JAPAN INTERNATIONAL COOPERATION AGENCY
IN COOPERATION WITH
NATIONAL DEVELOPMENT PLANNING AGENCY(BAPPENAS)
REPUBLIC OF INDONESIA

No. 23

DEVELOPMENT STUDY OF ECONOMIC MODEL FOR PLANNING EXERCISES, LONG TERM PROGRAMMING MODEL IN THE REPUBLIC OF INDONESIA

FINAL REPORT

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DAIWA INSTITUTE OF RESEARCH LTD.
ENGINEERING CONSULTING FIRMS ASSOCIATION, JAPAN

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PREFACE

In response to a request from the Republic of Indonesia, the Government of Japan decided to conduct the Development Study of Economic Model for Planning Exercises, Long-term Programming Model in Indonesia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Tomohiro Abe, Senior Managing Director, Daiwa Institute of Research Ltd. and consisted of Daiwa Institute of Research Ltd. and Engineering Consulting Firms Association, JAPAN, to Indonesia seven times between September 1995 and November 1998. In addition, JICA set up a steering committee headed by Prof. Dr. Takao Fukuchi, Asahi University, which examined the study from technical points of view.

The team together with the committee held a series of discussions with the concerned officials of the Government of the Republic of Indonesia. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of the economic and social development of the Republic of Indonesia as a effective planning tool, and also to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the study.

November 1998

Kimio Fujita
President
Japan International Cooperation Agency

FOREWORD

This document is the final report of three years study of "Development Study of Long-Term Model For Economic Planning" which was asked by and implemented in collaboration with National Development Agency (BAPPENAS) of Indonesian Government. When BAPPENAS asked JICA to consider this Development Study, the Government of Indonesia planned to further increase per-capita income and join to middle-income group after 25 years, and engaged in the Sixth Repelita and also in the Second 25 Years Plan after 1994. The basic framework of planning model of this study, Input-Output Multi-Periods Programming Model (IOPM), was proposed and constructed as a useful tool to consider the interrelationships of these plans and various important structural constraints, and efficiently prepare these plans in a consistent manner.

The development study aimed to construct IOPM for coming 25 years; and calculate out the optimum figures of basic variables (26 sectors, 5 periods, 5 variables) for coming 25 years on national as well as regional basis; and clarify the importance of long-term constraints, necessary speeds of resources accumulation, and regional tasks; and clarify the feasible and optimum growth path and future policy issues. These scheduled tasks were implemented by national as well as regionally decomposed versions.

As the economy of Indonesia has been hit by Asian economic crisis after the summer 1997, the government of Indonesia has tackled many urgent tasks of crisis management and social safety network. Even in such a crisis period, it is still important to keep in mind the medium problems like debt management and efficient utilization of labor force. After the crisis period, a new development plan will be needed based on new vision and wider scope. The basic framework of IOPM can be also a useful policy tool to prepare a recovery plan for the normal growth path, and to formulate the future sustainable growth path. The Team hopes that IOPM can be utilized in various occasions as a useful policy tool for future development of Indonesian economy.

November 1998

Takao Fukuchi
Chairman
Steering Committee

November 1998

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita

Letter of Transmittal

Submitted with this letter is our final report on Development Study of Economic Model for Planning Exercises, Long-term Programming Model in the Republic of Indonesia. This study aimed to build the Input-Output Multi-Period Programming Model (IOPM) including its mastery technology transfer to National Development Planning Agency of the Republic of Indonesia (BAPPENAS) and to forecast the development path of coming twenty-five years under various development targets and structural constraints. IOPM is expected to serve to check the feasibility, consistency and optimality of long-run planning such as the Second Twenty-five Year Plan (PJP II).

The report contains main simulated results of both national IOPM and two-region IOPM and also the research of selected important development issues. The economic circumstance of the Republic of Indonesia drastically changed by the current economic crisis erupted in the summer of 1997. Taking these change into consideration, we modified both IOPM's and recalculated the future growth paths. The main results are also provided in this final report.

We are indeed grateful for the advice, encouragement and support afforded to us by the staff of the Agency as well as the Ministry of Foreign Affairs of Japan, and the staff of Embassy of Japan in Jakarta. On this occasion we also wish to express our gratitude for the assistance provided by the personnel of BAPPENAS.

Tomohiro Abe
Leader
JICA Study Team

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Acronyms, Abbreviations and Definitions

ADB	Asian Development Bank
AMDAL	Indonesia's Environmental Impact Assessment System
BAPEDAL	Environmental Impact Management Agency
BAPPENAS	National Development Planning Agency
BOD	Biological Oxygen Demand
BPPT	Agency for Assessment and Application of Technology
BPS/CBS	Biro Pusat Statistik / Central Bureau of Statistics
COD	Chemical Oxygen Demand
COR	Capital-Output Ratio
DBPM	Debt and Balance of Payment Model
DOC, MME	Directorate of Coal, Ministry of Mine and Energy
DPU	Ministry of Public Works
EGW	Electricity, Gas and Water
EIA	Environmental Impact Assessment
EMC	Environmental Management Center
FDI	Foreign Direct Investments
FLC	Forward Linkage Coefficients
GRDP	Gross Regional Domestic Product
ICOR	Incremental Capital Output Ratio
I-O Table	Input-Output Table
IDE	Institute of Developing Economies
IDT	Inpres Desa Tertinggal
INPRES	Special Presidential Instruction Program
IOPM	Input-Output Multiperiod Planning Model
ISIC	International Standard Industrial Classification
JICA	Japan International Cooperation Agency
KLH	Minister of State for Environment
KPKs	Smaii Farmer Self-help Groups
LP	Linear Programming
LPEM	Institute for Economic and Social Research
Langit Biru	Blue Sky Program
MVA	Manufacturing Value Added
NOx	Nitrogen Oxides
OECF	Overseas Economic Cooperation Fund
PAE	Pollution Abatement Equipment

PJP II	Second Long-Term Development Plan
PKMD	Village Health Development
PKT	Integrated Area Development Program
PROKASIH	Clean River Program
PTBA	State-owned Coal Mining Company
QP	Quadratic Programming
Repelita	Five-year Development Plan
SAM	Social Accounting Matrix
SOx	Sulfur Oxides
TCF	Tera Cubic Feet
UPGF	Family Nutrition Improvement Program
USAID	United States Agency for International Development

Currency Equivalents

Annual Average 1980-1997

1980	US$1.00 = Rp. 627
1981	US$1.00 = Rp. 631.8
1982	US$1.00 = Rp. 661.4
1983	US$1.00 = Rp. 909.3[1]
1984	US$1.00 = Rp. 1,025.9
1985	US$1.00 = Rp. 1,110.6
1986	US$1.00 = Rp. 1,282.6[2]
1987	US$1.00 = Rp. 1,643.8
1988	US$1.00 = Rp. 1,685.7
1989	US$1.00 = Rp. 1,770.1
1990	US$1.00 = Rp. 1,842.8
1991	US$1.00 = Rp. 1,950.3
1992	US$1.00 = Rp. 2,029.9
1993	US$1.00 = Rp. 2,087.1
1994	US$1.00 = Rp. 2,160.8
1995	US$1.00 = Rp. 2,248.6
1996	US$1.00 = Rp. 2,342.3
1997	US$1.00 = Rp. 2,916.5

Source: IMF-IFS

Note:

[1] On March 30, 1983 the Rupiah was devalued from US$1.00 = Rp703 to US$1.00 = Rp970.

[2] On September 12, 1986 the Rupiah was devalued from US$1.00 = Rp1,134 to US$1.00 = Rp1,644.

Introduction

The scope of work for development study of economic model for long-term planning exercises was agreed upon between BAPPENAS and JICA on 17 March 1995, aimed to develop the Input-Output Multi-Period Programming Model (IOPM) and to forecast the development path of coming twenty-five years under various development targets and structural constraints. The IOPM is expected to serve to check the feasibility, consistency and optimality of long-run planning such as the Second Twenty-five Years Plan (PJPII). The scope of work also includes the trial construction of multi-regional Input-Output Model, technology transfer of IOPM and the research of selected important development issues.

The development study was scheduled in the time span of three years and a half and the work components are divided in the following four phases: the first nine months (July 1995-March 1996) are devoted (i) to construct the IOPM on the national basis, and (ii) to make additional study to improve the IOPM on national basis, and (iii) to prepare for the regional decomposition of IOPM (phase 1), the next twelve months (April 1996 - March 1997) are devoted (i) to enrich the IOPM exercises on the national basis based upon the further information, and (ii) to construct the IOPM on regional basis (phase 2), the next twelve months (April 1997 - March 1998) are devoted to improvement and integration of the whole exercises, and to study the implications of various simulations for future long term planning. In this phase technology transfer of IOPM on national basis is executed (phase 3), the last eight months (April 1998 - November 1998) are devoted to improvement of both national IOPM and regional IOPM for practical use including the impact of current economic crisis (phase 4).

In an addition to the construction of IOPM, five subjects i.e. balance of payments and external debt, industrial development, resource and energy, environment and poverty and income distribution were selected to be researched since these selected issues were directly or indirectly relating to the construction work of this long-term IOPM.

The achievement of works of these phases was submitted to BAPPENAS in the form of Progress Report I, II and III respectively and the contents of three Progress Reports summarized in the subsequent sections.

The study has been made as a joint work of BAPPENAS and the JICA-TSQ Team commissioned by JICA. In Japan the Team is composed of 17 membered JICA Steering Committee chaired by Prof. Dr. Fukuchi and of 12 membered JICA Study Team(Daiwa Institute Research and Engineering Consulting Firms Association, Japan)

Short History of Work in Fiscal Year 1995

The main components of Progress Report (I) in fiscal year 1995 were consisted of (i) the data collection for IOPM on national basis and also the preliminary data collection on regional basis, (ii) the construction of IOPM on the national basis, calculation of feasible and optimum solutions, and (iii) relevant studies to specify the structural constraints and to discuss the implications of solutions.

The availability of I-O Table at the starting year: the construction work of IOPM started in fiscal year 1995 was mostly devoted to the necessary data collection work. The planning period of IOPM was set for twenty-five years from 1994 to 2018 corresponding to the years of PJPII. However, since the preparation of I-O Tables at 1993 price by Indonesian government was scheduled to be completed by the end of fiscal year 1995, the IOPM construction work in fiscal year 1995 was made based upon the existing I-O Tables of 1980,1985 and 1990 and the planning exercises in fiscal year 1995 based upon the 1990 I-O Table data.

The estimation of future input coefficients: the Team repeatedly made the estimation of future input coefficients until 2018 by applying various extrapolation methods. Also the Team compared these estimated coefficients with Japanese input coefficients as a reference. After these trials we reached to a plausible set of technical coefficients, and utilized them to implement the planning exercises.

The estimation of parameters of structural constraints: the capital coefficients were estimated by the combined use of OGUCHI-estimates of sectoral capital coefficients and BPS data. the Team took the import coefficients from I-O Table 1990. The Team studied several labor coefficients from different sources, and incorporated the total labor requirement in some Versions. However ,the labor constraint was not incorporated in the latest Version since the total labor availability is rather redundant while the skilled labor is in short supply in reality. Certain proper treatment of labor requirement may be needed in the future. The estimation of structural constraints also lagged behind from the initial schedule. The Team planned to estimate the future tendency of important coefficient like other capital or import coefficients by regressing their past trends with per-capital income or sectoral productivity. However, the annual series of sectoral outputs was scheduled to be available at the end of fiscal year 1995. Therefore improvement of substantial numbers of estimation of structural constraints was made also in fiscal year 1996.

Many Versions of IOPM were built and different optimum solutions were calculated based upon the different combinations of target function and structural constraints. This report presents some alternative solutions and accompanying shadow prices. It is observed that the distribution of expenditure into consumption and investment and the subsectoral pattern of output changes greatly over time. Further improvement of exercises of national IOPM requires naturally updating and improvement of basic data on consecutive base and addition of other structural constraints to this IOPM.

Short History of Work in Fiscal Year 1996

According to the Scope of the Work signed at March 1995, the original working plan for the second year was the extension of national IOPM and the preliminary construction of multi-regional IOPM. However, at a later stage, some revisions become necessary to amend the initial schedule.

In March 1996 BAPPENAS side requested that the renewal of data-base and accordingly national IOPM would be improved and such results should be presented by the end of 1996 as a reference to the planning works of Repelita VII so that the Team activity was re-scheduled to accommodate this requirement, meanwhile, the necessary data collection and processing works encountered many difficulties and time-span was consumed more than initially expected. For example, the Team was asked to construct the IOPM based on the 1993 basis, since 1993 is the basic year for Repelita VI and PJPII; however, the newest I-O Table of 1993 became available only after June 1996. Under the above mentioned circumstances, the Team worked mostly devoted to achieve three studies; (1) the simulation exercises by the nation-wide IOPM, and the preliminary trials for the region-based modeling works, (2) the related data collection, and (3) the further research of important development issues.

The revised data base of 1993 price attained at June 1996 thus produced the newest I-O Table of 1993 and subsequently new simulation exercises by national IOPM(Version 20) from Version 19 based on old data-base of 1990 price. The results by old Version 19 was discussed at June Workshop held in Jakarta in June 1996. Subsequently in September Seminar at Puncak, the preliminary results by Version 20 was discussed. In these exercises the parameter values were basically fixed at the current values without taking into consideration of the expected parameter changes in the planning period. So that these results served mainly to explain the workability of IOPM, and to invite some comments for the future possible development paths in coming twenty-five years. After the September Seminar, the Team considered the changing trends of parameter values and improved the specification of IOPM of Version-20 to sketch the future possible development paths of the Indonesian economy. Some exercises turned out mostly similar features with the development path described the currently going-on PJPII Plan. This suggests that the current Version 20 is a meaningful tool to sketch the future development path of the Indonesian economy, as well as to exercise various simulation to see the relations between the various development targets and the necessary parameter values. Progress Report (II), therefore, contains the new results of exercises by Version 20 .

Meanwhile the modeling works of multi-regional IOPM was limited to the trial estimates of some equations, since the major efforts of the Team was devoted to national IOPM exercises and data collection necessary for multi-regional IOPM which took more time than initially scheduled.

Short History of Work in Fiscal Year 1997

In fiscal year 1997, our effort is devoted mainly to improvement of IOPM, construction of multi-regional IOPM and technology transfer of IOPM and the further research of important development issues.

This Progress Report (III) cantains the results of works realized between April 1997 to March 1998 in the third year of initially scheduled three years (1996-98). The major work components in fiscal year 1997 is consisted with two:

(1) The IOPM Modeling Advanced in Three Directions:

(a) Simulation on Export Price Change

The changes in export prices exert wide influences to the national development path. The simulation on export price change was tried and reported at September Seminar.

(b) Calculation of Shadow Prices

The usefulness of IOPM modeling is greatly enhanced by the calculation of shadow prices of limited resources. By properly defining the shadow prices, and by comparing the social benefits and accounting costs of activities with positive activity levels, the social marginal contribution or shadow price of unit increase of limited resource can be assessed.

(c) Preparation of Regionally Decomposed Input-Output (hereafter, I-O) Table

The five-regions I-O Table for Indonesia was prepared jointly by LPEM and DIR team. The two-regions I-O Table was also constructed for trial forecasting.

(2) Technology Transfer of IOPM

The necessary software package for national IOPM modeling exercise with output, capital and foreign currency constraints was made, and delivered to BAPPENAS with adequate hard equipments. A series of joint study were held in September and December 1997 with DIR Team to facilitate its mastery use by BAPPENAS staff and another joint-meeting were held in March 1998 to renew data-base.

Progress Report (III) including the results of the transfer work mentioned above was presented on March 1997 to BAPPENAS and in subsequently held meetings, the need of further inclusion of the impact of currency crisis was noted.

Short History of Work in Fiscal Year 1998

In fiscal year 1998, the work is devoted mainly to further improve IOPM especially focusing on analysis of current economic crisis, improved building of two-region IOPM, final technology transfer of IOPM and the further research of important development issues.

The achievement of this study from 1995 is thus reflected on 4 chapters of this Report; chapter 1 deals the analytical framework of national IOPM, chapter 2 deals the analytical framework of multi-regional IOPM, chapter 3 deals analysis of current economic crisis and chapter 4 discuss important policy issues.

Chapter 1

Long Term Perspective of Indonesian Economy by National IOPM

1.1 Description of the Basic Framework of National IOPM

During the decade of 1990's, the economy of Indonesia has been undergoing drastic structural changes, and experiencing a turning point for the modernization. "An important feature of the 1991 national accounts is that for the first time in the nation's history the output of manufacturing exceeded that of agriculture. This is an historic turning point in Indonesian economic development" (Hill, 1992,p.5). The share of agricultural employment was 50.4 per cent in 1990 (Manning, 1995, p.60), however, the employment share of non-agricultural sector would become dominant in the near future. The PJP II will be an important driving force in this important period of structural changes toward further modernization of the Indonesian economy. The main purpose of modeling exercises of this project is to explore the various feasible development paths and to compare these paths under different policy targets, and to present some useful information about the possible and desirable future structural changes and the corresponding necessary policy actions.

The main component utilized in this report is a multi-period input-output mathematical programming model. This model is basically a combination of (1) the modern optimization methodology of mathematical programming theories and (2) the wide and dynamic description of the whole national economy by I-O Table.

The IOPM is a large scale mathematical planning model, so that both the cost of implementation and the benefit of utilization are also expected to be quite large. At the cost side, the construction of IOPM requires a great deal of statistical data and of supporting information for the model building. At the benefit side, IOPM is an extremely useful tool to get insight into the dynamic structure of the economy from a general equilibrium point-of-view, as it seeks the optimal growth path of the economy under various important structural constraints. We will try to present various different scenarios for multi-period development process. Accordingly, it is quite important to recognize the actual structure of the model, and relevant data requirements on one hand, and then the scopes and the implications of the different scenarios on the other.

In Indonesia, the preparation and the systematization of various data sets in the form of social accounting matrix (SAM) was tried at national basis (see Keuning, 1991 and 1994), but the SAM has not been utilized for the policy making purposes so far. There are some discussions to extend SAM at regional basis in the future (see Tirta, 1991). The construction and application of IOPM for long term planning would further stimulate the better preparation of statistical system and the wider use of SAM for policy purposes.

LP is a part of mathematical optimization tools that assumes (1) linear technology constraints where the input coefficients of resources of each production activity are fixed, (2) linear optimization target in which the price of product of each activity is fixed, (3) non-negativity of the variables that the level of activity or the production level is non-negative. In general, when there are n activities (or products) and m resources, LP seeks to find out the optimum combination of m activities (kinds and volumes of products) which maximizes the total sale (sum of prices and production volumes).

It is well recognized that for a LP problem, there exists another linear programming problem, which is dual to the original problem. This dual programming problem minimizes the total resource cost, postulating that the price of i-th product does not exceed the accounting cost of i-th activity. Based upon the duality theorem, the maximum sale coincides with the minimum resource cost when the optimum solution exists. Thus the most simplified form of a linear programming problem can be specified as follows: Each vector is defined as a column vector.

(maximizing problem)

$$\text{MAX} \quad P'X \tag{1-1}$$

$$AX \leqq 0 \tag{1-2}$$

$$X \geqq 0 \tag{1-3}$$

(minimizing problem)

$$\text{MIN} \quad S'V \tag{1-4}$$

$$A'V \geqq 0 \tag{1-5}$$

$$V \geqq 0 \tag{1-6}$$

where

$P = (p_1,\ldots,p_n)'$, $X = (X_1,\ldots,X_n)'$, $A = (A_1,\ldots,A_n)$, $A_i = (a_{1i},\ldots,a_{mi})'$, $S = (S_1,\ldots,S_m)'$, $V = (V_1,\ldots,V_m)'$

1) The input coefficient of j-th resource (a_{ji}) of i-th activity (A_i) is fixed.
2) The price of i-th product (P_i) and the endowment of k-th resource (S_k) are fixed.
3) The activity level of i-th activity or the output of i-th product (X_i) and the shadow price of k-th resource (V_k) are non-negative. The optimum solution gives the optimal combination of m activities (X^*) and m shadow prices of resources (V^*). When $n < m$, (m-n) disposal activities are added to secure non-negative solution. The accounting price of each activity is defined as the sum of the product of the input coefficients and the corresponding resource shadow prices. When an activity is adopted in the optimum solution, its price exactly matches to its accounting cost. When an activity is not adopted, its accounting cost exceeds its price. This Simplex Criterion identifies the selected activities of same number with resources. When a structural constraint is dull in the optimum solution, its shadow price becomes zero, implying that an additional input of the resource does not contribute to increase the total sale so that its marginal productivity is zero.

Until now, the method of linear programming was usually applied to specific issues to figure out the optimal program of some activities; for example, Arifin (1993) applied to the local transmigration problem.

