_i$
335. $IMPT = \sum_i PWM_i eIM_i$
336. $EX^{REAL} = EXPT/PIXEX$
337. $IM^{REAL} = IMPT/PIXIM$
338. $Capexp = capexp^{gdp} GDP^{FD}$
339. $GovBdef = YG - \left\{\sum_{agng} TR_{agng,'gvt'} + G\right\} - capexp^{gdp} GDP^{FD}$
340. $LEON = Q_{c-agr} - \sum_h C_{c-agr,h} - CG_{c-agr} - INV_{c-agr} - VSTK_{c-agr} - DIT_{c-agr} - MRGN_{c-agr}$
341. $\frac{W_l}{PIXCON} = \frac{W_l^O}{PIXCONO}\left[\frac{unemp_l^O}{unemp_l}\right]^{0.25}$
342. $LS_l = LS_l^P[1 - unemp_l]$

ANNEX-3 PDM　（All Versions of PDM）

Project Design Matrix

Project Title: The Project for Strengthening capacity of macroeconomic policy and planning

Implementing Agency: Macroeconomic Policy Division, Economic Policy Department, Ministry of Finance

Target Group: Officers of Macroeconomic Policy Division, Economic Policy Department, Ministry of Finance.

Period of Project: December, 2019 to December, 2022 (Three years)

Project Site: Ulaanbaatar **Model Site:**

Version 0

Dated 2019-06-28

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal The capacity to develop the pluralized macro-economic scenarios for the sustainable development is enhanced.	1. Dialogue by the Macroeconomic Policy Division with the other government institutions, research institutions to formulate macro-economic forecast through the application of CGE modeling is occasionally held. 2. More precise macro-economic forecast with the feed backs from the relevant stakeholders is made by the Macroeconomic Policy Division.	* Minutes of conference * Macro-economic forecast			
Project Purpose The capacity to formulate macro-economic policy is enhanced.	1. Forum/conference for strengthening cooperation and information exchange among the government institutions and research institutions is held. 2. Improved CGE modeling is applied/utilized. 3. Periodically/institutionalized report based on the application/utilization of improved CGE modeling is shared. 4. Information sharing/Policy recommendation based on the application/utilization of improved CGE modeling is made.	* Minutes of forum/meeting * Improved CGE modeling * Periodical report	* Ministry of Finance secures necessary arrangement/ budget for maintaining database and holding conferences.		
Outputs					
Output1:The capacity of the officers of Ministry of Finance on macro-economic analysis and forecast is improved.	1. Capacity building * Training plan, manual are developed. * Relevant officers acquire necessary skills in the use of improved CGE modeling. * Career path/roadmap for government economist is developed.	* Training plan/manuals * Report of the trainings * Monitoring sheets/Project completion report	* Counterparts of the Ministry of Finance remain in charge during the Project period.	In progress	
Output 2: Macro-economic applied Computable General Equilibrium (CGE) modeling to analyze estimated prediction, evaluation of macro-economic indicator for each economic sector is refined and utilized.	2. Improvement and establishment of CGE modeling * Improved CGE modeling is developed.	* Monitoring sheets/Project completion report		The Social Accounting Matrix(SAM) for 2018, which is the basis for CGE modeling, has been constructed and multiplier exercises with it has been executed.	
Output3: Formats for periodical report and to utilize the data from "Tentative Title: Macro-economic Database" are developed.	3. Development of format for reporting * Periodical reporting format and format to extract the data from the Database are developed.	* Number and variety of the formats * Monitoring sheets/Project completion report		In progress	
Output 4: The capacity to develop policy recommendation to the policy makers is enhanced.	4. Information sharing/policy recommendation * Relevant officers share information with the relevant stakeholders and give policy recommendation to the policy makers.	* Monitoring sheets/Project completion report		In progress	