Another main component of IOPM is I-O Table for Indonesian economy. The input-output analysis starts out from the division of national economy into many sectors (at most 540 sectors as in the USA). By obtaining the tabled description of the inter-industry transactions of basic year among production sectors and final demand sectors, we may calculate the technical coefficient matrix A, assuming that the production function in each sector is fixed coefficient type without joint-output. The Leontief inverse matrix of (U-A) describes the overall multiplier repercussion effects of one unit increase of final demand (Y), where U stands for identity matrix.

$$(U\text{-}A)\,X = C + I + E \qquad (1\text{-}7)$$

$$X = (U\text{-}A)^{-1} \times (C + I + E) \qquad (1\text{-}8)$$

When the coefficient row vectors of capital (k), of labor (l) and of import (m) are given, the various quasi-inverse matrices (QK, QL, QM) can be calculated by multiplying these coefficient vectors to the Leontief inverse matrix.

$$QK = k \times (U\text{-}A)^{-1} \qquad (1\text{-}9)$$

$$QL = l \times (U\text{-}A)^{-1} \qquad (1\text{-}10)$$

$$QM = m \times (U\text{-}A)^{-1} \qquad (1\text{-}11)$$

These quasi-inverse matrices represent the direct and indirect additional needs of resources like capital, labor and foreign currency by one unit increase of final demand component. When the capital requirement can be given in a matrix form, then QK is also a matrix which shows the capital requirement by investment goods after an adding vector is multiplied from left-hand side. The change in capital utilization rate is important factor to decide the short-term capital-output ratio (see, Jansen-Kuyvenhoven, 1987), but in this study we assume that the rate is fixed at the average level since we are dealing with long-term projections. Several interesting studies can be implemented based upon the inverse and quasi-inverse matrices.

The use of input-output technique for economic analysis is relatively new in Indonesia. In the past, there were a few studies employing I-O Table to empirically study some policy issues. The scarcity of studies mainly originated from the technical and economic difficulties of preparing I-O Tables. To quote a few: Kuyvenhoven, Arie and Huib Poot (1986) used the I-O Table in 1980, and grouped 79 manufacturing subsectors into three groups (highly labor-intensive, labor-intensive, intermediate labor-intensive), and ranked each subsector according to labor coefficient, import coefficient, and capital coefficient. These ordering is useful to identify the optimum industrial structure when a specific resource constraint is politically emphasized. Fane-Phillips (1991) and Wymenga (1991) analyzed the degree of economic protection, and calculated the effective protection rates. Poot (1991) analyzed the industrial linkages utilizing I-O Table. Fujita-James (1992) calculated the employment multiplier. Siregar (1993) also calculated the income and employment multipliers for agricultural sectors.

The current IOPM is a programming model, and seeks to find out the optimal multi-period growth path of the Indonesian economy under the various important structural constraints and with the various planning targets. The construction of IOPM follows the following three steps:

(1) specification of the important structural constraints
(2) specification of target function
(3) addition of some side conditions

(1) Specification of the Important Structural Constraints

There are several important structural constraints which restrict the expansion of the Indonesian economy. Among them we considered are the following most important ones.

1) Capital constraint: the capital requirement cannot exceed the currently existing average capital stock (K(t)).

$$k\,X(t) \leqq [K(t)+K(t-1)]/2 \qquad (1\text{-}12)$$

$$K(t) = K(0) + (1-d)^{t-1} I(1) + \ldots + (1-d)\, I(t-1) + I(t) \qquad (1\text{-}13)$$

Here the current capital is defined as the sum of initial stock plus investment of preceding periods with corresponding rate of depletion, assuming that the invested capital is depleted by a depreciation rate (d) in each period.

2) Foreign currency constraint: the use of foreign currency by import cannot exceed the foreign currency earning by export plus the maximum permissible value of trade balance deficit in dollar terms (F(t)).

$$Pm(t)\,[m\,X(t) + M^{*}(t)] \leqq Pe(t)\,E(t) + F(t) \qquad (1\text{-}14)$$

Here Pe(t) or Pm(t) denote the row vector of export price or import price in dollar terms. In this case, m stands for a diagonal matrix with import coefficients as diagonal elements. The M*(t) stands for the final demand part of the import.

3) Labor constraint: the use of skilled labor is limited by its supply (L(t)).

When l stands for a row vector with spectral coefficient of skilled labor requirement, the constraint is written as follows.

$$l\,X(t) \leqq L(t) \qquad (1\text{-}15)$$

(2) Specification of Target Function

The main component of maximizing target is the sum of the discounted flow of consumption (C(t)) over the planning period (T). Another component is the capital stock at the end of the period (K(T)) evaluated by a coefficient (β). This component is necessary due partly to avoid the complete concentration to consumption to the end of planning period, and also to consider the carry-overs of productive capacity for the further generations at the end of the planning period.

$$\sum_{j=1}^{T} C(j) / (1+\rho)^{(j-1)} + \beta K(T) / (1+\rho)^{(T-1)} \qquad (1\text{-}16)$$

(3) Side Conditions

The IOPM is a multiperiod planning model, the solution of which differs from the continuation of successive one-period planning solutions, and exhibits the Turnpike property: 1) the investment concentrates to the former planning periods and the expenditure pattern gradually shifts to consumption, therefore 2) the subsectoral pattern relatively concentrates to investment goods producing subsectors first and then gradually shifts to consumption goods subsectors. But when this Turnpike property is too strong, and the levels of consumption and of other variables change too radically in a short time, then such drastic changes are not socially acceptable. Therefore in this occasion, it is necessary to mitigate this Turnpike property by adding some conditions which limit the short-term changes within certain intervals.

A possible condition to secure a reasonable interval is to require the short-term change of variable R(X(t)) within five per cent range compared with the previous period.

$$(1-0.05)\,X(t-1) \leqq X(t) \leqq (1+0.05)\,X(t-1) \qquad (1\text{-}17)$$

We can combine these constraints and target and specify the IOPM after rewriting and adding some conditions including the non-negativity constraints. The current IOPM is designed for five consecutive quinquennial periods. Output vectors (X), consumption vectors (C), investment (I), export vectors (E) and final good import vectors (M*) of each period are endogenous variables.

Once the coefficients and values of structural constraints are given, then IOPM seeks to find out the optimum solution: output, consumption, investment and export vectors in each period, and the value of sum of discounted consumption flows. Also we can calculate the shadow prices for structural constraints using the coefficient matrix of optimum solution: shadow prices of output, capital, foreign currency and labor of each period.

Naturally, the cost and the benefit matches when an activity is included in the optimum solution. But we can evaluate the another activity based upon the shadow prices. For example, when some products are not exported in i-th period, we can calculate it's accounting price, and figure out the ordering of priorities based upon the differences between export price and accounting cost.

One of basic characteristics of the programming model like IOPM is the indicative role of shadow price system to suggest the accompanying price system matched with the optimum solution. Thus these prices are different from market prices, which change according to the balance between demand and supply conditions. There are another type of models which describe the market clearing function of market prices; like Altemeier-Tabor-Daris (1991) model for Indonesian agricultural sector. Sometimes it will be interesting to compare the system of shadow prices with market prices in certain sectors.

(4) Concept of Shadow Price

The concept of shadow price attached to the current version of IOPM is conveniently understood through following four steps:

1) The Dual Structure of Input-Output System

The usefulness of a programming model is best understood through the dual structure of its optimum solution. For example, an I-O model can be written as the optimum solution of the following pair of LP problems.

(primal problem)

$$\min W'X \tag{1-18}$$

subject to:

$$(U-A)X \geqq Y \tag{1-19}$$

$$X \geqq 0 \tag{1-20}$$

(dual problem)

$$\max Y'P \tag{1-21}$$

subject to:

$$(U-A)'P \leqq W \tag{1-22}$$

$$P \geqq 0 \tag{1-23}$$

where U and A stand for identity matrix and technical input coefficient matrix. X, Y, P and W stand for output, final demand, price and primary input coefficient column vector, respectively.

At the optimum point, output and price vectors are simultaneously determined, and follow the next identities which guarantee the equality between the national sum of production, distribution and expenditure.

(output)		(distribution)		(expenditure)	
P'(U-A)X	=	W'X	=	P'Y	(1-24)

Also two basic I-O relationships at real and price aspects follow at the optimum solution.

$$(U-A)X = Y \qquad (1\text{-}25)$$

$$(U-A)'P = W \qquad (1\text{-}26)$$

2) Introduction of Additional Constraints

The primal problem can be extended to a LP model with additional constraints.

(extended problem)

$$\max B'C \qquad (1\text{-}27)$$

subject to:

$$(U-A+m)X \geqq C+I+E-M^* \qquad (1\text{-}28)$$

$$kX \leqq K+I \qquad (1\text{-}29)$$

$$Pe'E-Pm'(mX+M^*) \geqq 0 \qquad (1\text{-}30)$$

$$X, C, I, E, M^* \geqq 0 \qquad (1\text{-}31)$$

m is imported raw material input coefficients matrix and k is diagonal matrix of sectoral capital coefficients. C, I, K, E, M*, Pe, Pm and B stand for column vectors of consumption, investment, capital stock, exports, imports of final goods, export price and import prices, and consumption evaluation respectively. We assume that Pe < Pm, because otherwise, the re-export (E) of import (M*) creates the net foreign currency revenue, and a simultaneous increases of E and M* without limit can increase the value of target function, the optimum value of discounted sum of consumption, to infinity. On the other hand, the net foreign currency earning of one unit of export ($Pe'-Pm'm(U-A+m)^{-1}$) can be positive or negative. We assume that B>0, so at the optimum solution, (1-28) must hold with equality, while one of capital balance (1-29) and of foreign currency (value of exports minus value of imports) may be not binding. We write the shadow price (column vector) of (1-28), (1-29) and (1-30) as -SY, SK and SF. Then at the optimum solution, next identities follow.

$$((-)(U-A+m)X + (C+I+E-M^*))(SY) = 0 \qquad (1\text{-}32)$$

$$(kX - (K+I))(SK) = 0 \qquad (1\text{-}33)$$

$$(Pe'E-Pm'(mX+M^*))(SF) = 0 \qquad (1\text{-}34)$$

If K > 0, C > 0 and B = SY (1-35)

X > 0, so (U-A+m)'SY = kSK+m'PmSF (1-36)

E > 0, so SY = Pe (1-37)

Based on the assumption that Pe < Pm, (1-37) implies that SY < Pm, so that M* = 0. Therefore, the extended problem can be written as:

(simplified extended problem)

max B'C		(1-38)
subject to:	$(U-A+m)X \geqq C+I+E$	(1-39)
	$kX \leqq K+I$	(1-40)
	$Pe'E - Pm'mX \geqq 0$	(1-41)
	$X, C, I, E \geqq 0$	(1-42)

In this model, C can increase by decreasing I or E. So (1-40) and (1-41) are necessarily binding. By (1-36) and (1-37)

$$B=SY = SK = Pe \quad (1\text{-}43)$$

SF is determines by

$$m'PmSF = (U-A+m-k)'Pe \quad (1\text{-}44)$$

When we lay the upper and lower constraints for endogenous variables, in (1-27)-(1-31), the extended programming model is valid, in the sense that the re-export is limited independently with Pe > or < Pm. In this case, the definition of shadow price will be extended to include the shadow prices of (1-45)-(1-48) accordingly.

$X\ min < X < X\ max$	(1-45)
$I\ min < I < I\ max$	(1-46)
$E\ min < E < E\ max$	(1-47)
$M^*\ min < M^* < M^*\ max$	(1-48)

3) Extension to Multi-Period Programming Model

Now we are dealing the simplest multi-period Input-Output programming model taking the number of periods as two.

(two period extended problem)

max $B(1)'C(1)+B(2)'C(2)+H'K(2)$ (= Target)	(1-49)
subject to: $(U-A(1)+m(1))X(1) \geqq C(1)+I(1)+E(1)-M^*(1)$	(1-50)
$k(1)X(1) \leqq K(0)+(I(0)+I(1))/2$	(1-51)
$Pe(1)'E(1)-Pm(1)'(m(1)X(1)+M^*(1)) \geqq 0$	(1-52)
$(U-A(2)+m(2))X(2) \geqq C(2)+I(2)+E(2)-M^*(2)$	(1-53)

$$k(2)X(2) \leqq K(0)+H(0)+(I(1)+I(2))/2 \quad (1\text{-}54)$$

$$Pe(1)'E(1)+Pe(2)'E(2)-Pm(1)'(m(1)X(1)+M^*(1)) -Pm(2)'(m(2)X(2)+M^*(2)) \geqq 0 \quad (1\text{-}55)$$

$$K(2)=K(0)+H(0)+I(1)+I(2) \quad (1\text{-}56)$$

$$0 < X(1)\,min < X(1) < X(1)\,max \quad (1\text{-}57)$$

$$0 < C(1)\,min < C(1) < C(1)\,max \quad (1\text{-}58)$$

$$0 < E(1)\,min < E(1) < E(1)\,max \quad (1\text{-}59)$$

$$0 < M^*(1)\,min < M^*(1) < M^*(1)\,max \quad (1\text{-}60)$$

$$0 < X(2)\,min < X(2) < X(2)\,max \quad (1\text{-}61)$$

$$0 < C(2)\,min < C(2) < C(2)\,max \quad (1\text{-}62)$$

$$0 < E(2)\,min < E(2) < E(2)\,max \quad (1\text{-}63)$$

$$0 < M^*(2)\,min < M^*(2) < M^*(2)\,max \quad (1\text{-}64)$$

H stands for the evaluation of end-of-period capital stock as a transversality condition. The number in parentheses refer to the number of periods. The consumption evaluating vector, B(1) and B(2), are supposed to include the adequate time discount element, so that B(1) > B(2). The lower constraints in (1-57)-(1-64) automatically replace the non-negativity conditions of endogenous variables. The capital constraints, (1-51) and (1-54), consider the necessary gestation period of investment before the start of actual production.

In this two-period IOPM, the shadow price can be defined in a similar fashion with one-period model, (1-27)-(1-31) and (1-45)-(1-48). Each shadow price shows the marginal increment of the target function (1-49) by the one unit increase of each structural constraint from (1-50) to (1-64). And when an endogenous variable, each element of X(1), X(2), C(1), C(2), E(1), E(2), M*(1) and M*(2) (say, i-th variable), is positive, the following identity must hold. :

(i-th element of evaluation vector) =sum of (j-th element in i-th column of coefficient matrix of IOPM) multiplied by (the shadow price of j-th constraint) (1-65)

Inversely, we can calculate the shadow prices based on these social costs and benefits balances, (1-65).

4) Extension of IOPM to Non-Linear Type Model

The final extension is the introduction of non-linear target function. We assume that the consumption evaluating vector depends on the level of consumption. This makes the IOPM model as a non-linear programming type model. About the treatment and solution of non-linear programming model, we can refer to standard textbook like Mangasarian (1969). In a similar vein as before, we can calculate the optimum solution, calculate the shadow prices, and check the balance between social benefits and costs simultaneously. Here we take up a simple one-period IOPM case, and discuss these necessary procedures.

We consider an IOPM which includes two constraints; capital and labor.

We define $Y' = (X', C', I'), H' = (0', h', 0'), W' = (0', 0', e')$ (1-66)

$D' = (0', K(0)', L(1)'), \quad P=(-SY', SK', SL')$ (1-67)

$$V = \begin{bmatrix} 0 & 0 & 0 \\ 0 & -Q & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad (1\text{-}68) \qquad \begin{bmatrix} U-A+m & U & g \\ k & 0 & -\frac{1}{2} \\ l' & 0 & 0 \end{bmatrix} \quad (1\text{-}69)$$

where Y and P stand for real and (shadow) price vectors. Then we have,

(primal problem)

min (-)(H'Y - (1/2)Y'VY + W'Y) (1-70)

$BY \leqq D$ (1-71)

$Y \geqq 0$ (1-72)

(dual problem)

max (- (1/2)Y'VY - D'P) (1-73)

$VY+B'P = W+H$ (1-74)

$P \geqq 0$ (1-75)

where consumption is evaluated by a quadratic function, (h'C - C'QC / 2). The vector e evaluates the investment which is a part of end-of-period capital stock. The three constraints in real aspect in (1-71) are output balance, capital balance and labor balance. L(1), l, SL stand for three vectors of labor force in period 1, labor coefficient and shadow price of labor. The second equation in dual problem, (1-74), is written as:

$$-\begin{Bmatrix} 0 \\ h \\ 0 \end{Bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & -Q & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{Bmatrix} X \\ C \\ I \end{Bmatrix} + \begin{bmatrix} (U-A+m)' & k & l \\ U & 0 & 0 \\ g & -\frac{1}{2}U & 0 \end{bmatrix} \begin{Bmatrix} -SY \\ SK \\ SL \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ e \end{Bmatrix} \quad (1\text{-}76)$$

At the optimum solution,

0 = (-)(U-A+m)SY + kSK + lSL (1-77)

-h - Q'C = SY (1-78)

e = -g'SY - (1/2)SK (1-79)

The implication is intuitively clear.

$$\partial (\text{Target}) / \partial X = 0 = (\text{accounting cost}) \quad (1\text{-}80)$$

$$\partial (\text{Target}) / \partial C = (\text{accounting cost}) > 0 \quad (1\text{-}81)$$

$$\partial (\text{Target}) / \partial I = (\text{accounting cost}) > 0 \quad (1\text{-}82)$$

At the later stage, another structural constraints will be considered. The preparation of core infrastructure like electricity, water, transportation facilities is an important precondition for development of local economies; for example, Rietveld-Schipper-Vlaanderen (1994) described its importance in central Java, and Crane (1994) described the water supply in Jakarta. Another is the environmental constraint; Nestor (1995) described a trial environmental input-output table in U.S.A. and MacAndrews (1994) described the expected role of BAPEDAL in Indonesia. We can add these constraints after the preparation of adequate data. Then we can obtain the various useful information based upon the various runs with different specification and with additional constraints.

1.2 Data Preparation for Model

1.2.1 Prediction of Future Technical Coefficients

(1) Aggregation of Sectors of I-O Table

To handle the model in an appropriate size and also analyze the characteristics of industries, relevant sector aggregation is required. In this respect we considered 28 industrial sectors meaningful and operational. All economic activities in Indonesia are aggregated into 28 from 161 sectors of I-O Table published by BPS. In our Model, 26 sector I-O classification is utilized. This is obtained by the following way; we delete first 26th sector out of 28 I-O Table classification because all factors of both row and column vectors of this sector are zero in intermediate transaction. Second, we put 27th and 28th sectors of I-O Table together. The relation between 28 and 26 sector is shown on Table 1-1 and that of 28 and 161 sectors is shown in Appendix 1.

Table 1-1 The Relation between 26 and 28 Sector I-O Classification

26 Sector Classification		28 Sector Classification	
1	Farm food	1	Farm food
2	Estate crops	2	Estate crops
3	Livestock	3	Livestock
4	Forestry	4	Forestry
5	Fishery	5	Fishery
6	Crude Oil & Natural Gas	6	Crude Oil & Natural Gas
7	Non Crude Oil & Natural Gas	7	Non Crude Oil & Natural Gas
8	Food Processing	8	Food Processing
9	Textile	9	Textile
10	Wood Processing	10	Wood Processing
11	Paper & Printing	11	Paper & Printing
12	Chemical & Rubber	12	Chemical & Rubber
13	Non Metallic Mineral	13	Non Metallic Mineral
14	Iron & steel	14	Iron & steel
15	Non Ferrous Metallic Basic Products	15	Non Ferrous Metallic Basic Products
16	Fabricated Metal Products	16	Fabricated Metal Products
17	Machine & Electrical Machine	17	Machine & Electrical Machine
18	Transport Equipment	18	Transport Equipment
19	Other manufacturing	19	Other manufacturing
20	Electricity, Gas, Water Supply	20	Electricity, Gas, Water Supply
21	Construction	21	Construction
22	Wholesale & Retail Trade	22	Wholesale & Retail Trade
23	Restaurant, Hotel	23	Restaurant, Hotel
24	Transportation	24	Transportation
25	Banking & Other Finance	25	Banking & Other Finance
**	******************************	26	Public Administration & Defense
27	Other Services	27	Other Services
		28	Non specified Sector

Source: Indonesian I-O Table of 1990 volume I, BPS.

(2) Tested Method for Prediction

At first we estimated future input coefficient matrices by 5 non-survey methods. Data utilized in the estimation are input coefficient matrices of 1985 and 1990 both in real term. After evaluating the results of those methods, we determined the one to be applied for IOPM as a first step. After obtaining new data, that is I-O Tables of 1980,1985,1990 and 1993 at 1993 price, we improved the method for the estimation and developed new method named RECRAS-QP method which is the mixed use of RECRAS method and quadratic programming. Finally this method is utilized for predicting future input coefficients.

1) Tested 5 Non-Survey Methods:

(i) RAS method, (ii) RECRAS method, (iii) Lagrangean multiplier method, (iv) Two-stage RAS-Lagrange method (TSRL method) and (v) Error minimum method were tested. Followings are short description of each non-survey method.

(i) RAS Method;

Variation of input coefficient can be explained by following two factors;

a) Substitution of raw materials to be input (substitution-change)

b) Changes in capital intensity, productivity, and product- mix (processing-change)

Substitution-change signifies the change along the rows of input coefficient matrices, and processing-change signifies the change along the columns; therefore, input coefficient matrix of the predicted year can be described as:

$$A_1 = RA_0 S \qquad (1\text{-}83)$$

where A_0 : input coefficient matrix of the base year or of the end year, A_1: input coefficient matrix of the predicted year, R is diagonal matrix with the effect of substitution-change as its element, and S is diagonal matrix with that of processing-change as its element.

R and S are calculated by sequential solution, when the known vectors of both intermediate inputs and intermediate outputs are given, of which values in the matrix are adjusted one by one to arrive the final solution. Input coefficient matrix for the predicted year is calculated by multiplying with R and S exponentially from the both sides of either input coefficient matrix of the base year or of the end year.

i) Data needed for RAS method; a) I-O Table of the base year, b) intermediate demand of the end year for each sector, c) intermediate input of the end year for each sector

ii) Features of RAS method; it predicts input coefficient matrix using R and S only. it does not guarantee the value-added ratio to be positive, since it is presented as residual, when applied to the predicted year.

(ii) RECRAS Method;

This is the method to calculate the variation of value-added ratio in the same way as that of input coefficient. It does not have the shortcoming of RAS method which value-added ratio turned out negative.

Under the constraint of column total 1, we must take R* and S* closest to tentative R and S calculated by RAS method.

$$\text{Minimize } e'_{m+1} \cdot (R^* - R)^2 \cdot e_{m+1} + e'_m \cdot (S^* - S)^2 \cdot e_m \qquad (1\text{-}84)$$

$$\text{subject to } e'_{m+1} \cdot R^* A_0 S^* = e'_m \qquad (1\text{-}85)$$

where

R : diagonal matrix of substitution change by RAS method

S : diagonal matrix of processing change by RAS method

R^* :diagonal matrix of substitution change by RECRAS method

S^* :diagonal matrix of processing change by RECRAS method

e_k :column vector whose elements are all 1

e'_k :row vector whose elements are all 1

i) Data needed for RECRAS method ; a) I-O Table of the base year, b) intermediate demand of the end year for each sector, c) intermediate input of the end year for each sector.

ii) Features of RECRAS method; a) value added ratio≧0 and column total = 1, which are characteristic of input coefficient matrices, can be maintained even for the predicted year. b) no data of the predicted year is required.

(iii) Lagrangean Multiplier Method;

Under the constraints of row-total and column-total, this method minimizes the difference between input coefficient matrix of the predicted year and that of the base year. This method produces different results depending on the selected objective function.

We select the following objective function to arrive input coefficient prediction:

$$\text{Minimize} \quad \sum_i \sum_j \left(\frac{\hat{a}_{ij}}{a_{ij}} - 1 \right)^2 \tag{1-86}$$

$$\text{subject to} \quad \sum_i \hat{a}_{ij} x_j = \hat{w}_i \tag{1-87}$$

$$\sum_i \hat{a}_{ij} \hat{x}_j = \hat{c}_j \tag{1-88}$$

where

a_{ij}: input coefficient at the base year

$\hat{a}_{ij}$: input coefficient at the predicted year

$\hat{x}_j$: output of the predicted year for each sector

$\hat{w}_i$:intermediate demand of the predicted year for each sector

$\hat{c}_j$: intermediate input of the predicted year for each sector

i) Data needed for Lagrangean multiplier method; a) input coefficient matrix of the base year, b) output of the predicted year for each sector, c) intermediate demand of the predicted year for each sector, d) intermediate input of the predicted year for each sector.

ii) Features of Lagrangean multiplier method; a) in case of RAS method, input coefficient matrices are predicted by calculating convergence; however it does not, in some cases, converge depending on its initial values. Lagrangean multiplier method guarantees solution uniquely determined. b) when some cells of input coefficient matrix of the base year are zero, the corresponding cells of that of the predicted year become zero.

(iv) Two-Stage RAS-Lagrange Method (TSRL Method);

This is the method to adjust the results of RAS method by Lagrangean multiplier method.

i) Data needed for TSRL method; a) I-O Table of the base year, b) output of the predicted year for each sector, c) intermediate demand of the end year for each sector, d) intermediate input of the end year for each sector.

ii) Feature of TSRL method; it produces the prediction of input coefficient matrix even though intermediate demand and intermediate input for the predicted year is not given.

(v) Error Minimum Method;

This is a variation of Lagrangean multiplier method of which objective function is so modified that the cells with bigger input coefficient values have larger weight.

$$\text{Minimize} \quad \sum_{i=1}^{m+1}\sum_{j=1}^{m}\left(\frac{\hat{a}_{ij}}{a_{ij}}-1\right)^2 |a_{ij}x_j| \tag{1-89}$$

$$\text{subject to} \quad \sum_{i=1}^{m+1}\hat{a}_{ij}=1 \ (j=1,2,.......,m) \tag{1-90}$$

$$\sum_{i=1}^{m}\hat{a}_{ij}x_j = \text{intermediate demand of the predicted year for each sector} \tag{1-91}$$

i) Data needed for error minimum method; a) input coefficient matrix of the base year, b) row total of input coefficient matrix of the predicted year, c) column total of input coefficient matrix of the predicted year.

ii) Feature of error minimum method; The cells with bigger values of input coefficient matrix of the base year are given much important evaluation.

2) Results of 5 Methods Tested:

(i) RAS method; prediction for 1990 turned out no negative value for the value-added sectors, and there seems to be no problem in applying this method. However, when it is applied further into the future, it turns out negative value for one value- added sector (19th other manufacturing) in 2005, for 9 sectors in 2010, and for 14 sectors in 2015.

(ii) RECRAS method; prediction for 1990 showed no negative value for the value-added sectors, and there seems to be no problem in applying this method.

(iii) Lagrangean multiplier method; prediction for 1990 showed negative values (-0.00042) for input coefficients from 4th forestry to 21st construction sectors.

(iv) TSRL method; prediction for 1990 showed negative values (-0.00042), as in the case of Lagrangean multiplier method, for input coefficients from 4th forestry to 21st construction sectors.

(v) Error minimum method; prediction for 1990 turned out no negative value for the value-added sectors, and there seems to be no problem in applying this method.

As a result of the application of 5 non-survey methods to predict input coefficient of 1990, we have found (i) RAS method, (ii) RECRAS method and (v) Error minimum method are proven to be applicable for our purpose. Then we employed those three methods to predict input coefficients of 1995, 2000, 2005, 2010, and 2015.

3) The Evaluations of the Results:

(i) RAS method; the results are stable for 1995 and 2000, with no negative value for the value added sectors, but show negative value for one value added sector (19th other manufacturing) for 2005, for 9 sectors in 2010, and for 14 sectors for 2015.

(ii) RECRAS method; the results seem stable for respective predicted years.

(v) Error minimum method; this method cannot be applied, simply because there is no data available for the predicted years.

The evaluations of respective results lead us to the conclusion that RECRAS method is the most suitable for prediction of input coefficient matrices, because; a) availability of data needed for long-term prediction, b) stability of input coefficients when long-term prediction is conducted.

RECRAS method which brought about the best results among 5 tested methods as described before. However, this method also did not satisfy us so much. Therefore we developed a new method to forecast input coefficients, upon obtaining a new I-O Table at 1993 price in June, 1996. We call it RECRAS-QP (Quadratic Programming) method. This method is similar to TSRL method which has been used to forecast input coefficients so far, with one difference that forecast of input coefficients is formulated as quadratic programming problem.

In the first step in RECRAS-QP method, the change in value-added ratio was calculated from Japanese I-O Table and utilized as reference for that in value-added ratio in Indonesia. Then, given this change in Indonesian value-added ratio as scenarios, row change vector which shows processing change and column change vector showing substitution change were calculated by RECRAS method, and finally row sum and column sum of input coefficient matrix to be forecasted were calculated.

The second step was to employ quadratic programming to forecast input coefficients, with those row sum and column sum as constraints, so as to minimize the square sum of their change. In evaluating the square sum of change in input coefficients, weights were given in proportion to the size of change in each input coefficient. In case the change in input coefficient from 1985 to 1990 is great, for example, its square sum is evaluated less.

By repeating this process for the forecast period, input coefficients with stable and smooth change can be forecasted. Since this method formulates forecast of input coefficients as quadratic programming problem, it is flexible enough to incorporate the insight of experts and information obtained by survey methods into its constraints. Therefore, it is possible to improve its accuracy by incorporating such information as we go obtaining them in the future.

1.2.2 Estimation of Capital Coefficient and Depreciation Rate

In dynamic I-O model like IOPM, capital coefficient matrix is a key factor. However, it is very difficult to estimate this matrix because of the limitation of relaiable data in Indonesia. We face big difficulty in preparing data for IOPM, especially in estimating capital stock. A considerable length of time were spent estimating capital stock.

Although BPS published capital stock data at 1993 price from 1980 to 1994, these data did not contain K_0 (benchmark capital stock data of 1980) reflecting accumulated net investment before 1980. Therefore we first concentrated our attention on estimating capital stock by 9 sectors including K_0. Two types of methods were tested for the estimation. One is the linear regression model utilizing depreciation estimated by BPS. The other is exponensial regression model utilizing depreciation derived from ADB data.

Estimated capital stock by 9 sectors was divided into 26 sectors by investment share of each sector. And then time series of output by 26 sectors at 1993 price was estimated from revised average annual growth rate of output by 26 sectors derived from both output by 9 sectors and I-O Tables of 1985, 1990 and 1993 by 26 sectors.

After those work, capital coefficients of 26 sectors for IOPM were calculated from those data by two formula of both Incremental Capital Output Ratio (ICOR) and Average Capital Coefficients (ACC).

The summary of the flow chart for obtaining capital coeffcients and depreciation rate are presented on Figure 1-1 and the estimation results of ICOR, ACC and depreciation rate are presentedd on Table 1-2 to Table 1-4.

Figure 1-1 Calculation process of ICOR and Average Capital Coefficient

ADB+BPS

① Capital Stock (K_t : t=1983～1994)
ADB Data (9 sector)
② Investment (I_t : t=1983～1994)
ADB Data (9 sector)
③ Depreciation (D_t : t=1983～1994)
BPS Data (9 sector)

↓

Estimate depreciation by linear regression model.

$$D_t = dK_{t-1} = \hat{\alpha} + \hat{\beta} \sum_{\tau=1983}^{1994} (I_\tau - D_\tau)$$

$$\hat{\alpha} = dK_0 \quad , \hat{\beta} = d$$

↓

Estimete K_{1983} by 9 sector.

$$K_{1983} = \frac{\hat{\alpha}}{\hat{\beta}}$$

↓

Divide K_t, I_t, X_t to 26 sector.

↓

① ICOR

$$ICOR = \frac{\sum_{t=1989}^{1993} (I_t - D_t)}{X_0 - X_{-1}}$$

$$X_0 = x_{1989} + \cdots + x_{1993}$$

$$X_{-1} = x_{1984} + \cdots + x_{1988}$$

② ACC (Average Capital Coefficient)

$$ACC = \frac{(K_{1988} + K_{1993})/2}{X_0}$$

ADB

① Capital Stock (K_t : t=1981～1994)
ADB Data (9 sector)
② Investment (I_t : t=1981～1994)
ADB Data (9 sector)
③ Depreciation (D_t)
Estimate it from the following formation using ADB data.
$D_t = dK_{t-1} = K_{t-1} + I_t - K_t$

↓

Estimate ($I_t - D_t$) by exponential regression model.

$$(I_t - D_t) = a \cdot e^{bt}$$

$$\log(I_t - D_t) = \log a + bt$$

↓

Estimate K_{1980} by 9 sector.

$$K_{1980} = \sum_{\tau=1967}^{1980} (I_\tau - D_\tau)$$

↓

Divide K_t, I_t, X_t to 26 sector.

↓

① ICOR

$$ICOR = \frac{\sum_{t=1989}^{1993} (I_t - D_t)}{X_0 - X_{-1}}$$

$$X_0 = x_{1989} + \cdots + x_{1993}$$

$$X_{-1} = x_{1984} + \cdots + x_{1988}$$

② ACC (Average Capital Coefficient)

$$ACC = \frac{(K_{1988} + K_{1993})/2}{X_0}$$

Table 1-2 ICOR by Two Estimation Methods

Sector	Linear Regression	Exponential Regression
1.Farm food	0.21125	0.26664
2.Estate crops	0.19129	0.24145
3.Livestock	0.18449	0.23286
4.Forestry	0.15262	0.19264
5.Fishery	0.09451	0.11929
6.Oil & Gas	4.60169	5.22314
7.Non Oil, Gas	0.49298	0.55075
8.Food	0.09093	0.10712
9.Textile	0.25883	0.30491
10.Wood	0.24440	0.28792
11.Paper	0.36398	0.42880
12.Chemical	0.35816	0.42194
13.Non Metallic	1.25311	1.47625
14.Iron & steel	0.24974	0.29421
15.Non Ferrous metal	0.19470	0.22937
16.Fabricated Metal	0.32972	0.38843
17.Machinery	0.21362	0.25166
18.Transport Equip	0.25751	0.30336
19.Oth manufacturing	0.23963	0.28229
20.Elec.Gas,Water	0.26137	0.32248
21.Construction	0.50647	0.59394
22.Trade	0.41135	0.49713
23.Restrant,Hotel	0.38398	0.46405
24.Transportation	0.62006	0.89580
25.Finance	0.55316	0.63315
27.Oth. Service	10.20645	0.28947
Total sector	0.38598	0.46638

Source: JICA Study Team

Table 1-3 ACC by Two Estimation Methods

Sector	Linear Regression	Exponential Regression
1.Farm food	0.38717	0.13162
2.Estate crops	0.41515	0.14113
3.Livestock	0.40253	0.13685
4.Forestry	0.50825	0.17279
5.Fishery	0.43771	0.14881
6.Oil & Gas	0.87253	1.23196
7.Non Oil, Gas	0.85553	1.26572
8.Food	0.09043	0.11039
9.Textile	0.40770	0.49766
10.Wood	0.32530	0.39708
11.Paper	0.62630	0.76450
12.Chemical	0.17131	0.20911
13.Non Metallic	0.89110	1.08773
14.Iron & steel	0.34379	0.41965
15.Non Ferrous metal	0.28491	0.34778
16.Fabricated Metal	0.27706	0.33820
17.Machinery	0.31864	0.38896
18.Transport Equip	0.26098	0.31857
19.Oth.manufacturing	0.24895	0.30388
20.Elec.Gas,Water	0.26295	0.61170
21.Construction	0.46660	0.29067
22.Trade	0.40646	0.24116
23.Restrant,Hotel	0.41874	0.24845
24.Transportation	0.56976	0.62780
25.Finance	1.05937	0.87926
27.Oth. Service	0.15047	0.14795
Total sector	0.42201	0.38401

Source: JICA Study Team

Table 1-4 Depreciation Rate by Two Estimation Methods

Sector	Linear Regression	Exponential Regression
Total sector	0.07882	0.04744

Source: JICA Study Team

1.2.3 Estimation of Skilled Labor Coefficients

Table 1-5 shows numbers of total employment and skilled labors, domestic total output, labor coefficients for total employment and skilled labors. According to this table, number of skilled labors is 13 million which accounts for 18.7% of total employment of 71 million. Skilled labors here are defined as engineers, technicians and skilled laborers. Percentage of skilled labors in total employment is extremely low in agricultural sector, in contrast to high percentage in manufacturing sector. In service sector, this percentage is remarkably high in construction.

Table 1-5 Labor Coefficients for 26 Sectors

Sector	Number of Skilled Labor (1990, Person) (1)	Number of Total Employment (1990, Person) (2)	Domestic Total Output at 1993 Price (1990, Millions of Rp.) (3)	Labor Coefficients for Skilled Labor (1)/(3)	Labor Coefficients for Total Employment (2)/(3)
1.Farm food	136306	30798662	33145445	0.00411	0.92920
2.Estate crops	142064	3879616	9367975	0.01517	0.41414
3.Livestock	10824	1944153	8035826	0.00135	0.24194
4.Forestry	504279	618199	4456626	0.11315	0.13872
5.Fishery	7555	1039600	6592354	0.00115	0.15770
6.Oil & Gas	55677	87066	23426909	0.00238	0.00372
7.Non Oil ,Gas	129586	611072	6349385	0.02041	0.09624
8.Food	1832736	2761170	50356019	0.03640	0.05483
9.Textile	1693122	1872633	15843126	0.10687	0.11820
10.Wood	1666592	1728152	11522365	0.14464	0.14998
11.Paper	155159	180601	6011585	0.02581	0.03004
12.Chemical	367041	473008	37544693	0.00978	0.01260
13.Non Metallic	501595	537087	3357468	0.14940	0.15997
14.Iron & steel	28849	31935	4140002	0.00697	0.00771
15.Non Ferrous metal	67076	74252	2280308	0.02942	0.03256
16.Fabricated Metal	188537	218928	3948345	0.04775	0.05545
17.Machinery	110224	127991	9055453	0.01217	0.01413
18.Transport Equip	274173	318368	7722580	0.03550	0.04123
19.Oth.manufacturing	60200	427701	644348	0.09343	0.66377
20.Elec.Gas,Water	91591	136789	6199796	0.01477	0.02206
21.Construction	2693187	2872043	47510389	0.05669	0.06045
22.Trade	220303	9913035	38937949	0.00566	0.25459
23.Restaurant,Hotel	24588	468193	16890592	0.00146	0.02772
24.Transportation	233649	2568079	33370686	0.00700	0.07696
25.Finance	130050	364271	26052161	0.00499	0.01398
27.Oth. Service	2085694	7493461	26526250	0.07863	0.28249
Total	13410657	71546065	439288635	0.03115	0.16287

*Skilled Labor=(Engineer+Technician+Skilled)

Source: BPS, JICA Study Team

Therefore, labor coefficient of total employment in agricultural sector becomes quite high while that of skilled labors becomes exctremely low. Not much difference is seen in these two coefficients in manufacturing sector. In service sector, a very large gap is seen between these two coefficients especially in 22nd trade, 23rd restaurant/hotel,and 24th transportation sectors.

1.2.4 Estimation of Export (Import) Prices and Import Coefficient

Export and import prices were predicted by linear regression using the export (import) price indices of 20 industries excluding service sector from 1981 to 1993, with their figures in 1983 as 100, which were collected in the starting year of this work (1995). The export price data of 1st farm food sector in 1993 and 18th transport equipment sector in 1993 were judged abnormal as the result of examination and so excluded when the estimation was conducted.

Predicted results of export (import) prices by 26 sectors for each period are presented on Table 1-6 to Table 1-7. Because of the lack of export (import) price indices for service sector (23rd restaurant & hotel, 24th transportation, 25th finance, 27th other service), export (import) prices of total sector are utilized for those sectors.

Import coefficient matrix here is defined as the ratio of import for intermediate goods to total input in each sector (see Table 1-8). This import coefficient matrix is utilized in national IOPM.