Activities	Inputs		Important Assumption
	The Japanese Side	The Mongolian Side	Pre-Conditions
			▼
			<Issues and countermeasures>
1-1 To review current situation of application/utilization of CGE modeling. 1-2 To formulate training plan for capacity building on CGE modeling application/utilization and analysis. 1-3 To conduct on-site training based on the issues which are clarified at 1-1. 1-4 To conduct advanced theoretical/practical technical training in Japan for the selected officers to acquire further knowledge. 1-5 To draft a career path/roadmap for government economist, referring to the existing career path of government officers. 2-1 To develop the improved CGE modeling. 2-2 To improve, localize other modeling tools which MOF uses ordinarily. 2-3 To develop manuals and materials for application/utilization of the improved CGE modeling. 2-4 To conduct trial operation for analysis, using the improved CGE modeling, manuals and materials. 3-1 To confirm the current status and quality of reporting based on the existing practice. 3-2 To develop formats to utilize the data from "Tentative Title: Macro-economic Database" for CGE modeling and for reporting activities. 3-3 To develop a format of "a brochure summarizing the result of analysis". 3-4 To make up above mentioned brochure. 3-5 To conduct trial base periodical reporting, using the above mentioned formats. 4-1 To provide above mentioned brochure at 3-4 to MOF, related government institutions and secretariat's office. 4-2 To conduct working-level conference in place for the relevant stakeholders and donors to exchange the views of macro-economic analysis and forecast. 4-3 To report the result of the discussion regarding above 4-2 to policy makers and to disseminate them to the public.	・Experts (Long-term / Short-term) ・Trainings / Workshop / Seminars (Mongolia and Japan) ・Project expense for activities ・Software ・Local staff	・Counterpart personnel ・Project office ・Local expense	COVID-19 pandemic has led to radical changes in the governments' policies, including the Mongolian Gov., such as closing borer, lock-down of communities and strict quarantine requirements. These policies have disturbed daily lives and working style in general. It caused delay in transnational dispatching of international cooperation personnel and interrupt close communication. The pandemic caused general delay in work agendas and timetables. On-line communication prevails in working places.

Project Monitoring Sheet I （Revision of Project Design Matrix）

Project Title: The Project for Strengthening capacity of macroeconomic policy and planning

Implementing Agency: Macroeconomic Policy Department, Ministry of Economy and Development

Target Group: Officers of Macroeconomic Policy Department, Ministry of Economy and Development.

Period of Project: December, 2019 to April, 2023

Project Site: Ulaanbaatar **Model Site:**

Version 1

Dated May 23, 2022

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal The capacity to develop the pluralized macro-economic scenarios for the sustainable development is enhanced.	Important background documents for policy making, such as the quarterly economic reports, include constant feedback from the simulation results with the CGE model.	* Periodical report Hearing from Government perssonel			
Project Purpose The capacity to formulate macro-economic policy is enhanced.	In the Macroeconomic Policy Department, a working flow is established to examine whether or not the regular reporting of macroeconomic perspectives should reflect the results of CGE model simulations.	* Minutes of forum/meeting * Periodical report * Monitoring sheets/Project completion report	* Ministry of Economy and Development secures necessary arrangements/ budget for maintaining the database and holding conferences.		
Outputs					
Output1:The capacity of the officers of Ministry of Economy and Development on macro-economic analysis and policy impact evaluation is improved.	1. Capacity building * Training plan, manual are developed. * Relevant officers acquire necessary skills in the use of improved CGE modeling.	* Training plan/manuals * Report of the trainings * Monitoring sheets/Project completion report	* Counterparts of the Ministry of Economy and Development remain in charge during the Project period.	3 sessions were conducted on technical skill development for the economic analysis.	
Output 2: Computable General Equilibrium (CGE) modeling to analyze narrative prediction, evaluation of policy impacts for each economic sector is refined and utilized.	2. Improvement and establishment of CGE modeling * Improved CGE modeling is developed.	* Monitoring sheets/Project completion report		The standard models of Static and Dynamic CGEwere constructed. Training was made on the CGE modeling with GAMS.	Under examination of aquired ability.
Output3: Ability of the Macroeconomic Policy Department for policy analisis and recommendation is enhanced.	3. The Macroeconomic Policy Department has several times examined if CGE modeling results shall be reflected in the Quarterly Economic Report.	* Monitoring sheets/Project completion report		Database has been developed electronically and shared by all members of the Macroeconomic Policy Department. Quarterly Economic Reports have been incorporate in the annual plan and the medium term fiscal plan.	The Macroeconomic projection is almost consistent with IMF's perspective.