Table 1-6 Export Price Prediction

	1 (R-VI)	2 (R-VII)	3 (R-VIII)	4 (R-IX)	5 (R-X)
1.Farm food	1.11357	1.30284	1.49212	1.68140	1.87068
2.Estate crops	1.18257	1.48685	1.79114	2.09542	2.39970
3.Livestock	1.25562	1.68166	2.10770	2.53373	2.95977
4.Forestry	1.23253	1.62007	2.00762	2.39517	2.78271
5.Fishery	1.26312	1.70164	2.14017	2.57870	3.01723
6.Oil & Gas	1.09311	1.24828	1.40346	1.55864	1.71382
7.Non Oil, Gas	1.23588	1.62902	2.02215	2.41529	2.80842
8.Food	1.14725	1.39268	1.63810	1.88352	2.12894
9.Textile	1.23025	1.61401	1.99776	2.38152	2.76527
10.Wood	1.21434	1.57157	1.92881	2.28604	2.64327
11.Paper	1.24202	1.64538	2.04874	2.45211	2.85547
12.Chemical	1.09642	1.25712	1.41783	1.57853	1.73923
13.Non Metallic	1.19933	1.53156	1.86378	2.19601	2.52823
14.Iron & steel	1.20326	1.54203	1.88080	2.21957	2.55834
15.Non Ferrous metal	1.20534	1.54758	1.88982	2.23206	2.57430
16.Fabricated Metal	1.14631	1.39017	1.63402	1.87787	2.12173
17.Machinery	1.11106	1.29615	1.48125	1.66634	1.85144
18.Transport Equip	1.21913	1.58434	1.94955	2.31477	2.67998
19.Oth.manufacturing	1.21734	1.57957	1.94180	2.30403	2.66626
20.Elec.Gas,Water	0.00000	0.00000	0.00000	0.00000	0.00000
21.Construction	0.00000	0.00000	0.00000	0.00000	0.00000
22.Trade	1.24362	1.64966	2.05569	2.46173	2.86776
23.Restaurant,Hotel	1.24362	1.64966	2.05569	2.46173	2.86776
24.Transportation	1.24362	1.64966	2.05569	2.46173	2.86776
25.Finance	1.24362	1.64966	2.05569	2.46173	2.86776
27.Oth. Service	1.24362	1.64966	2.05569	2.46173	2.86776

Source: JICA Study Team

Table 1-7 Import Price Prediction

	1 (R-VI)	2 (R-VII)	3 (R-VIII)	4 (R-IX)	5 (R-X)
1.Farm food	1.18347	1.48926	1.79505	2.10084	2.40663
2.Estate crops	1.21167	1.56444	1.91722	2.27000	2.62278
3.Livestock	1.16862	1.44964	1.73067	2.01170	2.29272
4.Forestry	1.24100	1.64267	2.04433	2.44600	2.84767
5.Fishery	1.20852	1.55604	1.90357	2.25110	2.59862
6.Oil & Gas	1.09436	1.25163	1.40889	1.56616	1.72343
7.Non Oil, Gas	1.19808	1.52821	1.85834	2.18848	2.51861
8.Food	1.16631	1.44348	1.72066	1.99784	2.27502
9.Textile	1.22074	1.58865	1.95655	2.32446	2.69236
10.Wood	1.24562	1.65499	2.06436	2.47373	2.88310
11.Paper	1.24986	1.66629	2.08272	2.49915	2.91558
12.Chemical	1.29755	1.79348	2.28940	2.78532	3.28125
13.Non Metallic	1.41944	2.11852	2.81759	3.51666	4.21573
14.Iron & steel	1.20216	1.53909	1.87603	2.21296	2.54989
15.Non Ferrous metal	1.22732	1.60618	1.98504	2.36390	2.74276
16.Fabricated Metal	1.18747	1.49991	1.81236	2.12481	2.43725
17.Machinery	1.21667	1.57779	1.93891	2.30003	2.66115
18.Transport Equip	1.17600	1.46932	1.76265	2.05597	2.34930
19.Oth.manufacturing	1.20533	1.54754	1.88975	2.23196	2.57417
20.Elec.Gas,Water	0.00000	0.00000	0.00000	0.00000	0.00000
21.Construction	0.00000	0.00000	0.00000	0.00000	0.00000
22.Trade	0.00000	0.00000	0.00000	0.00000	0.00000
23.Restaurant,Hotel	1.14608	1.38955	1.63301	1.87648	2.11995
24.Transportation	1.14608	1.38955	1.63301	1.87648	2.11995
25.Finance	1.14608	1.38955	1.63301	1.87648	2.11995
27.Oth. Service	1.14608	1.38955	1.63301	1.87648	2.11995

Source: JICA Study Team

Table 1-8 Import Coefficient Matrix

Continue

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.000221	0.000000	0.000259	0.000000	0.000000	0.000000	0.000000	0.011264	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.000000	0.000146	0.000000	0.000000	0.000000	0.000000	0.000000	0.001658	0.000028	0.000000	0.000000	0.000000	0.000000
3	0.000000	0.000000	0.001240	0.000000	0.000000	0.000000	0.000000	0.000014	0.000000	0.000000	0.000000	0.000000	0.000000
4	0.000000	0.000000	0.000000	0.000024	0.000000	0.000000	0.000000	0.000000	0.000000	0.000112	0.000000	0.000088	0.000000
5	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000007	0.000000	0.000000	0.000000	0.000000	0.000000
6	0.000000	0.000000	0.000000	0.000000	0.000000	0.000299	0.000000	0.000000	0.000000	0.000000	0.000000	0.068040	0.000000
7	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000079	0.000009	0.000000	0.000008	0.000268	0.003977	0.043375
8	0.000000	0.000000	0.044569	0.000000	0.002166	0.000000	0.000000	0.007263	0.000143	0.000153	0.000219	0.000013	0.000000
9	0.000299	0.001322	0.000000	0.000000	0.002477	0.000012	0.000200	0.001023	0.100316	0.000380	0.000257	0.003696	0.000036
10	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000000	0.001232	0.000002	0.000001	0.000000
11	0.000000	0.000032	0.000008	0.000060	0.000000	0.000006	0.000000	0.001249	0.000007	0.000191	0.078229	0.000497	0.003559
12	0.004026	0.014140	0.005916	0.000739	0.001095	0.001935	0.009447	0.001339	0.081519	0.016116	0.042470	0.096906	0.024941
13	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000010	0.000000	0.000000	0.000001	0.000152	0.003060
14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000000	0.000000	0.000000	0.000000	0.000001	0.000004	0.000012
15	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000000	0.000009	0.000000
16	0.000047	0.001448	0.000000	0.001887	0.000000	0.000004	0.000024	0.000465	0.000230	0.000034	0.000008	0.000187	0.000139
17	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.001187	0.000000	0.000002	0.000002	0.000000	0.000486	0.000001
18	0.000000	0.000000	0.000000	0.000000	0.000000	0.000122	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
19	0.000000	0.000001	0.000010	0.000001	0.000002	0.000001	0.000000	0.000000	0.000076	0.000002	0.000000	0.000010	0.000015
20	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
22	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
23	0.000000	0.000008	0.000000	0.000035	0.000000	0.000154	0.000006	0.000041	0.000063	0.000561	0.000020	0.000489	0.000129
24	0.000000	0.000008	0.000000	0.000039	0.000000	0.000879	0.000260	0.000022	0.000034	0.000008	0.000026	0.000308	0.000205
25	0.000000	0.000000	0.000000	0.000000	0.000000	0.007857	0.000009	0.000047	0.000665	0.000000	0.000000	0.000806	0.000027
27	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003990	0.000000	0.000000	0.002126	0.002887	0.000000

continue

	14	15	16	17	18	19	20	21	22	23	24	25	27
1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000509	0.000000	0.000000	0.000161
2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000069	0.000000	0.000000	0.000012
3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000011	0.000000	0.000000	0.000000
4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000009	0.000000	0.000000	0.000000
5	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000000	0.000000	0.000000
6	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
7	0.004895	0.002345	0.000004	0.000003	0.000000	0.000005	0.001648	0.001852	0.000000	0.000000	0.000000	0.000000	0.000000
8	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005587	0.000000	0.000000	0.000401
9	0.000000	0.000000	0.000034	0.000451	0.000028	0.030225	0.000000	0.000683	0.000690	0.000269	0.000058	0.000060	0.000277
10	0.000000	0.000000	0.000030	0.000012	0.000176	0.000169	0.000000	0.000139	0.000076	0.000007	0.000000	0.000000	0.000000
11	0.000000	0.000000	0.000052	0.000136	0.000002	0.000069	0.000000	0.000067	0.000957	0.000578	0.000130	0.004098	0.001321
12	0.030335	0.004713	0.018631	0.013631	0.002410	0.086257	0.009513	0.008850	0.001197	0.001054	0.028309	0.000817	0.012941
13	0.000004	0.000002	0.000025	0.000898	0.001419	0.007896	0.000000	0.019099	0.000009	0.001220	0.000000	0.000004	0.000177
14	0.074441	0.000096	0.115339	0.001794	0.044129	0.000295	0.000000	0.024329	0.000000	0.000000	0.000000	0.000000	0.000000
15	0.000174	0.248795	0.020064	0.001826	0.002431	0.001761	0.000000	0.001919	0.000000	0.000000	0.000000	0.000000	0.000000
16	0.000586	0.000049	0.040962	0.002607	0.003263	0.000330	0.000005	0.047823	0.000000	0.000044	0.000001	0.000001	0.002161
17	0.000000	0.000002	0.000027	0.421416	0.004658	0.000071	0.046246	0.005030	0.000031	0.000006	0.000105	0.000109	0.013961
18	0.000000	0.000000	0.000000	0.000000	0.236762	0.000000	0.000000	0.000000	0.000000	0.000000	0.006575	0.000000	0.028604
19	0.000103	0.000000	0.000010	0.005473	0.009600	0.015526	0.000000	0.001170	0.000064	0.000009	0.00010	0.000309	0.007278
20	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
22	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
23	0.000558	0.000118	0.000019	0.000107	0.000094	0.000053	0.000000	0.000233	0.000320	0.000141	0.000881	0.000520	0.000123
24	0.000103	0.000453	0.000065	0.000028	0.000080	0.000000	0.000039	0.000295	0.001151	0.000043	0.010610	0.001002	0.000078
25	0.000000	0.004874	0.000000	0.000110	0.003258	0.000000	0.000000	0.005651	0.011171	0.002524	0.004662	0.030357	0.000602
27	0.046801	0.004527	0.000000	0.000000	0.000000	0.000986	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011592

Source: Indonesian I-O Table of 1990 volume I, BPS.

1.3 Explanation of Optimum Solutions of National IOPM

1.3.1 History of Improving National IOPM

In programming exercise, many Versions of IOPM were constructed and different kinds of optimum solutions were calculated under the different combination of objective function, structural constraint, and side condition. The numbering to Versions was given carefully in such a manner as the numbering of Version increases, IOPM improves. Regarding respective Versions, according to objective function, structural constraint and of other side-condition, there are ramifications of cases. After Version 20, the results of simulation were categorized by the date when they were derived.

Optimum solutions of IOPM from Version 1 to Version 11 were calculated before Progress Report (I) meeting in March 1996 and optimum solutions of Version 8,9,10 were presented on that Report. Since then optimum solutions of IOPM from Version 12 to 17 were calculated and at Workshop in June 1996, optimum solutions of Version 15, 17 were presented. In September Seminar 1996, optimum solutions of three scenarios of Version 20 (base scenario, scenario A, scenario B) were presented. In Version 20, the future input coefficients were estimated by RECRAS-QP method utilizing I-O Tables of 1980,1985,1990 and 1993 by 28 sectors at 1993 price and capital stock by 26 sectors for national IOPM was estimated by new methods utilizing time series of investments by 10 sectors at 1993 price. At September Seminar 1996 we received valuable comments on IOPM from BAPPENAS side. Taking these comments into account, we made the minor modifications in the framework of IOPM and changed the estimation method of export (import) prices to derive more reasonable solution. Short history of IOPM Version is presented on Table 1-9, Chart 1-1.

The following are several modified points on IOPM from Version 20.4-B1 which was presented in September Seminar 1996:

(1) Evaluation parameter in objective function;

Evaluation for consumption of sectors (1-5,8) is assumed to decline as the corresponding consumption level increases. Calculation of evaluation parameters for those sectors was made by quadratic programming equation.

(2) Structural constraint;

Skilled labor constraint is divided into two parts; one for sectors (6-19) and another for sectors (1-5, 20-27).

(3) Side condition;

1) Imports for final demand of sectors 27 is fixed to the initial figure.
2) Imports for final demand of sectors (8-19) are assumed to be in the range of 80 to 150 % of the corresponding import for final demand of the previous period.
3) Exports of sectors (1-7, 12,22) are assumed to be in the range of 80 to 150 % of the corresponding export of the previous period.

(4) Estimation method for export (import) prices;

Export (import) prices are derived from linear regression model, using 1983-1993 export (import) price indices.

(5) Assumption for Export prices;

Export prices of manufacturing sectors are assumed to rise by 10% as the passage of each period.

(6) Assumption for skilled labor coefficient in sector 8;

Skilled labor coefficient of sector 8 is assumed to rise by 10 % as the passage of each period.

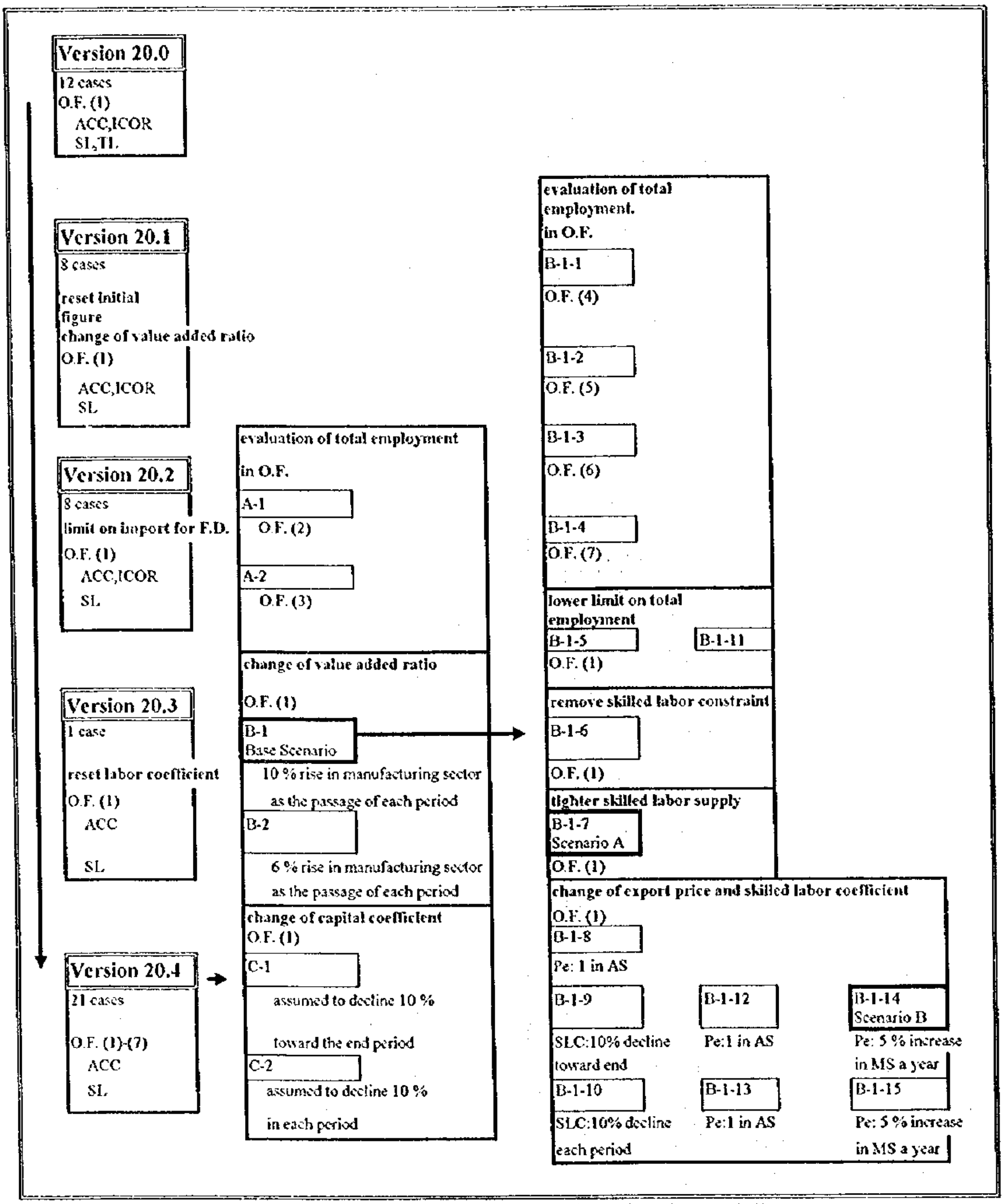
As far as calculation by IOPM after September Seminar 1996 is concerned, we have examined simulations by using following 8 viewpoints which reflect BAPPENAS comments: 1) achievement of the higher growth rate of GDP as the passage of periods, 2) achievement of the reasonable share of GDP in manufacturing sector, 3) improvement in the growth rate of GDP, export and import in light industry,4) restraint on the consumption growth rate in agriculture sector,5) improvement in GDP growth rate of sectors (4, 9, 13, 19, 27), 6) achievement of the reasonable growth rate of investment, 7) restraint on the growth rates of output and GDP in sector 8, 8) achievement of the reasonable share of GDP in agriculture sector.

We examined optimum solutions of many cases carefully from the various points of view and selected 18 cases which satisfies BAPPENAS request mentioned above and sent them to BAPPENAS at the end of 1996. At the meeting held in March 1997 with BAPPENAS, we presented optimum solutions of the 18 cases and their analysis contained in Progress Report (II).

Table 1-9 History of IOPM Versions

Version	The number of main cases	Short description of Version	Presentation
Data for Model are on 1990 price basis			
1	2	Change of Foreign Currency Constraint	
2	6	Change of Objective Function (Investment & Consumption) Change of Foreign Currency Constraint Change of Labor Constraint	
3	10	Setting of Side Conditions for Exports Change of Investment Price by Industry from (0.1,....., 0.1) to (1.0,.....,1.0) Setting of Depreciation Rate for Capital Stock (annually 7 %)	
4	10	Change of Side Conditions for Exports Change of Investment Price by Industry from (0.1,....., 0.1) to (1.0,.....,1.0) Setting of Depreciation Rate for Capital Stock (annually 7 %)	
5	5	Revision of Capital Coefficient Change of Export Constraint Change of Depreciation Rate for Capital Stock (annually 2 %, 4 %) Change of Foreign Currency Constraint (4 Patterns) Setting of Lower Limit on Output	
6	2	Change of Function for Output Constraint Change of Capital Coefficient	
7	3	Change from "Pattern" to "Variable" for Consumption by Sector Setting of Upper & Lower Limits on Consumption	
8	10	Change of Upper & Lower Limits on Consumption Change of Side Conditions for Export(Import) Change of Foreign Currency Constraint Change of Discount Rate for Objective Function (annually 2 %, 3 %)	Progress (I) in March 1996
9	8	Setting of Consumption Price by Industry in Objective Function Change of Evaluation for Capital Stock at the end of planning period Change of Side Conditions for Exports	Progress (I) in March 1996
10	8	Setting of Import Price & Export Price for Foreign Currency Constraint Setting of Consumption Price by Industry in Objective Function Setting of Import Price & Export Price in Foreign Currency Constraint Change of Side Conditions for Exports	Progress (I) in March 1996
11	4	Change of Capital Coefficient	
12	4	Imports are treated as variable	
13	4	Change of method for input coefficient projection The change of value-added ratio is taken into consideration as the passage of each period	
14	4	Change of Structural Constraint Here we replace Total Labor Constraint with Skilled Labor Constraint	
15	4	Imports for intermediate demand are assumed to have linear relation with output	Workshop in June 1996
16	4	Change of Capital Constraint We replace Capital Constraint using ACC with Capital Constraint using ICOR	
17	9	Several types of assumption of value-added ratio are tested Terms of trade is taken into consideration in foreign currency constraint We replace Skilled Labor Constraint with Total labor constraint	Workshop in June 1996
18	2	Import for intermediate demand is assumed to have linear relation with intermediate demand	
19	2	Evaluation of total employment is taken into consideration in objective function	
Data for Model are changed to 1993 price basis			
20	200	Change of method for input coefficient projection (RECRAS-QP method is used) Change of method for capital stock estimation We replace Total Labor Constraint with Skilled Labor Constraint Evaluation of total employment is taken into consideration in objective function Evaluation for Consumption is assumed to decline as consumption level increases Skilled Labor Constraint is divided into 2 parts	Seminar in Sep.1996 Progress (II) in March 1997

Chart 1-1 The Flow Chart of Version 20



Note: O.F: Objective Function, ACC: Average Capital Coefficient, ICOR: Incremental Capital Output Ratio, SL: Skilled Labor, TL: Total Labor, Pe: Export Price, AS: Agriculture Sector, MS: Manufacturing Sector, SLC: Skilled Labor Coefficient

1.3.2 Structure of Version 20

Here we explain the framework of Version 20 of IOPM. Objective function consists of two parts. One is the sum of discounted flow of consumption during planning period. And, the other is the capital stock at the end of planning period. Depreciation of capital stock is taken into consideration here. Evaluation parameters for consumption of sectors (1-5,8) in objective function are assumed to decline in several cases as the corresponding consumption levels increase.

Output, capital, foreign currency and skilled labor are incorporated into IOPM as structural constraints. Note that, here, skilled labor constraint is divided into 2 parts; one for sectors (6-19) and the other for sectors (1-5, 20-27).

We set side conditions to output, consumption, export and import. The output of each sector in i-th sector is required to be more than 95 % of that of corresponding sector in previous period. The growth rate of consumption is restricted to change from 2 to 10 % of the previous year. Export of each sector is restricted to range from 80 to 200 % of corresponding sector's export in previous period. The import for final demand in each sector is restricted to range from 80 to 200 % of the previous period. However, side conditions for export (import) are changed depending on cases.

Note that value added ratio of manufacturing sector is assumed to rise by 10 per cent in each period, while that of agriculture sector is assumed to reach 50 per cent of initial figure at the end of planning period.

As to parameters, Input coefficients were projected by utilizing many types of non-survey methods like RAS, RECRAS, RECRAS-QP, etc. After examining each result, we decided to employ RECRAS-QP method to project input coefficients. As to capital stock estimation, we tested two types of methods. One was regression of depreciation with accumulated net investment. Here capital stock was derived by linear regression model. The other was based on the assumption that net real investment had exponential relation with time. In this method, capital stock was derived by exponential regression model. Export (import) prices are derived from linear regression model, using 1983-1993 export (import) price index. Export prices of manufacturing sectors are assumed to rise by 10% as the passage of each period. Skilled labor coefficient of sector 8 is assumed to rise by 10 % as the passage of each period.

Following is the essence of IOPM Structure:

(1) Objective Function

$$\sum_{t=1}^{5}\left[\sum_{i=1}^{26}\left\{\frac{pc_t^i}{(1+\rho)^{t-1}}C_t^i+\beta_t^i\frac{1}{(1+\rho)^4}I_t(1-d)^{5-t}\right\}\right]\qquad\text{(1-92)}$$

(2) Structural Constraints

1) output $(A_t - U - m_t)X_t + C_t + I_t + E_t - M_t^{(F.D.)} \leq 0$ ....(1-93)

2) capital $k_t X_t \leq \frac{K_{t-1} + K_t}{2}$ .... (1-94)

3) foreign currency $\sum_{\tau=1}^{t} \{pm_\tau(m_\tau X_\tau + M_\tau^{(F.D)}) - pe_\tau E_\tau\} \leq 0$ .... (1-95)

4) skilled labor $l_{tE}^s X_{tE} \leq L_{tE}^s$ .... (1-96)

(3) Side Conditions

1) output $0.95 X_{t-1}^i \leq X_t^i$ ....(1-97)

2) consumption $(1.02)^5 C_{t-1}^i \leq C_t^i \leq (1.10)^5 C_{t-1}^i$ ....(1-98)

3) export $0.8 E_{t-1}^i \leq E_t^i \leq 2 E_{t-1}^i$ ....(1-99)

4) import $0.8 M_{t-1}^{i(F.D.)} \leq M_t^{i(F.D.)} \leq 2 M_{t-1}^{i(F.D.)}$ .... (1-100)

where

X_t^i :output of i-th sector at t-th period, K_t :capital stock at t-th period, A_t : input coefficient at t-th period, pm_t :import price at t-th period m_t : import coefficient matrix at t-th period, pe_t :export price at t-th period, U : identity matrix, pc_t^i : consumption price of i-th sector at t-th period, C_t^i :consumption of i-th sector at t-th period, X_{tE} : output at the end of t-th period, I_t : investment at t-th period, l_{tE}^s :skilled labor coefficient at the end of t-th period, E_t^i : export of i-th sector at t-th period, L_{tE}^s :skilled labor supply at the end of t-th period, $M_t^{i(F.D.)}$: import for final demand of i-th sector at t-th period, β_t^i : evaluation parameter of capital stock of i-th sector at t-th period, d : depreciation rate

1.3.3 Summary of Optimum Solutions of National IOPM

Here, we list up first the assumptions of 18 cases sent to BAPPENAS at the end of December 1996 and then proceed to resource requirements of sectors and the summary of optimum solutions of those cases.

(1) Assumptions of Each Case

Presented cases are divided broadly into two parts in accordance with the assumption of skilled labor coefficients. One is those cases with an assumption that skilled labor coefficients of sectors (9-27) decline by 10 % as the passage of each period. The other is those cases with an alternative assumption that skilled labor coefficients of sectors (9-27) decline by 15 % as the passage of each period. In each assumption of skilled labor coefficient's change, there are several cases in accordance with different assumptions of evaluation parameters for consumption, of skilled labor supply and of side conditions for exports. The summary of assumptions in each case is presented on Table1-10.

Table 1-10 Assumptions of 18 Cases

Skilled labor coefficients of sectors (9-27) are assumed to decline by 10 % as the passage of each period

Case 1	(1)Exports of sectors (6,8) are assumed to be in the range of 80 to 110 % of the corresponding export of previous period. (2)Exports of sectors (22-27) are assumed to be in the range of 80 to 150 % of the corresponding export of previous period.
Case 1-1	Aggregate skilled labor supply is assumed to grow at annual 5.5% but growth rates for agriculture and service sectors are assumed to be at annual 5.0 %
Case 1-2	Aggregate skilled labor supply is assumed to grow at annual 5.5 % but growth rate for manufacturing sector is assumed to be at annual 5.0 %
Case 2	Evaluation parameter for consumption is changed higher than that of Case 1 in objective function
Case 2-1	Aggregate skilled labor supply is assumed to grow at annual 5.5% but growth rates for agriculture and service sectors are assumed to be at annual 5.0 %
Case 2-2	Aggregate skilled labor supply is assumed to grow at annual 5.5 % but growth rate for manufacturing sector is assumed to be at annual 5.0 %
Case 3	Evaluation parameter for consumption is changed higher than that of Case 2 in objective function
Case 3-1	Aggregate skilled labor supply is assumed to grow at annual 5.5% but growth rates for agriculture and service sectors are assumed to be at annual 5.0 %
Case 3-2	Aggregate skilled labor supply is assumed to grow at annual 5.5 % but growth rate for manufacturing sector is assumed to be at annual 5.0 %

Skilled labor coefficients of sectors (9-27) are assumed to decline by 15 % as the passage of each period

Case 4	(1)Exports of sectors (6,8) are assumed to be in the range of 80 to 110 % of the corresponding export of previous period. (2)Exports of sectors (22-27) are assumed to be in the range of 80 to 150 % of the corresponding export of previous period.
Case 4-1	Aggregate skilled labor supply is assumed to grow at annual 5.5% but growth rates for agriculture and service sectors are assumed to be at annual 5.0 %
Case 4-2	Aggregate skilled labor supply is assumed to grow at annual 5.5 % but growth rate for manufacturing sector is assumed to be at annual 5.0 %
Case 5	Evaluation parameter for consumption is changed higher than that of Case 4 in objective function
Case 5-1	Aggregate skilled labor supply is assumed to grow at annual 5.5% but growth rates for agriculture and service sectors are assumed to be at annual 5.0 %
Case 5-2	Aggregate skilled labor supply is assumed to grow at annual 5.5 % but growth rate for manufacturing sector is assumed to be at annual 5.0 %
Case 6	Evaluation parameter for consumption is changed higher than that of Case5 in objective function
Case 6-1	Aggregate skilled labor supply is assumed to grow at annual 5.5% but growth rates for agriculture and service sectors are assumed to be at annual 5.0 %
Case 6-2	Aggregate skilled labor supply is assumed to grow at annual 5.5 % but growth rate for manufacturing sector is assumed to be at annual 5.0 %

(2) Resource Requirements of Sectors

The direct and indirect additional resource (capital, skilled labor) requirement by one unit increase of final demand and net foreign currency earning ratio play vital role in operating IOPM, because calculation in IOPM is conducted mainly based on those figures. The direct and indirect additional needs of capital and skilled labor by one unit increase of final demand are derived by multiplying k (capital coefficient), l (skilled labor coefficient) and Leontief inverse matrix respectively. The following is the short explanation of net foreign currency earning ratio; One unit increase of export will bring about the gain of Pe (export price). On the other hand, the increase in B $\{B=(U - A + m)^{-1}$, Leontief inverse matrix modified by import coefficient} of output is required for producing one unit increase of export. In our Model, import for intermediate demand is assumed to have linear relation with output and the import coefficient is m. Therefore, finally Pm • m • B of import is brought about by one unit increase of export. In terms of cost and benefit, those sectors that have bigger positive scale on the difference between Pe and Pm • m • B are considered to have larger profit. Here (Pe- Pm • m • B) is named as net foreign currency earning ratio.

We derive those figures in Case 1 and put them in decreasing order of magnitude on Table 1-11. Those sectors that have high ranking of resource requirement are considered inefficient. On the other hand those sectors that have high ranking of net foreign currency earning ratio are considered efficient in earning of foreign currency.

Table 1-11 shows that sectors with high ranking of capital and skilled labor requirements concentrate at manufacturing sector, while sectors with low ranking of those requirements concentrate at agriculture and service sectors. However, as skilled labor coefficients of sectors (9-27) are assumed to decline by 10 % as the passage of each period in Case 1, a decline in ranking of skilled labor requirement of those sectors is seen as the passage of each period. On the other hand, sectors with high ranking of net foreign currency earning ratio concentrate at agriculture and service sectors, while sectors with low ranking concentrate at manufacturing sector. However, as export prices of manufacturing sector are assumed to increase by 10 % as the passage of each period in Case 1, an increase in ranking of manufacturing sector is seen as the passage of each period.

Table 1-11 Ranking of Sectors in Case 1 (in decreasing order of magnitude)

	1 (R-VI)			2 (R-VII)			3 (R-III)			4 (R-IX)			5 (R-X)		
	KB	IB	NFER	KB	IB	NFER	KB	IB	NFER	KB	IB	NFER	KB	IB	NFER
1.Farm food	26	25	13	26	25	18	26	24	20	26	20	21	26	20	21
2.Estate crops	25	15	9	25	15	12	24	14	13	25	14	13	25	13	15
3.Livestock	24	21	7	24	18	4	25	17	4	21	15	3	21	14	3
4.Forestry	22	4	5	21	4	8	20	2	9	22	2	10	22	2	11
5.Fishery	23	24	1	23	24	1	23	25	1	23	22	1	23	21	1
6.Oil & Gas	4	26	12	3	26	16	3	26	18	1	26	20	1	26	20
7.Non Oil ,Gas	2	13	4	2	13	6	2	13	6	4	13	6	4	12	7
8.Food	21	9	11	22	8	14	22	8	15	19	6	17	19	5	17
9.Textile	8	3	19	9	3	19	9	4	16	15	4	15	15	4	14
10.Wood	12	1	8	12	1	7	11	1	7	9	1	7	9	1	6
11.Paper	3	11	16	4	11	13	4	12	10	8	12	9	7	15	9
12.Chemical	16	18	20	19	19	23	21	19	23	11	19	23	12	19	23
13.Non Metallic	1	2	14	1	2	11	1	3	12	5	3	12	5	3	12
14.Iron & steel	9	19	18	8	21	17	8	21	17	12	25	16	11	25	16
15.Non Ferrous metal	10	12	21	10	12	20	10	11	21	6	11	19	6	11	19
16.Fabricated Metal	13	8	22	13	9	22	13	9	22	7	9	22	8	9	22
17.Machinery	17	20	24	17	20	24	17	20	24	17	21	24	17	22	24
18.Transport Equip	15	10	23	15	10	21	15	10	19	16	10	18	16	10	18
19.Oth.manufacturing	14	5	17	14	5	15	14	5	14	18	5	14	18	6	13
20.Elec.Gas,Water	5	14	25	5	14	25	5	15	25	2	16	25	2	17	25
21.Construction	11	7	26	11	7	26	12	7	26	10	8	26	10	8	26
22.Trade	19	23	2	18	23	2	18	23	2	24	23	2	24	23	2
23.Restaurant,Hotel	18	17	3	16	16	3	16	16	3	13	17	4	13	16	4
24.Transportation	7	16	10	7	17	9	7	18	8	3	18	8	3	18	8
25.Finance	6	22	6	6	22	5	6	22	5	20	24	5	20	24	5
27.Oth. Services	20	6	15	20	6	10	19	6	11	14	7	11	14	7	10

Note: k: Capital Coefficient, l: Skilled Labor Coefficient, B: Leontief Inverse Matrix modified by Import Coefficient Matrix,

NFER :Net Foreign Currency Earning Ratio (Pe-Pm*m*B)

Source: JICA Study Team

(3) Observation

1) Annual Growth Rate of GDP

Annual GDP growth rate of 18 cases are presented on Table 1-12. The lowest growth scenario attains average 8.0 % (Case 1-1, Case 2-1), while the highest growth scenario attains average 8.8 % (Case 6, Case 6-2) during the planning period. The increase in GDP growth rate is seen as skilled labor constraint cases.

Comparing Case 1 with Case 4, we find the increase in the growth rates of total GDP in Case 4 because of the decline in skilled labor coefficients.

The increase in the average annual growth rate of total GDP during the planning period is observed as the numbering of case increases, i.e., 8.1 % in Case 1, 8.3 % in Case 2 and 8.4 % in Case 3 because of the change in evaluation parameter for consumption in sectors (1-5) which becomes higher as the numbering of case increases.

Table 1-12 Annual Growth Rate of GDP in Each Case (Unit :%)

	0-1 (R-VI)	1-2 (R-VII)	2-3 (R-VIII)	3-4 (R-IX)	4-5 (R-X)	0-5 Average
Case 1	7.5	7.8	8.3	8.3	8.5	8.1
Case 1-1	7.5	7.9	8.0	8.2	8.4	8.0
Case 1-2	7.3	7.9	8.4	8.2	8.5	8.1
Case 2	7.8	8.1	8.6	8.7	8.3	8.3
Case 2-1	7.9	7.8	8.0	8.2	8.1	8.0
Case 2-2	7.6	8.2	8.7	8.7	8.3	8.3
Case 3	7.8	8.1	8.6	8.7	8.8	8.4
Case 3-1	7.9	7.9	8.0	8.3	8.5	8.1
Case 3-2	7.7	8.2	8.6	8.7	8.7	8.4
Case 4	7.6	8.4	8.9	8.8	9.2	8.6
Case 4-1	7.8	8.3	8.8	8.6	8.9	8.5
Case 4-2	7.6	8.3	8.7	8.8	9.1	8.5
Case 5	8.0	8.6	9.0	9.2	8.9	8.7
Case 5-1	8.0	8.4	8.9	9.2	8.7	8.6
Case 5-2	7.9	8.6	9.0	9.1	8.8	8.7
Case 6	8.0	8.6	9.0	9.3	9.3	8.8
Case 6-1	8.0	8.4	8.9	9.2	9.2	8.7
Case 6-2	7.9	8.6	9.0	9.2	9.2	8.8

Source: JICA Study Team

2) Sectoral Share of GDP

Sectoral share in total GDP is presented on Table 1-13. As shown on that Table, as the passage of each period, agriculture's share of GDP declines, while manufacturing's share of GDP increases. Agriculture's share of GDP in the last period is about between 7 and 11 %, while manufacturing's share of GDP is about between 32 and 38 %. The GDP share of other sectors in the last period is about between 48 and 55 %.

Comparing Case 1 with Case 4, agriculture's share in GDP between initial period and the last period declines from -11.7 % in Case 1 to -12.4 % in Case 4 and also service sector's share declines from 2.8 % in Case 1 to 1.0 % in Case 4, while manufacturing sector's share increases from 14.6 % in Case 1 to 15.6 % in Case 4 and construction sector's share increases from 0.5% in Case 1 to 1.9 % in Case 4

Agriculture's share in GDP increases as the number of Case increases, i.e., -11.7 % in Case 1, -9.9 % in Case 2 and -7.9 % in Case 3, while those of the other sectors declines, i.e. manufacturing sector's share is 14.6 % in Case 1, 12.3 % in Case 2 and 11.9 % in Case 3 and service sector's share is 2.8 % in Case1, 1.2 % in Case 2, 0.4 % in Case 3.

Table 1-13 Sectoral Share of GDP (Unit:%)

			0	1 (R-VI)	2 (R-VII)	3 (R-VIII)	4 (R-IX)	5 (R-X)
Case 1		1 Agriculture(1-5)	19.1	17.8	15.5	12.7	9.8	7.4
		2 Mining (6-7)	10.9	8.2	6.3	5.0	4.1	3.6
		3 Manufacturing(8-19)	22.0	26.1	28.9	31.6	34.2	36.6
		4.Others (20-27)	48.0	48.0	49.4	50.7	52.0	52.5
	Case 1-1	1 Agriculture(1-5)	19.1	17.5	15.5	12.1	9.5	7.5
		2 Mining (6-7)	10.9	8.2	6.2	4.9	4.0	3.3
		3 Manufacturing(8-19)	22.0	26.4	29.8	33.1	35.8	38.2
		4.Others (20-27)	48.0	47.9	48.6	49.9	50.8	51.0
	Case 1-2	1 Agriculture(1-5)	19.1	17.0	15.0	12.6	9.4	7.2
		2 Mining (6-7)	10.9	8.3	6.3	4.9	4.1	3.5
		3 Manufacturing(8-19)	22.0	25.5	27.9	30.1	32.4	34.3
		4.Others (20-27)	48.0	49.2	50.9	52.3	54.1	55.0
Case 2		1 Agriculture(1-5)	19.1	17.4	15.0	13.1	11.9	9.2
		2 Mining (6-7)	10.9	8.8	7.7	7.0	6.5	6.3
		3 Manufacturing(8-19)	22.0	26.1	28.6	30.7	32.3	34.3
		4.Others (20-27)	48.0	47.8	48.7	49.2	49.3	50.2
	Case 2-1	1 Agriculture(1-5)	19.1	17.8	15.5	13.7	12.0	9.1
		2 Mining (6-7)	10.9	8.6	7.5	5.7	4.5	4.3
		3 Manufacturing(8-19)	22.0	26.6	29.4	32.1	34.3	36.6
		4.Others (20-27)	48.0	47.1	47.6	48.5	49.2	50.0
	Case 2-2	1 Agriculture(1-5)	19.1	17.1	14.8	13.1	11.6	9.0
		2 Mining (6-7)	10.9	8.8	7.8	7.1	6.6	6.4
		3 Manufacturing(8-19)	22.0	25.6	27.6	29.3	30.7	32.2
		4.Others (20-27)	48.0	48.5	49.8	50.6	51.1	52.4
Case 3		1 Agriculture(1-5)	19.1	17.4	15.2	13.4	12.2	11.2
		2 Mining (6-7)	10.9	8.8	7.7	7.0	6.5	6.0
		3 Manufacturing(8-19)	22.0	26.1	28.6	30.7	32.3	33.9
		4.Others (20-27)	48.0	47.8	48.5	48.9	49.0	48.8
	Case 3-1	1 Agriculture(1-5)	19.1	18.0	15.7	13.9	12.6	11.7
		2 Mining (6-7)	10.9	8.6	7.5	5.7	4.5	3.4
		3 Manufacturing(8-19)	22.0	26.5	29.4	32.1	34.3	36.4
		4.Others (20-27)	48.0	46.9	47.3	48.3	48.7	48.5
	Case 3-2	1 Agriculture(1-5)	19.1	17.1	14.8	13.1	12.0	11.0
		2 Mining (6-7)	10.9	8.8	7.8	7.1	6.6	6.1
		3 Manufacturing(8-19)	22.0	25.6	27.6	29.3	30.5	31.7
		4.Others (20-27)	48.0	48.5	49.8	50.6	51.0	51.2
Case 4		1 Agriculture(1-5)	19.1	16.9	14.6	12.1	8.9	6.7
		2 Mining (6-7)	10.9	8.2	6.2	4.9	4.2	3.8
		3 Manufacturing(8-19)	22.0	26.1	29.1	32.0	34.8	37.6
		4.Others (20-27)	48.0	48.8	50.1	51.0	52.1	51.9
	Case 4-1	1 Agriculture(1-5)	19.1	17.5	15.0	12.5	9.4	7.0
		2 Mining (6-7)	10.9	8.2	6.2	4.9	4.2	3.6
		3 Manufacturing(8-19)	22.0	26.5	29.9	33.1	36.1	38.9
		4.Others (20-27)	48.0	47.8	48.8	49.5	50.4	50.4
	Case 4-2	1 Agriculture(1-5)	19.1	16.8	14.5	11.5	8.8	6.7
		2 Mining (6-7)	10.9	8.2	6.2	4.9	4.1	3.6
		3 Manufacturing(8-19)	22.0	25.7	28.0	30.5	32.6	34.8
		4.Others (20-27)	48.0	49.3	51.3	53.1	54.5	54.9
Case 5		1 Agriculture(1-5)	19.1	17.2	14.6	12.6	11.0	8.3
		2 Mining (6-7)	10.9	8.8	7.8	7.0	6.5	6.4
		3 Manufacturing(8-19)	22.0	26.0	28.6	30.8	33.0	35.3
		4.Others (20-27)	48.0	48.1	49.0	49.6	49.5	50.1
	Case 5-1	1 Agriculture(1-5)	19.1	17.3	14.8	12.8	11.5	8.6
		2 Mining (6-7)	10.9	8.7	7.6	6.9	6.4	6.1
		3 Manufacturing(8-19)	22.0	26.6	29.6	32.2	34.3	36.7
		4.Others (20-27)	48.0	47.5	48.0	48.0	47.9	48.5
	Case 5-2	1 Agriculture(1-5)	19.1	16.7	14.3	12.5	11.0	8.3
		2 Mining (6-7)	10.9	8.9	7.7	7.0	6.4	6.2
		3 Manufacturing(8-19)	22.0	25.6	27.6	29.3	30.9	32.7
		4.Others (20-27)	48.0	48.8	50.3	51.2	51.6	52.7
Case 6		1 Agriculture(1-5)	19.1	17.2	14.6	12.6	11.3	10.0
		2 Mining (6-7)	10.9	8.8	7.8	7.0	6.5	6.1
		3 Manufacturing(8-19)	22.0	26.0	28.6	30.9	32.9	34.9
		4.Others (20-27)	48.0	48.0	49.0	49.6	49.4	49.0
	Case 6-1	1 Agriculture(1-5)	19.1	17.3	14.9	13.0	11.7	10.5
		2 Mining (6-7)	10.9	8.7	7.6	6.9	6.3	5.9
		3 Manufacturing(8-19)	22.0	26.6	29.6	32.2	34.2	36.3
		4.Others (20-27)	48.0	47.4	47.8	47.9	47.8	47.3
	Case 6-2	1 Agriculture(1-5)	19.1	16.7	14.3	12.5	11.3	10.2
		2 Mining (6-7)	10.9	8.9	7.7	7.0	6.4	5.9
		3 Manufacturing(8-19)	22.0	25.6	27.7	29.3	30.8	32.4
		4.Others (20-27)	48.0	48.8	50.3	51.2	51.5	51.4

Source: JICA Study Team

3) Shadow Prices of Important Resources

Table 1-14 and Table 1-15 show the shadow prices of output (vector), capital, foreign currency and skilled labor constraints in the simulation Case 4. Some interesting points are:

(i) The facts that the shadow prices of capital, foreign currency and output constraint equals to zero in certain periods do not imply that these resources are not useful, because of the facts that in some occasions other constraints such as the upper or lower bound constraints for output and export are binding.