Activities	Inputs		Important Assumption
	The Japanese Side	The Mongolian Side	Pre-Conditions
			▼
			<Issues and countermeasures>
1-1 To review current situation of application/utilization of CGE modeling. 1-2 To formulate training plan for capacity building on CGE modeling application/utilization and analysis. 1-3 To conduct on-site training based on the issues which are clarified at 1-1. 1-4 To conduct advanced theoretical/practical technical training in Japan for the selected officers to acquire further knowledge.	・Experts (Long-term / Short-term) ・Trainings / Workshop / Seminars (Mongolia and Japan) ・Project expense for activities ・Software ・Local staff	・Counterpart personnel ・Project office ・Local expense	
2-1 To develop the improved CGE modeling.	JICA Mongolia Office made contract with ERI on CGE model construction and training according to TOR drafted by the Chief Advisor.	4 staff were nominated as modeller of CGE modeling.	
2-2 To improve, localize other modeling tools which MED uses ordinarily.	Prof. Taguchi has lectured MED on variety of economic models. Dr. Enkhbayar of ERINA made lecture on the Intoduction of GTAP.	1 staff was nominated to participate in the short course of GTAP	
2-3 To develop manuals and materials for application/utilization of the improved CGE modeling.	in progress		
2-4 To conduct trial operation for analysis, using the improved CGE modeling, manuals and materials.	in progress		
3-1 To include the simulation results of CGE modeling in data sharing system of the Macroeconomic Policy Department.	facilitate CGE model simulations to be included.		
		C/P has made Quarterlt Economic Report since early 2020.	
3-2 To conduct working level workshop with experts to exchange views and opinions regarding the simulation results.	facilitate unofficial meeting to be held	Already in practice.	
		Getting alignment among relevant entities of Mongolian Government on current situation and policy recommendations.	
3-3 To examine the validity of the simulation results in the current context of the economy.		Steering the above in the Cabinet Meeting..	
3-4 To propose ideas to integrate the analyses and recommendations examined in above 3-3 into the periodical reporting practice and policy planning documents.			

Project Monitoring Sheet I （Revision of Project Design Matrix）

Project Title: The Project for Strengthening capacity of macroeconomic policy and planning

Implementing Agency: Macroeconomic Policy Department, Ministry of Economy and Development

Target Group: Officers of Macroeconomic Policy Department, Ministry of Economy and Development.