(ii) Another interesting observation is the over-time tendency of output shadow prices by sectors. In many sectors, the shadow prices attain the highest value in second period, while others do in second or fourth period. These facts suggest the different time patterns of sectoral priorities in PJPII period.

(iii) The relative sizes of output shadow prices by sectors are the results of the whole optimization process of IOPM under specific targets and constraints (for example, in Case 4). The clarification of complex relations between these shadow prices by sectors, by periods and basic external parameter values is an important task for further simulation works, and will greatly enrich the usefulness of whole IOPM modeling exercises.

Table 1-14 Shadow Price of Output Constraint in Case 4 (Unit: Rp million)

	0-1 (R-VI)	1-2 (R-VII)	2-3 (R-VIII)	3-4 (R-IX)	4-5 (R-X)
1.Farm food	0.117070	0.182430	0.243810	0.154310	0.190610
2.Estate crops	0.282500	0.302210	0.366280	0.267620	0.332620
3.Livestock	0.208480	0.306980	0.275190	0.222260	0.361080
4.Forestry	1.300200	1.084080	1.203860	1.110710	1.403720
5.Fishery	0.129450	0.167280	0.226270	0.101900	0.124690
6.Oil & Gas	0.000000	0.000000	0.000000	0.043140	0.056510
7.Non Oil, Gas	0.259420	0.407600	0.759060	0.249330	0.359820
8.Food	0.427260	0.762910	0.419150	0.512220	0.901580
9.Textile	1.441190	1.926500	0.881990	0.957360	1.057090
10.Wood	1.550660	1.869020	0.921320	1.097190	1.260530
11.Paper	0.586620	0.770660	0.782430	0.356710	0.379520
12.Chemical	0.441160	0.577960	0.418300	0.281110	0.295040
13.Non Metalic	1.229980	1.822220	0.900040	1.016520	0.875040
14.Iron & steel	0.461240	0.574110	0.572260	0.257240	0.269670
15.Non Ferrous metal	0.734100	1.003520	0.686180	0.510960	0.567630
16.Fabricated Metal	0.774650	1.010070	0.592350	0.506760	0.567450
17.Machinery	0.784460	0.994380	0.603110	0.453700	0.480040
18.Transport Equip	0.868500	1.095020	0.611200	0.513610	0.553680
19.Oth.manufacturing	1.071840	1.443520	0.662090	0.749030	0.843360
20.Elec.Gas,Water	0.433690	0.478770	0.742070	0.286050	0.314920
21.Construction	1.011270	0.975800	0.848810	0.608100	0.630210
22.Trade	0.164730	0.164880	0.282490	0.100250	0.107620
23.Restaurant,Hotel	0.205210	0.290750	0.337880	0.182480	0.269160
24.Transportation	0.326200	0.334340	0.589350	0.183540	0.192010
25.Finance	0.207070	0.214030	0.586370	0.119380	0.127720
27.Oth. Service	1.000000	0.862610	0.744090	0.590720	0.600000

Source: JICA Study Team

Table 1-15 Shadow Prices of Capital, Foreign Currency and Skilled Labor in Case 4

	0-1 (R-VI)	1-2 (R-VII)	2-3 (R-VIII)	3-4 (R-IX)	4-5 (R-X)
Capital	0.000000	0.006230	0.441990	0.000000	0.000000
Foreign Currency	0.000060	0.729380	0.040530	0.020620	0.359330
Skilled labor (Sector 1-5,20-27)	15.024380	4.251950	1.480720	0.563670	0.129260
Skilled labor (Sector 6-19)	14.399560	4.662870	0.932410	0.614080	0.158860

Source: JICA Study Team

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Chapter 2

Long Term Perspective of Indonesian Regional Economies by Multi-Regional IOPM

2.1 Basic Framework of Multi-Regional IOPM

2.1.1 Introduction

The IOPM is one of the analytical tools to analyze the whole economy from the general equilibrium point-of-view, and aims to describe the interrelationships among various social sectors of national economy. The main feature of IOPM is to describe the percussion process of effective demand originated from the final demand components to various industries, and to show the total multiplier effects through the interindustrial repercussions. Thus the national IOPM is conveniently described as follows:

$$(U - A)X = Y \qquad (2\text{-}1)$$

where U and A stand for identity and technical input coefficient matrix respectively, and X and Y show the output and final demand vector. Once the final demand is given, the sectoral output can be calculated as follows:

$$X = (U - A)^{-1} Y \qquad (2\text{-}2)$$

The inverse matrix of (U-A) is referred as Leontief inverse (matrix). Defining and calculating various semi-Leontief-inverse matrices of labor, capital and foreign currency demands, and also shadow prices and accounting costs of activities further strengthens the usefulness. IOPM is a programming model, combining the target function of economic development, the basic output balance (2-1), and other structural constraints of limited resources.

(National IOPM)

$$\max \quad B'C \qquad (2\text{-}3)$$

subject to:

$$(U - A + m)X \geqq C + I + E \qquad (2\text{-}4)$$

$$kX \leqq K + I \qquad (2\text{-}5)$$

$$Pe'E - Pm'mX \geqq 0 \qquad (2\text{-}6)$$

$$X, C, I, E \geqq 0 \qquad (2\text{-}7)$$

where C, I, E, Pe, Pm and B stand for consumption, investment, export,export price, import price and consumption evaluation column vector respectively, and m is the imported input coefficients matrix. This model can be extended further by introducing additional variables like imports of final goods, and by adding another constraints, and by increasing the number of planning periods. The full version of IOPM can be specified and manipulated after taking all these amendments.

The decomposition of national I-O Table into multiple number of regions is another useful way of extending the basic Input-Output system, and strengthening its analytical capacity and widening the policy making relevancy. The national IOPM handles the national aggregates of final demands, intermediate demand and primary inputs. In the actual world, the decomposition of final demand, technical structure represented by technical input coefficients and by primary inputs may differ greatly by regions. If such structural differences are large enough, the actual multiplier repercussion effects can be reasonably assessed only through a regionally decomposed IOPM, and must differ from the result of the national IOPM which handles the relation between national averages, and suppresses the regional structural differences.

The simplest form of IOPM for two regions can be described as follows:

(Two-region IOPM)

$$\max \quad W_1'C_1 + W_2'C_2 \tag{2-8}$$

subject to :

$$(U_1 - A_{11})X_1 - A_{12}X_2 \geqq C_1 + Y_{11} + Y_{12} \tag{2-9}$$

$$-A_{21}X_1 + (U_2 - A_{22})X_2 \geqq C_2 + Y_{21} + Y_{22} \tag{2-10}$$

$$C_1, C_2, X_1, X_2 \geqq 0 \tag{2-11}$$

where Ci, Xi and Wi(i = 1, 2) stand for consumption, output and consumption evaluation column vectors of i-th region(i = 1, 2). Aij stands for the input coefficient matrix from i-th region to j-th region. Yij shows the final demand originated in j-th region and directed to i-th region. The export and import of final goods are included in the final demand component (Yii), while the interregional transaction of intermediate inputs appear to the left-hand sides of (2-9) and (2-10). The interregional erosion of final demand is explicitly described by Yij ($i \neq j$).

The model specification above is very simple, but still it points out two important merits compared with the national version. (a) The evaluation vector can differ among regions. So when the governmental emphasizes the regional equity target, it can be explicitly considered in the target function. (b) The developed (underdeveloped) region has different decomposition of final demand and different input structures. These differences would result in the different comparative advantage structures originated from demand and supply sides. So two-region IOPM, even if simple, can take into consideration the regionally different development emphasis and the different technical features originated from the different development stages.

Indonesia is a big country in her population size as well as the geographical extension. Thus there exist great regional differences in demand compositions and industrial complexities as well as technical levels. To adequately reflect these differences, the subdivision of national economy and the decomposition of IOPM into five regions is highly desirable. However, as the number of region increases, the limited availability of statistical data greatly diminishes the accuracy of empirical works. In every country concerned, especially the statistical estimation of interregional transaction of goods, services and demands requires quite different sources of data, and poses an extreme difficulty for data preparation. The geographical feature of Indonesia with many islands and scattered in a wide area makes such data compilation work more difficult.

JICA TSQ Team tried to prepare the full-version of five-region interregional I-O Table in cooperation with the LPEM stuffs, and we also tried to construct a more compact two-region IOPM. The final objective of regional IOPM modeling work is to break down the planned national figures into regions, so that the regional implication of national development plan can be assessed explicitly. This report includes the results of preparation of five-region interregional I-O Table and two-region IOPM, and some related preliminary calculations as the necessary and important steps to the final target.

2.1.2 Consistency Issues with the National IOPM

Though our data preparation task faces many difficulties to extend the IOPM into regional dimensions, another methodological consistency problem arises from the design of modeling works. We have already constructed a national IOPM, which enables to find various optimal paths across the PJP II period. The multi-regional IOPM to be constructed may or may not be consistent with the national model. First, the I-O Tables between the two may not be consistent each other even at the base year observations. If the construction work of interregional I-O Table is done from the locally collected survey materials, the aggregation of the regional data will not usually match the national table, even if it is conceptually expected to be consistent. To assure the statistical consistency, we needed to implement some assumptions and conditions onto the compilation process of the interregional I-O Tables. The coefficients of national I-O Table must be weighted averages of intra-regional coefficients with the weights being the regional shares of the sectoral outputs. This means that the base regional tables must have as detailed subdivision of sectors as possible to minimize aggregation errors. Depending on the base year selected, these detailed tables may not be available nor be possible to construct. We needed to augment this with some heuristic assumptions during the table compilation processes of interregional I-O Table.

Second, even if the base year interregional I-O Table is constructed as being consistent with the national I-O Table, there remains a task of forecasting the interregional input coefficient matrix for the future planning periods to enable our multi-regional IOPM operational. Most turnpike models in the past, even for national aggregate level, have assumed the production technologies (i.e., input coefficients A), to remain fixed in the future periods. Our national IOPM, however, assumes future transitional changes in technological coefficients as well as value added ratios etc. These future changes in technical coefficients are critical in the development processes such as in Indonesia. Development process in an open economy generally requires introduction of foreign capitals and technologies, especially for the industrialization. This means that technical production coefficients would generally shift toward modern global standard technology during the development process. The popular method to update input coefficients is well known RAS method. The RAS method requires at least two tables at different time periods to extrapolate. For our national IOPM, we have explored several RAS variant methods and developed RECRAS-QP method, which we adopted as the best consistent and operational predictor for our model. For multi-regional IOPM, we also need to develop a certain methodology to forecast future interregional input coefficient matix. Unlike national I-O Tables, we have been able to compile only one interregional I-O Table at the base year, 1993. We have alleviated this difficulty by extending REQRAS-QP method with side conditions of being consistent with the future national input coefficients, which we have already predicted and utilized. The RECRAS-QP method which we have developed is essentially equivalent to the RECRAS method which requires side information on value-added ratios, but our RECRAS-QP method is flexible enough to incorporate various exogenous side information as constraints.

Third, even if all the coefficients and parameters of the multi-regional IOPM are consistent with the corresponding ones of the national IOPM, we may not have a consistent optimal solution when the regional solution values are aggregated to national level. In one view, multi-regional IOPM is a regional break down of the national economy so that there may be quite a few interregional immobility and irreversibility of factors and commodities. While the national IOPM assumes free mobility of these among the implicit regions, the multi-regional IOPM imposes more realistic and specific constraints to the allocation of resources. This means that the optimal value of the target function for multi-regional IOPM would be less than that of the national IOPM. This is theoretically backed up by the well-known Le Chatelier Principle in mathematics. On the other hand, another view states that since the regions are characterized by different technologies in the multi-regional IOPM, there will be gains from trade among regions, which stem from the principle of comparative advantages. This suggests that the optimal value of the multi-regional IOPM may exceed that of the national IOPM. The both arguments seem to be correct and we may not preclude either of the possibilities. The realty will be a mix of the both theoretic outcomes. We can only expect that our optimal solution path of multi-regional IOPM will not be the same as that of national IOPM, but not far different.

2.1.3 Regional Dimension Issues of IOPM

Though we have intended to incorporate regional dimensions into our IOPM analysis, the number of regions to decompose the whole Indonesian economy was a matter of discussion at great deal. With anticipated difficulties in data preparations, we have perceived possible two set of regional decompositions, five- region and two-region. The five-region decomposition of Indonesia consists of SUMATRA, JAVA (including BALI), KALIMANTAN, SLAWESI, and OTHERS.The two-region decomposition consists of JAVA (including BALI) and OUTSIDE JAVA. The five-region decomposition is mainly from geographical reasons and it may involve large variations among the regional socio-economic characteristics. The five-region decomposition is preferable from a standpoint of regional policy making. The more detailed description of the geographically widespread economy is better suitable in finding any local economic problems and to make counter policies to them. However, the five-region decomposition of islands, in view of I-O Table compilation and the utilization, has many statistical and analytical difficulties since the rural regions are quantitatively and qualitatively (or socio-economically) quite different from the main JAVA island. Industrial compositions, populations, natural resource endowments and the development stages to name a few. In some regions, some industries are virtually null or totally dependent to the other regions. Even if the accurate interregional I-O Table of the five-region decomposition is available, to build a five-region interregional dynamic model for policy making purposes requires a great amount of supporting side information other than I-O Table. These regional supplemental data availability are worse than province levels since most of the regional statistics are the aggregates or the averages of the province level statistics. If any of provinces in a region lacks the statistics, so does the region. We face analytically serious difficulties.

The preparation and compilation of the actual five-region interregional I-O Table has been a consecutive array of difficulties and delays. Not only the delay of data collection due to various local reasons, but also due to the conceptual troubles in compilation process to deal with the insufficient and inconsistent data. As a result, our desired task to build a five-region IOPM was forced to alter the scheme. First, to grasp some five-region economic prospects consistent with the national IOPM optimal projection, we have considered a conventional method to disaggregate the national sectoral GDP into the regional sectoral GDPs. The task was done by extrapolating regional shares of sectoral GDPs from the past time series. The experiment produced fairly reasonable figures for the beginning of the next century, the year 2001, and presented at the September seminar in 1997. The forecast, however, can not be extended to the more distant future due to the statistical reliability.

The second best alternative for the construction of the multi-regional IOPM is to adopt a two-region decomposition. Two-region interregional I-O Table has the advantages of analytical simplicity and well-balanced magnitude in terms of statistical properties. The JAVA region outstands among five regions in many respects, but in two-region decomposition, most of the observations become relatively comparable levels after regions outside of JAVA are consolidated to one region. The conceptual framing and compilation of the two-region interregional I-O Table has been started in 1997 by the members of JICA Study Team, independent of and in parallel to the five-region interregional I-O Table compilation tasks by the local consultants. The current two-region interregional I-O Table we utilized is based on a preliminary five-region interregional table prepared by the Team. Utilizing the five-region trade coefficient matrix surveyed by the LPEM and by the aggregation, the two-region interregional I-O Table was estimated and compiled by a quadratic programming methodology which incorporates the consistency condition with the corresponding national I-O Table. The extension of the two-region interregional I-O Table to the future periods are also estimated by a quadratic programming model keeping the aggregation consistency with the one of national IOPM.

2.1.4 The Structure of Two-Region IOPM

Standard framework of the two-region IOPM is as follows:

$$\max \; f(\mathbf{C}_t^J,\ \mathbf{C}_t^O,\ K_T^J,\ K_T^O)$$
$$=\max \sum_{t=1}^{T}\frac{1}{(1+\rho)^{t-1}}\sum_{i=1}^{N}\left(C_{it}^J - q_i(C_{it}^J)^2 + C_{it}^O - q_i(C_{it}^O)^2\right)+\frac{\lambda}{(1+\rho)^{T-1}}\sum_{i=1}^{N}\left(K_{iT}^J + K_{iT}^O\right) \qquad (2\text{-}12)$$

subject to:

$$\begin{pmatrix}\mathbf{A}_t^{JJ} & \mathbf{A}_t^{JO}\\ \mathbf{A}_t^{OJ} & \mathbf{A}_t^{OO}\end{pmatrix}\begin{pmatrix}\mathbf{X}_t^J\\ \mathbf{X}_t^O\end{pmatrix}+\begin{pmatrix}\mathbf{T}_t^{JJ,FD} & \mathbf{T}_t^{JO,FD}\\ \mathbf{T}_t^{OJ,FD} & \mathbf{T}_t^{OO,FD}\end{pmatrix}\left[\begin{pmatrix}\mathbf{C}_t^J\\ \mathbf{C}_t^O\end{pmatrix}+\begin{pmatrix}\boldsymbol{\beta}_t^J I_t^J\\ \boldsymbol{\beta}_t^O I_t^O\end{pmatrix}\right]+\begin{pmatrix}\mathbf{E}_t^J\\ \mathbf{E}_t^O\end{pmatrix}-\begin{pmatrix}\mathbf{M}_t^J\\ \mathbf{M}_t^O\end{pmatrix}\leqq\begin{pmatrix}\mathbf{X}_t^J\\ \mathbf{X}_t^O\end{pmatrix} \qquad (2\text{-}13)$$

$$\begin{pmatrix}\mathbf{M}_t^J\\ \mathbf{M}_t^O\end{pmatrix}=\begin{pmatrix}\mathbf{m}_t^{J,IM} & 0\\ 0 & \mathbf{m}_t^{O,IM}\end{pmatrix}\begin{pmatrix}\mathbf{A}_t^{JJ} & 0\\ 0 & \mathbf{A}_t^{OO}\end{pmatrix}\begin{pmatrix}\mathbf{X}_t^J\\ \mathbf{X}_t^O\end{pmatrix}+\begin{pmatrix}\mathbf{M}_t^{J,FD}\\ \mathbf{M}_t^{O,FD}\end{pmatrix} \qquad (2\text{-}14)$$

$$\begin{pmatrix}\mathbf{k}_t^J & 0\\ 0 & \mathbf{k}_t^O\end{pmatrix}'\begin{pmatrix}\mathbf{X}_t^J\\ \mathbf{X}_t^O\end{pmatrix}\leqq\frac{1}{2}\begin{pmatrix}K_{t-1}^J + K_t^J\\ K_{t-1}^O + K_t^O\end{pmatrix} \qquad (2\text{-}15)$$

$$\begin{pmatrix}K_t^J\\ K_t^O\end{pmatrix}=\begin{pmatrix}(1-d)K_{t-1}^J + I_t^J\\ (1-d)K_{t-1}^O + I_t^O\end{pmatrix} \qquad (2\text{-}16)$$

$$\begin{pmatrix}\mathbf{l}_t^{s,J} & 0\\ 0 & \mathbf{l}_t^{s,O}\end{pmatrix}'\begin{pmatrix}\mathbf{X}_t^J\\ \mathbf{X}_t^O\end{pmatrix}\leqq\begin{pmatrix}L_t^{Skill,J}\\ L_t^{Skill,O}\end{pmatrix} \qquad (2\text{-}17)$$

$$\sum_{t=1}^{t} exr_t \cdot F_t \geqq R\$_t \qquad (2\text{-}18)$$

$$F_t = \begin{pmatrix} \mathbf{Pe}_t^{J\prime} & \mathbf{Pe}_t^{O\prime} \end{pmatrix} \begin{pmatrix} \mathbf{E}_t^J \\ \mathbf{E}_t^O \end{pmatrix} - \begin{pmatrix} \mathbf{Pm}_t^{J\prime} & \mathbf{Pm}_t^{O\prime} \end{pmatrix} \begin{pmatrix} \mathbf{M}_t^J \\ \mathbf{M}_t^O \end{pmatrix} \tag{2-19}$$

$$\begin{pmatrix} GDP_t^J \\ GDP_t^O \end{pmatrix} = \begin{pmatrix} \mathbf{v}_t^J & 0 \\ 0 & \mathbf{v}_t^O \end{pmatrix}^{t} \begin{pmatrix} \mathbf{X}_t^J \\ \mathbf{X}_t^O \end{pmatrix} \tag{2-20}$$

Side conditions:

$$\left(1+\gamma_L^{ij}\right)^5 X_{t-1}^{ij} \leqq X_t^{ij} \leqq \left(1+\gamma_U^{ij}\right)^5 X_{t-1}^{ij} \qquad i=1,\cdots N,\ j=J,O \tag{2-21}$$

$$\left(1+\theta_U^{ij}\right)^5 C_{t-1}^{ij} \leqq C_t^{ij} \leqq \left(1+\theta_U^{ij}\right)^5 C_{t-1}^{ij} \qquad i=1,\cdots N,\ j=J,O \tag{2-22}$$

$$\left(1+\phi_U^{j}\right)^5 I_{t-1}^{j} \leqq I_t^{j} \leqq \left(1+\phi_U^{j}\right)^5 I_{t-1}^{j} \qquad j=J,O \tag{2-23}$$

$$\left(1+\sigma_U^{ij}\right)^5 E_{t-1}^{ij} \leqq E_t^{ij} \leqq \left(1+\sigma_U^{ij}\right)^5 E_{t-1}^{ij} \qquad i=1,\cdots N,\ j=J,O \tag{2-24}$$

$$\left(1+\mu_L^{ij}\right)^5 M_{t-1}^{FD,ij} \leqq M_t^{FD,ij} \leqq \left(1+\mu_U^{ij}\right)^5 M_{t-1}^{FD,ij} \qquad i=1,\cdots N,\ j=J,O \tag{2-25}$$

$$(1', 1')\begin{pmatrix} GDP_1^J \\ GDP_1^O \end{pmatrix} = (1+g_1)^5 \cdot (1', 1')\begin{pmatrix} GDP_0^J \\ GDP_0^O \end{pmatrix} \tag{2-26}$$

where

Endogenous variables:

$\mathbf{X}_t^i$ = Output vector of region $i=J,O$ in period t (at 1993 constant prices)

$\mathbf{C}_t^i$ = Consumption vector of region $i=J,O$ in period t (at 1993 constant prices)

I_t^i = Investment of region $i=J,O$ in period t (at 1993 constant prices)

$\mathbf{E}_t^i$ = Export vector of region $i=J,O$ in period t (at 1993 constant prices)

$\mathbf{M}_t^i$ =Import vector of region $i=J,O$ in period t (at 1993 constant prices)

$\mathbf{M}_t^{FD,i}$ = Import vector of final goods by region $i=J,O$ in period t (at 1993 constant prices)

K_t^i = Capital stock of region $i=J,O$ in period t (at 1993 constant prices)

GDP_t^i = GDP of region $i=J,O$ in period t (at 1993 constant prices)

F_t = National trade balance in period t in terms of Rupiah

Exogenous variables:

$L_t^{Skill,i}$ = Skilled labor endowments of region $i=J,O$ in period t

$\mathbf{Pe}_t$ = Export price vector in period t in terms of Rupiah.

Pm_t =Import price vector in period t in terms of Rupiah.

exr_t = Foreign exchange rate ($/Rupiah)

$R\$_t$ = National foreign reserve requirement at the end of period t in terms of current US$

Parameters:

$\begin{pmatrix} A_t^{JJ} & A_t^{JO} \\ A_t^{OJ} & A_t^{OO} \end{pmatrix}$ = Two-region interregional input coefficient matrix in period t.

$\begin{pmatrix} T_t^{JJ,FD} & T_t^{JO,FD} \\ T_t^{OJ,FD} & T_t^{OO,FD} \end{pmatrix}$ = Two-region interregional trade coefficient matrix at period t.

$\begin{pmatrix} m_t^{J,IM} & 0 \\ 0 & m_t^{O,IM} \end{pmatrix}$ = Regional import coefficient diagonal matrix at period t.

$\begin{pmatrix} k_t^J & 0 \\ 0 & k_t^O \end{pmatrix}'$ = Capital coefficient vectors

$\begin{pmatrix} l_t^{s,J} & 0 \\ 0 & l_t^{s,O} \end{pmatrix}'$ = Skilled labor coefficient vectors

$\begin{pmatrix} \beta_t^J \\ \beta_t^O \end{pmatrix}$ = Industrial share vector (in final demand) of investment

$\begin{pmatrix} v_t^J & 0 \\ 0 & v_t^O \end{pmatrix}'$ = Diagonal matrix of value added reties.

ρ = Discount factor for future values

λ = Relative weight of terminal capital stocks in objective evaluation.

d = Capital depreciation rate

q_j = The rate of decline in marginal utility of consumption of j-th good.

g_1 = Estimated growth rate of national GDP in period 1.

$\gamma_k^{ij}, \theta_k^{ij}, \phi_k^{ij}, \sigma_k^{ij}, \mu_k^{ij}$ = Lower and Upper ($k = L, U$) bound annual growth rates for each corresponding endogenous variable $X_t^{ij}, C_t^{ij}, I_t^j, X_t^{ij}, M_t^{FD,ij}$.

2.2 Regional Decomposition of Sectoral GDP in RepelitaVII Period.

Harmonized regional development is an important development target. The mechanism of regional development is multifaceted. Based on the changing comparative advantage structure and the changing factor endowment and regional market size of each region, each industry shows a different pattern of growth. So in general, the development of i-th sector and of j-th region depends on the i-th sector specific factor, j-th region specific factor and on their interaction effects. Here we concentrated to the sector specific factor, and calculated the regional decomposition of sectoral GDP for case 1 and case 4 based on the regional share of each sector. We extrapolated the j-th region's share of i-th sector (S_{ij}) based on the next formula ($i=1,\ldots,N(=26); j=1,\ldots,5$).

$$S_{ij}\,(2001) = S_{ij}(\text{average in 91-93}) + (9/8) * (S_{ij}(\text{average in 91-93}) - S_{ij}(\text{average in 83-85}))$$

So, $$S_{ij}\,(2001) = (17/8) * S_{ij}(\text{average in 91-93}) - (9/8) * S_{ij}(\text{average in 83-85}) \qquad (2\text{-}27)$$

Table 2-7 shows the shares in 1983/85, 1991/93 and the extrapolated values at 2001. Based on the extrapolation of past trend, the sign of change in share (S_{ij}) is as follows. The number in the last column shows the relative growth rate of each sector to the national average.

Table 2-1 Summary(1) : Changes in Regional Shares by Sector

Sector	Sumatra	Java	Kalimantan	Sulawesi	Others	Rel.G.R
1.Farm food	+*	--*	+	+	--	--***
2.Estate crops	--*	+***	+	+*	--*	--***
3.Livestock	+*	+*	--*	--*	--*	--***
4.Forestry*	--***	--*	+***	+*	+*	--***
5.Fishery	+*	+***	--*	--***	--	+*
6.Oil & Gas*	+***	--	--***	0	--	--***
7.Non Oil,Gas*	--***	--***	+***	--***	+***	+
8.Food	--	+	+	--	--	--*
9.Textile	--	--*	0	0	+*	--*
10.Wood*	--***	--*	+***	--*	--	--*
11.Paper	--*	+*	+	--	--	+***
12.Chemical*	--***	+***	+***	0	+	+*
13.Non Metalic	--*	--*	+	+*	+	--***
14.Iron & steel	--*	+*	--	--*	0	+***
15.Non Ferrous metal	--*	+*	0	0	0	+***
16.Fabricated Metal*	+***	-***	+	+	+	+***
17.Machinery	+*	--*	0	0	--	+***
18.Transport Equip	--*	+***	--	--	+	+***
19.Oth.manufacturing	--*	--*	+*	0	+***	+***
20.Elec.Gas,Water	+*	--*	0	--	--	+*
21.Construction	--*	--	+*	--*	+*	+
22.Trade	+*	--*	+*	--*	--	--
23.Restrant,Hotel*	--*	+*	--*	--	+*	+*
24.Transportation	--***	+***	--	--*	+*	+*
25.Finance	--*	+*	0	--*	+	+*
27.Oth. Service	+	+*	+	--*	--	--*
TOTAL	--***	+***	--	--	+	0

Source: JICA Study Team

As the sign of share change of relative growth rate in Table 2-1 coincides with the sign of relative growth rate for a particular region , such the region shows the same sectoral share, too, is either increasing or decreasing. Therefore, the number of same signs shows how each region is successfully reforming the sectoral structure and shifting the comparative advantage structure to match the social needs. The number of cases (same signs, counter signs, zero) are as follows:

Table 2-2 Summary(2) : Changes in Regional Shares by Sector - Number of Cases -

Cases	Sumatra	Java	Kalimant.	Sulawesi	Others
Parallel	10	16	7	6	16
Inverse	16	10	13	14	8
Zero	0	0	6	6	2

Source: JICA Study Team

Java and Others are successfully behaving in 16 industries by either increasing their shares in technically-oriented industry or decreasing their shares in low-tech industry. In cases of Sumatra, Kalimantan and Sulawesi, the number of counter signs exceeds the number of parallel signs. Therefore, these regions will loose their shares in national economy, when we limit ourselves to consider the sector-specific factors.

We calculated out the regional GDP by sectors and their shares for case 1 and case 4 either by the decomposition based on the formula (simple extrapolation case), and by the decomposition based on the same current share in the future (fixed current share case). When the extrapolated value is negative, we assumed the share as average between 1991 and 1993.

Table 2-4, 2-5, 2-6 show the results. The GDP shares of five regions are as follows:

Table 2-3 Summary(3) : GDP Share of Five Regions (Unit: %)

Region	Share(1993)	Ext.Total	Case(1)	Case(4)
Sumatra	24.0	18.9	20.0	19.7
Java	59.5	64.8	64.2	64.5
kalimantan	9.2	8.9	9.1	8.8
Sulawesi	3.9	3.7	3.2	3.1
Other	3.4	3.7	3.5	3.6
Total	100.0	100.0	100.0	100.0

Source: JICA Study Team

Note: The third column is the extrapolated share of total. The fourth and fifth columns are calculated by (1) calculating the regional GDP of each sector (sectoral GDP multiplied by regional share extrapolated), (2) aggregating the sectoral regional GDP by sectors, (3) aggregating the regional GDP to national total, (4) then calculating the regional shares accordingly.

The general tendency is as follows. Compared with the share at 1993,

1) The share of Java will increase by 4.7 % (case 1) or by 5.0 % (case 4).
2) The share of Other will increase by 0.1 % (case 1) or by 0.2 % (case 4).
3) The share of Kalimantan will decrease by 0.1 % (case 1) or by 0.4 % (case 4).
4) The share of Sulawesi will decrease by 0.7 % (case 1) or by 0.8 % (case 4).
5) The share of Sumatra will decrease by 4.0 % (case 1) or by 4.3 % (case 4).

As a whole, the exercise above indicates that the concentration of economic activity to the island of Java will continue into the future. When the proper regional policies (like the change of resource endowment with transmigration schemes of population and of factories, and special investment promotion, and others) taken into consideration, another pattern of regional development would emerge. Naturally this result solely considers the sector-specific factor, so it is very tentative in nature.

Table 2-4 Regional Value-Added - Fixed Current Share Case -

(1) Case 1

SECTOR	SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Case1(99/2003)
1.Farm food	42,474,819	135,850,105	8,612,125	16,454,885	12,034,610	215,426,543
2.Estate crops	24,993,430	21,085,022	2,938,167	4,995,125	1,657,906	55,669,650
3.Livestock	13,023,368	28,685,031	2,571,531	3,993,667	2,962,364	51,235,961
4.Forestry	9,015,050	6,096,966	14,598,296	1,284,025	2,808,040	33,802,376
5.Fishery	24,274,451	25,573,809	9,036,224	10,455,804	6,860,274	76,200,562
6.Oil & Gas	70,358,203	14,119,737	18,348,628	0	1,177,764	104,004,332
7.Non Oil,Gas	12,448,969	10,422,800	14,945,681	4,683,579	28,425,445	70,926,473
8.Food	26,216,291	155,439,592	1,423,037	4,155,543	509,684	187,744,148
9.Textile	319,756	29,747,722	26,190	94,180	1,233,019	31,420,867
10.Wood	12,412,910	6,548,136	29,335,617	2,129,606	1,387,266	51,813,534
11.Paper	3,385,928	45,532,917	370,129	591,041	380,305	50,260,319
12.Chemical	87,159,125	87,044,801	64,008,523	131,988	419,570	238,764,006
13.Non Metalic	2,282,168	6,226,676	32,085	690,013	53,809	9,284,750
14.Iron & steel	576,335	28,103,431	92,317	780,442	0	29,552,525
15.Non Ferrous metal	12,816,822	5,245,187	0	0	0	18,062,009
16.Fabricated Metal	5,176,220	20,992,156	17,465	97,580	158,467	26,441,889
17.Machinery	2,660,642	97,331,043	0	15,546	257,658	100,264,889
18.Transport Equip	1,465,372	49,676,071	282,316	566,794	355,833	52,346,387
19.Oth.manufacturing	474,736	8,204,158	379,909	155,898	1,434,458	10,649,158
20.Elec.Gas,Water	4,718,943	32,387,339	1,260,928	936,272	534,439	39,837,921
21.Construction	24,237,665	136,991,680	11,622,669	6,317,265	7,420,113	186,589,392
22.Trade	75,945,538	225,156,681	27,643,924	13,402,411	8,850,231	350,998,785
23.Restrant,Hotel	9,681,633	102,104,212	4,884,910	1,637,622	1,813,209	120,121,585
24.Transportation	53,633,955	170,580,711	20,276,175	15,840,007	10,057,535	270,388,384
25.Finance	39,820,578	228,588,826	15,497,861	8,749,205	4,919,118	297,575,589
27.Oth. Service	13,158,880	92,870,883	3,775,292	2,701,578	2,464,902	114,971,535
TOTAL	671,068,020	1,662,061,814	256,924,291	108,910,049	95,389,396	2,794,353,569

(2) Case 4

SECTOR	SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Case4(99/2003)
1.Farm food	41,234,790	131,884,035	8,360,699	15,974,493	11,683,266	209,137,284
2.Estate crops	24,788,457	20,912,102	2,914,071	4,954,159	1,644,310	55,213,098
3.Livestock	12,650,135	27,862,955	2,497,834	3,879,213	2,877,467	49,767,604
4.Forestry	7,954,952	5,380,011	12,881,652	1,133,034	2,477,837	29,827,486
5.Fishery	23,976,951	25,260,384	8,925,479	10,327,661	6,776,197	75,266,671
6.Oil & Gas	70,358,203	14,119,737	18,348,628	0	1,177,764	104,004,332
7.Non Oil,Gas	13,182,606	11,037,032	15,826,453	4,959,590	30,100,601	75,106,282
8.Food	23,569,997	139,749,393	1,279,395	3,736,079	458,237	168,793,100
9.Textile	701,053	65,220,803	57,422	206,486	2,703,349	68,889,113
10.Wood	9,423,009	4,970,885	22,269,539	1,616,647	1,053,115	39,333,194
11.Paper	3,498,158	47,042,149	382,397	610,631	392,910	51,926,246
12.Chemical	88,531,042	88,414,919	65,016,041	134,066	426,174	242,522,241
13.Non Metalic	2,633,602	7,185,533	37,026	796,269	62,095	10,714,525
14.Iron & steel	621,207	30,291,491	99,505	841,205	0	31,853,408
15.Non Ferrous metal	13,246,116	5,420,872	0	0	0	18,666,988
16.Fabricated Metal	5,540,273	22,468,573	18,694	104,443	169,613	28,301,597
17.Machinery	2,878,095	105,285,836	0	16,817	278,716	108,459,464
18.Transport Equip	1,569,210	53,196,170	302,322	606,957	381,048	56,055,707
19.Oth.manufacturing	499,200	8,626,941	399,487	163,932	1,508,379	11,197,939
20.Elec.Gas,Water	4,867,736	33,408,551	1,300,687	965,794	551,291	41,094,059
21.Construction	26,557,512	150,103,493	12,735,103	6,921,907	8,130,310	204,448,325
22.Trade	77,852,771	230,811,079	28,338,151	13,738,988	9,072,488	359,813,478
23.Restrant,Hotel	9,702,690	102,326,289	4,895,534	1,641,183	1,817,153	120,382,850
24.Transportation	54,279,408	172,633,549	20,520,187	16,030,633	10,178,572	273,642,347
25.Finance	40,059,018	229,957,585	15,590,660	8,801,594	4,948,573	299,357,430
27.Oth. Service	16,060,600	113,350,238	4,607,798	3,297,315	3,008,448	140,324,399
TOTAL	690,219,039	1,709,493,932	264,256,427	112,018,137	98,111,630	2,874,099,164

Source: LPEM, "Value Added at Current Price by Sector and Province, 1983-1993",
Jica Study Team

Note: Calculated by using "Regional Share of Value Added at 1993"

Table 2-5 Regional Value-Added - Simple Extrapolation Case-

(1) Case 1

SECTOR	SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Case1(99/2003)
1.Farm food	46,495,549	133,997,615	8,624,501	15,880,959	10,427,918	215,426,543
2.Estate crops	22,617,589	23,759,720	2,947,964	5,573,122	771,256	55,669,650
3.Livestock	13,397,098	30,457,078	2,157,849	2,969,240	2,254,696	51,235,961
4.Forestry*	9,146,393	6,302,234	13,982,074	1,206,169	3,165,506	33,802,376
5.Fishery	23,938,620	29,487,391	7,912,112	8,140,359	6,722,079	76,200,562
6.Oil & Gas*	68,131,718	14,955,173	19,725,693	0	1,191,748	104,004,332
7.Non Oil,Gas*	12,924,291	10,157,144	11,780,274	6,709,027	29,355,737	70,926,473
8.Food	25,586,951	156,212,201	1,626,561	3,898,934	419,501	187,744,148
9.Textile	257,754	29,099,808	32,622	96,865	1,933,819	31,420,867
10.Wood*	12,710,594	6,416,569	29,117,180	2,188,788	1,380,402	51,813,534
11.Paper	3,055,351	45,919,575	591,001	538,622	155,770	50,260,319
12.Chemical*	84,243,581	89,344,199	64,632,010	135,777	408,439	238,764,006
13.Non Metalic	2,133,731	6,041,758	35,506	1,002,746	71,010	9,284,750
14.Iron & steel	348,661	28,700,524	37,228	466,112	0	29,552,525
15.Non Ferrous metal	12,610,351	5,451,658	0	0	0	18,062,009
16.Fabricated Metal*	4,847,970	21,337,400	16,695	90,822	149,002	26,441,889
17.Machinery	3,527,077	96,593,510	0	13,424	130,879	100,264,889
18.Transport Equip	302,309	51,064,442	110,598	424,687	444,350	52,346,387
19.Oth.manufacturing	311,864	7,998,980	464,458	157,518	1,716,338	10,649,158
20.Elec.Gas,Water	5,329,812	31,862,570	1,291,931	886,573	467,035	39,837,921
21.Construction	20,874,245	136,283,497	14,635,161	5,502,093	9,294,395	186,589,392
22.Trade	77,665,089	223,323,442	31,509,015	10,892,554	7,608,685	350,998,785
23.Restrant,Hotel*	10,333,507	101,521,275	4,871,387	1,636,911	1,758,505	120,121,585
24.Transportation	47,738,374	178,906,423	19,024,406	12,773,142	11,946,039	270,388,384
25.Finance	36,620,900	235,700,284	15,440,099	4,884,341	4,929,964	297,575,589
27.Oth. Service	13,198,439	93,757,872	3,851,949	2,007,070	2,156,205	114,971,535
TOTAL	529,372,995	1,811,144,216	247,588,469	103,966,242	102,281,647	2,794,353,569