Period of Project: December, 2019 to April, 2023

Project Site: Ulaanbaatar **Model Site:**

Version 2

Dated December 22, 2022

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal The capacity to develop the pluralized macro-economic scenarios for the sustainable development is enhanced.	Important background documents for policy making, such as the quarterly economic reports, include constant feedback from the simulation results with the CGE model.	* Periodical report Hearing from Government perssonel			
Project Purpose The capacity to formulate macro-economic policy is enhanced.	In the Macroeconomic Policy Department, a working flow is established to examine whether or not the regular reporting of macroeconomic perspectives should reflect the results of CGE model simulations.	* Minutes of forum/meeting * Periodical report * Monitoring sheets/Project completion report	* Ministry of Economy and Development secures necessary arrangements/ budget for maintaining the database and holding conferences.	Discussions with Japanese and Mongolian economists and policy simulation exercises are fostering awareness of policy issues and scope of analytical framework.	
Outputs					
Output1:The capacity of the officers of Ministry of Economy and Development on macro-economic analysis and policy impact evaluation is improved.	1. Capacity building * Training plan, manual are developed. * Relevant officers acquire necessary skills in the use of improved CGE modeling.	* Training plan/manuals * Report of the trainings * Monitoring sheets/Project completion report	* Counterparts of the Ministry of Economy and Development remain in charge during the Project period.	Upon the simulation results on three policu issues, modelers and CGE training team discussed the implications and relevance to specialists' views.	
Output 2: Computable General Equilibrium (CGE) modeling to analyze narrative prediction, evaluation of policy impacts for each economic sector is refined and utilized.	2. Improvement and establishment of CGE modeling * Improved CGE modeling is developed.	* Monitoring sheets/Project completion report		The standard models of Static and Dynamic CGEwere constructed. Training was made on the CGE modeling with GAMS.	Under examination of aquired ability.
				Modelers learnt simulation methods on variety of policy issues.	Continuous excercises will be needed.
Output3: Ability of the Macroeconomic Policy Department for policy analisis and recommendation is enhanced.	3. The Macroeconomic Policy Department has several times examined if CGE modeling results shall be reflected in the Quarterly Economic Report.	* Monitoring sheets/Project completion report		Database has been developed electronically and shared by all members of the Macroeconomic Policy Department. Quarterly Economic Reports have been incorporate in the annual plan and the medium term fiscal plan.	The Macroeconomic outlook of MED is discussed and revised on the discussion with IFIs' mission continuously.

Activities	Inputs		Important Assumption
	The Japanese Side	The Mongolian Side	Pre-Conditions
			↓
			<Issues and countermeasures>
1-1 To review current situation of application/utilization of CGE modeling. 1-2 To formulate training plan for capacity building on CGE modeling application/utilization and analysis. 1-3 To conduct on-site training based on the issues which are clarified at 1-1. ~~1-4 To conduct advanced theoretical/practical technical training in Japan for the selected officers to acquire further knowledge.~~	・Experts (Long-term /~~ Short-term)~~ ・Trainings / Workshop / Seminars (Mongolia and Japan) ・Project expense for activities ・Software ・Local staff	・Counterpart personnel ・Project office ・Local expense	Under the continued circumstances of the pandemic, alternative measures such as online communications have been adopted.
2-1 To develop the improved CGE modeling.	JICA Mongolia Office made contract with ERI on CGE model construction and training according to TOR drafted by the Chief Advisor.	4 staff were nominated as modeller of CGE modeling.	Modelers will not dropped out from CGE modeling excises.
2-2 To improve, localize other modeling tools which MED uses ordinarily.	Prof. Taguchi has lectured MED on variety of economic models. Dr. Enkhbayar of ERINA made lecture on the Intoduction of GTAP.	1 staff has completed the short course on GTAP and made a trial model with GTAP.	
2-3 To develop manuals and materials for application/utilization of the improved CGE modeling.	Reviewing the training materials.	Self-evaluation and review	
2-4 To conduct trial operation for analysis, using the improved CGE modeling, manuals and materials.	Discussion with ERI team and MED staff for selecting policy issues	Focusing on relevant policy issues	
3-1 To include the simulation results of CGE modeling in data sharing system of the Macroeconomic Policy Department.	Facilitate CGE model simulations to be included.	Information sharing is developing in MED.	
		C/P has made Quarterly Economic Report since early 2020.	
3-2 To conduct working level workshop with experts to exchange views and opinions regarding the simulation results.	Organize unofficial meeting to be held with Jaoanes and Mongolian economists.	Getting alignment among relevant entities of Mongolian Government on current situation and policy recommendations.	
3-3 To examine the validity of the simulation results in the current context of the economy.	Simulation results are discussed on the relevance to specialists' views.	Steering the above in the Cabinet Meeting..	
3-4 To propose ideas to integrate the analyses and recommendations examined in above 3-3 into the periodical reporting practice and policy planning documents.			