(2) Case 4

SECTOR	SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Case4(99/2003)
1.Farm food	45,138,137	130,085,629	8,372,714	15,417,323	10,123,481	209,137,284
2.Estate crops	22,432,100	23,564,864	2,923,788	5,527,416	764,931	55,213,098
3.Livestock	13,013,155	29,584,217	2,096,008	2,884,145	2,190,079	49,767,604
4.Forestry*	8,070,850	5,561,142	12,337,893	1,064,333	2,793,268	29,827,486
5.Fishery	23,645,236	29,126,003	7,815,144	8,040,594	6,639,695	75,266,671
6.Oil & Gas*	68,131,718	14,955,173	19,725,693	0	1,191,748	104,004,332
7.Non Oil,Gas*	13,685,940	10,755,721	12,474,504	7,104,400	31,085,717	75,106,282
8.Food	23,004,183	140,444,014	1,462,374	3,505,372	377,157	168,793,100
9.Textile	565,116	63,800,275	71,522	212,373	4,239,828	68,889,113
10.Wood*	9,648,990	4,871,009	22,103,717	1,661,574	1,047,904	39,333,194
11.Paper	3,156,623	47,441,624	610,590	556,475	160,933	51,926,246
12.Chemical*	85,569,607	90,750,511	65,649,342	137,914	414,868	242,522,241
13.Non Metalic	2,462,308	6,972,139	40,973	1,157,161	81,945	10,714,525
14.Iron & steel	375,807	30,935,073	40,126	502,402	0	31,853,408
15.Non Ferrous metal	13,032,728	5,634,259	0	0	0	18,666,988
16.Fabricated Metal*	5,188,936	22,838,099	17,869	97,210	159,481	28,301,597
17.Machinery	3,815,342	104,488,026	0	14,521	141,575	108,459,464
18.Transport Equip	323,731	54,682,922	118,435	454,781	475,837	56,055,707
19.Oth.manufacturing	327,936	8,411,189	488,393	165,635	1,804,786	11,197,939
20.Elec.Gas,Water	5,497,867	32,867,235	1,332,668	914,528	481,761	41,094,059
21.Construction	22,872,171	149,327,529	16,035,929	6,028,712	10,183,985	204,448,325
22.Trade	79,615,506	228,931,802	32,300,306	11,166,101	7,799,763	359,813,478
23.Restrant,Hotel*	10,355,982	101,742,084	4,881,982	1,640,472	1,762,330	120,382,850
24.Transportation	48,312,877	181,059,455	19,253,353	12,926,859	12,089,803	273,642,347
25.Finance	36,840,181	237,111,625	15,532,552	4,913,588	4,959,484	299,357,430
27.Oth. Service	16,108,883	114,432,820	4,701,359	2,449,657	2,631,679	140,324,399
TOTAL	544,480,305	1,862,830,865	254,654,178	106,933,244	105,200,573	2,874,099,164

Source: LPEM, "Value Added at Current Price by Sector and Province, 1983-1993",
Jica Study Team

Note: * Sector 4,6,7,10,12,16,23 are calculated by using "Average share 1991-1993"

Table 2-6 Regional Share of Value Added by Sector

(1) 1993

(Unit: %)

SECTOR	SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Sum
1.Farm food	19.7	63.1	4.0	7.6	5.6	100.0
2.Estate crops	44.9	37.9	5.3	9.0	3.0	100.0
3.Livestock	25.4	56.0	5.0	7.8	5.8	100.0
4.Forestry	26.7	18.0	43.2	3.8	8.3	100.0
5.Fishery	31.9	33.6	11.9	13.7	9.0	100.0
6.Oil & Gas	67.6	13.6	17.6	0.0	1.1	100.0
7.Non Oil,Gas	17.6	14.7	21.1	6.6	40.1	100.0
8.Food	14.0	82.8	0.8	2.2	0.3	100.0
9.Textile	1.0	94.7	0.1	0.3	3.9	100.0
10.Wood	24.0	12.6	56.6	4.1	2.7	100.0
11.Paper	6.7	90.6	0.7	1.2	0.8	100.0
12.Chemical	36.5	36.5	26.8	0.1	0.2	100.0
13.Non Metalic	24.6	67.1	0.3	7.4	0.6	100.0
14.Iron & steel	2.0	95.1	0.3	2.6	0.0	100.0
15.Non Ferrous metal	71.0	29.0	0.0	0.0	0.0	100.0
16.Fabricated Metal	19.6	79.4	0.1	0.4	0.6	100.0
17.Machinery	2.7	97.1	0.0	0.0	0.3	100.0
18.Transport Equip	2.8	94.9	0.5	1.1	0.7	100.0
19.Oth manufacturing	4.5	77.0	3.6	1.5	13.5	100.0
20.Elec.Gas,Water	11.8	81.3	3.2	2.4	1.3	100.0
21.Construction	13.0	73.4	6.2	3.4	4.0	100.0
22.Trade	21.6	64.1	7.9	3.8	2.5	100.0
23.Restrant,Hotel	8.1	85.0	4.1	1.4	1.5	100.0
24.Transportation	19.8	63.1	7.5	5.9	3.7	100.0
25.Finance	13.4	76.8	5.2	2.9	1.7	100.0
27.Oth. Service	11.4	80.8	3.3	2.3	2.1	100.0
TOTAL	24.0	59.5	9.2	3.9	3.4	100.0

(2) 2001

(Unit: %)

SECTOR	SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Sum
1.Farm food	21.6	62.2	4.0	7.4	4.8	100.0
2.Estate crops	40.6	42.7	5.3	10.0	1.4	100.0
3.Livestock	26.1	59.4	4.2	5.8	4.4	100.0
4.Forestry*	27.1	18.6	41.4	3.6	9.4	100.0
5.Fishery	31.4	38.7	10.4	10.7	8.8	100.0
6.Oil & Gas*	65.5	14.4	19.0	0.0	1.1	100.0
7.Non Oil,Gas*	18.2	14.3	16.6	9.5	41.4	100.0
8.Food	13.6	83.2	0.9	2.1	0.2	100.0
9.Textile	0.8	92.6	0.1	0.3	6.2	100.0
10.Wood*	24.5	12.4	56.2	4.2	2.7	100.0
11.Paper	6.1	91.4	1.2	1.1	0.3	100.0
12.Chemical*	35.3	37.4	27.1	0.1	0.2	100.0
13.Non Metalic	23.0	65.1	0.4	10.8	0.8	100.0
14.Iron & steel	1.2	97.1	0.1	1.6	0.0	100.0
15.Non Ferrous metal	69.8	30.2	0.0	0.0	0.0	100.0
16.Fabricated Metal*	18.3	80.7	0.1	0.3	0.6	100.0
17.Machinery	3.5	96.3	0.0	0.0	0.1	100.0
18.Transport Equip	0.6	97.6	0.2	0.8	0.8	100.0
19.Oth.manufacturing	2.9	75.1	4.4	1.5	16.1	100.0
20.Elec.Gas,Water	13.4	80.0	3.2	2.2	1.2	100.0
21.Construction	11.2	73.0	7.8	2.9	5.0	100.0
22.Trade	22.1	63.6	9.0	3.1	2.2	100.0
23.Restrant,Hotel*	8.6	84.5	4.1	1.4	1.5	100.0
24.Transportation	17.7	66.2	7.0	4.7	4.4	100.0
25.Finance	12.3	79.2	5.2	1.6	1.7	100.0
27.Oth. Service	11.5	81.5	3.4	1.7	1.9	100.0
TOTAL	18.9	64.8	8.9	3.7	3.7	100.0

Source: LPEM, "Value Added at Current Price by Sector and Province, 1983-1993",
Jica Study Team

Note: * Sector 4,6,7,10,12,16,23 are calculated by using "Average share 1991-1993"

Table 2-7 Development of "Regional Share of Value Added"

(Unit: %)

Sector		SUMATRA	JAVA	KALIMANTAN	SULAWESI	OTHERS	Sum
1.Farm food	Average 83/85	17.3	66.0	3.7	7.3	5.6	100.0
	Average 91/93	19.3	64.2	3.9	7.4	5.3	100.0
	2001	21.6	62.2	4.0	7.4	4.8	100.0
2.Estate crops	Average 83/85	44.9	37.3	5.0	7.9	5.0	100.0
	Average 91/93	42.9	39.8	5.1	8.9	3.3	100.0
	2001	40.6	42.7	5.3	10.0	1.4	100.0
3.Livestock	Average 83/85	23.4	54.9	5.6	8.9	7.3	100.0
	Average 91/93	24.7	57.0	4.9	7.4	5.9	100.0
	2001	26.1	59.4	4.2	5.8	4.4	100.0
4.Forestry	Average 83/85	34.5	19.8	35.6	2.6	7.5	100.0
	Average 91/93	27.1	18.6	41.4	3.6	9.4	100.0
	2001	18.7	17.4	47.8	4.6	11.4	100.0
5.Fishery	Average 83/85	30.3	30.3	13.4	16.9	9.1	100.0
	Average 91/93	30.8	34.3	12.0	14.0	9.0	100.0
	2001	31.4	38.7	10.4	10.7	8.8	100.0
6.Oil & Gas	Average 83/85	61.0	14.7	21.8	0.0	2.5	100.0
	Average 91/93	65.5	14.4	19.0	0.0	1.1	100.0
	2001	70.6	14.0	15.8	0.0	-0.4	100.0
7.Non Oil,Gas	Average 83/85	31.8	25.2	4.2	18.7	20.1	100.0
	Average 91/93	18.2	14.3	16.6	9.5	41.4	100.0
	2001	2.9	2.1	30.6	-1.0	65.4	100.0
8.Food	Average 83/85	14.2	82.7	0.6	2.2	0.3	100.0
	Average 91/93	13.9	82.9	0.7	2.1	0.3	100.0
	2001	13.6	83.2	0.9	2.1	0.2	100.0
9.Textile	Average 83/85	1.2	96.9	0.1	0.3	1.7	100.0
	Average 91/93	1.0	94.9	0.1	0.3	3.8	100.0
	2001	0.8	92.6	0.1	0.3	6.2	100.0
10.Wood	Average 83/85	27.2	13.8	51.5	4.7	2.7	100.0
	Average 91/93	24.5	12.4	56.2	4.2	2.7	100.0
	2001	21.5	10.7	61.5	3.7	2.6	100.0
11.Paper	Average 83/85	7.2	89.6	0.5	1.4	1.3	100.0
	Average 91/93	6.7	90.4	0.8	1.2	0.8	100.0
	2001	6.1	91.4	1.2	1.1	0.3	100.0
12.Chemical	Average 83/85	50.1	30.7	19.0	0.1	0.1	100.0
	Average 91/93	35.3	37.4	27.1	0.1	0.2	100.0
	2001	18.6	45.0	36.1	0.1	0.3	100.0
13.Non Metalic	Average 83/85	25.0	68.1	0.3	6.2	0.4	100.0
	Average 91/93	24.1	66.7	0.3	8.3	0.6	100.0
	2001	23.0	65.1	0.4	10.8	0.8	100.0
14. Iron & Steel	Average 83/85	3.2	92.2	0.6	4.0	0.0	100.0
	Average 91/93	2.3	94.5	0.4	2.9	0.0	100.0
	2001	1.2	97.1	0.1	1.6	0.0	100.0
15.Non Ferrous me	Average 83/85	70.8	29.2	0.0	0.0	0.0	100.0
	Average 91/93	70.4	29.6	0.0	0.0	0.0	100.0
	2001	69.8	30.2	0.0	0.0	0.0	100.0
16.Fabricated Meta	Average 83/85	11.4	87.8	0.0	0.2	0.5	100.0
	Average 91/93	18.3	80.7	0.1	0.3	0.6	100.0
	2001	26.1	72.7	0.1	0.5	0.6	100.0
17.Machinery	Average 83/85	1.6	98.1	0.0	0.0	0.3	100.0
	Average 91/93	2.5	97.3	0.0	0.0	0.2	100.0
	2001	3.5	96.3	0.0	0.0	0.1	100.0
18.Transport Equip	Average 83/85	5.2	92.0	0.9	1.3	0.6	100.0
	Average 91/93	3.0	94.6	0.6	1.1	0.7	100.0
	2001	0.6	97.6	0.2	0.8	0.8	100.0
19.Oth.manufacturi	Average 83/85	6.5	79.0	2.9	1.5	10.1	100.0
	Average 91/93	4.8	77.2	3.6	1.5	12.9	100.0
	2001	2.9	75.1	4.4	1.5	16.1	100.0
20.Elec.Gas.Water	Average 83/85	10.6	81.9	3.2	2.8	1.5	100.0
	Average 91/93	11.9	81.0	3.2	2.5	1.4	100.0
	2001	13.4	80.0	3.2	2.2	1.2	100.0
21.Construction	Average 83/85	14.7	73.8	4.5	4.0	3.1	100.0
	Average 91/93	13.0	73.4	6.1	3.5	4.0	100.0
	2001	11.2	73.0	7.8	2.9	5.0	100.0
22.Trade	Average 83/85	20.7	64.7	7.2	4.6	2.8	100.0
	Average 91/93	21.4	64.2	8.1	3.9	2.5	100.0
	2001	22.1	63.6	9.0	3.1	2.2	100.0
23.Restrant,Hotel	Average 83/85	10.3	82.3	5.0	1.4	1.0	100.0
	Average 91/93	8.6	84.5	4.1	1.4	1.5	100.0
	2001	6.7	87.0	3.0	1.3	2.0	100.0
24.Transportation	Average 83/85	22.7	59.9	7.4	7.0	3.0	100.0
	Average 91/93	20.3	62.9	7.2	5.9	3.7	100.0
	2001	17.7	66.2	7.0	4.7	4.4	100.0
25.Finance	Average 83/85	14.4	74.6	5.2	4.3	1.5	100.0
	Average 91/93	13.4	76.8	5.2	3.1	1.6	100.0
	2001	12.3	79.2	5.2	1.6	1.7	100.0
27.Oth. Service	Average 83/85	11.0	80.3	3.2	3.0	2.4	100.0
	Average 91/93	11.2	80.9	3.3	2.4	2.2	100.0
	2001	11.5	81.5	3.4	1.7	1.9	100.0
TOTAL	Average 83/85	28.9	54.1	9.8	4.1	3.2	100.0
	Average 91/93	24.2	59.1	9.3	3.9	3.4	100.0
	2001	18.9	64.8	8.9	3.7	3.7	100.0

Source: LPEM, "Value Added at Current Price by Sector and Province, 1983-1993"
Jica Study Team

2.3 Data Preparation for Model

2.3.1 Detailed Description and Compilation Procedure of Parameters.

(1) Objective Function

The capital stock of each region at the end of planning periods is defined as;

$$K_5^J = (1-d)^5 K_0^J + \sum_{t=1}^{5}(1-d)^{5-t} I_t^J$$
$$K_5^O = (1-d)^5 K_0^O + \sum_{t=1}^{5}(1-d)^{5-t} I_t^O \qquad (2\text{-}28)$$

Accordingly, the evaluation of final capital stocks in the objective function is equivalent to evaluate the sum of investments of each period remaining after the depreciation at the final period. Note that the first term is constant and thus need not be included in the objective function.

The evaluation of consumption component in the objective function for two-region IOPM is preliminary defined as the same as the national IOPM. The relative dispersion of regional welfare is not yet considered here.

The consumption level of i-th good at time t in Jawa, $C_{i,t}^J$ and in Others, $C_{i,t}^O$ are each evaluated by the weights, $\omega^{(J)}(i,t), \omega^{(O)}(i,t)$. The weights $\omega^{(J)}(i,t), \omega^{(O)}(i,t)$ are the linear declining function of the relative growth rates $C_{i,t}^J / C_{i,0}^J, C_{i,t}^O / C_{i,0}^O$ from the initial consumption level, $C_{i,0}^J, C_{i,0}^O$. Let a_i^J, a_i^O be the linear coefficients, then the weights are expressed as;

$$\omega^{(J)}(i,t) = -a_i^J\left(\frac{C_{i,t}^J}{C_{i,0}^J} - 1\right) + 1 \qquad ,a_i^J > 0$$
$$\omega^{(O)}(i,t) = -a_i^O\left(\frac{C_{i,t}^O}{C_{i,0}^O} - 1\right) + 1 \qquad ,a_i^O > 0 \qquad (2\text{-}29)$$

Therefore, the detailed objective function is formulated as;

$$
\max z = \sum_{t=1}^{T}\left[\left(\frac{(1-d)^{T-t}}{(1+\rho)^{t-1}}\left(I_t^J + I_t^O\right)\right) + \sum_{i=1}^{N}\left(\frac{1}{(1+\rho)^{t-1}}\left(\omega^{(J)}(i,t)C_{i,t}^J + \omega^{(O)}(i,t)C_{i,t}^O\right)\right)\right]
$$

$$
\Rightarrow \min z = -\sum_{t=1}^{T}\left[\left(\frac{(1-d)^{T-t}}{(1+\rho)^{t-1}}\left(I_t^J + I_t^O\right)\right) + \sum_{i=1}^{N}\left(\frac{1}{(1+\rho)^{t-1}}\left(\omega^{(J)}(i,t)C_{i,t}^J + \omega^{(O)}(i,t)C_{i,t}^O\right)\right)\right]
$$

$$
\begin{aligned}
&= -\sum_{t=1}^{T}\left(\frac{(1-d)^{T-t}}{(1+\rho)^{t-1}}\left(I_t^J + I_t^O\right)\right) \qquad (2\text{-}30)\\
&+ \sum_{t=1}^{T}\sum_{i=1}^{N}\left(\frac{-\left(a_i^J+1\right)}{(1+\rho)^{t-1}}C_{i,t}^J + \frac{a_i^J}{C_{i,0}^J(1+\rho)^{t-1}}\left(C_{i,t}^J\right)^2\right)\\
&+ \sum_{t=1}^{T}\sum_{i=1}^{N}\left(\frac{-\left(a_i^O+1\right)}{(1+\rho)^{t-1}}C_{i,t}^O + \frac{a_i^O}{C_{i,0}^O(1+\rho)^{t-1}}\left(C_{i,t}^O\right)^2\right)
\end{aligned}
$$

which is quadratic objective specification.

(2) $\begin{pmatrix} \mathbf{A}_t^{JJ} & \mathbf{A}_t^{JO} \\ \mathbf{A}_t^{OJ} & \mathbf{A}_t^{OO} \end{pmatrix}$:Two-region interregional input coefficient matrix

The two-region interregional Input coefficient matrix is compiled by aggregating the five-region interregional Input coefficient matrix (the latest version 1998/7/15), independently prepared by a member of the Team. It is then adjusted by mathematical programming method so as the intermediate demands of both regions to be consistent with the one of national I-O table of the same base year, 1993. The extension of the two-region interregional I-O Table toward the future periods during the planning span is done by quadratic programming model with side information, such as rates of changes of value added ratios and of input coefficients from the national IOPM. For detailed procedures, refer to chapter2.3.2.

(3) $\begin{pmatrix} \mathbf{m}_t^{J,IM} & \mathbf{0} \\ \mathbf{0} & \mathbf{m}_t^{O,IM} \end{pmatrix}$:Intermediate demand import coefficient matrix

Intermediate demand import coefficient matrix for each of the two-region is

$\mathbf{m}_t^{J,IM}$: Diagonal matrix of intermediate demand coefficient of Java.

$\mathbf{m}_t^{O,IM}$: Diagonal matrix of intermediate demand coefficient of Outside Java.

The intermediate demand import coefficients are calculated from the two-region interregional I-O Table. Since the table assumes that the interregional trades do not include any imported goods, the formulas for the import coefficients are as follows;

$$\mathrm{m}_{i,1993}^{J,IM}=\frac{M_{i,1993}^{J,IM}}{IM_{i,1993}^{JJ}}=\frac{M_{i,1993}^{J}}{\sum_{j=1}^{N}IM_{ij,1993}^{JJ}+C_{i,1993}^{JJ}+I_{i,1993}^{JJ}} \qquad (2\text{-}31)$$

$$\mathrm{m}_{i,1993}^{O,IM}=\frac{M_{i,1993}^{O,IM}}{IM_{i,1993}^{OO}}=\frac{M_{i,1993}^{O}}{\sum_{j=1}^{N}IM_{ij,1993}^{OO}+C_{i,1993}^{OO}+I_{i,1993}^{OO}} \qquad (2\text{-}32)$$

Since we have no sufficient information on the dynamic changes of these intermediate demand import coefficients, we assume the matrix to be constant over the planning periods.

(4) $\begin{pmatrix} \mathrm{T}_t^{JJ,FD} & \mathrm{T}_t^{JO,FD} \\ \mathrm{T}_t^{OJ,FD} & \mathrm{T}_t^{OO,FD} \end{pmatrix}$: Final demand trade coefficient matrix

Final demand trade coefficient matrix is calculated from the two-region interregional I-O Table of 1993, which is based on the five-region interregional I-O Table developed by a member of the Team. This matrix is also assumed to be constant over the future planning period due to the lack of information to extrapolate.

(5) $(\beta_t^J \quad \beta_t^O)'$: Investment pattern matrix

The calculation of investment pattern vector for each region is also based on the preliminary two-region interregional I-O Table, except for the Java's 4,Forestry which is replace by the national IOPM's investment share to avoid negative share.

(6) $\mathbf{k}_t^J$,$\mathbf{k}_t^O$: Capital coefficient vector

Capital coefficient vectors for both regions are assumed to be the same as that of national IOPM. They are also set to be constant over the whole planning periods.

(7) K_t^J ,K_t^O : Capital stock

The initial Capital stock at 1993 for the national IOPM is divided into the two regions with the regional output shares of 1993.

(8) $\mathbf{l}_t^{J,skill}$,$\mathbf{l}_t^{O,skill}$: Skilled labor coefficient vector

The regional coefficient vectors of skilled labor for Java and Outside Java are assumed to change over time depending on the groups of sectors as in the national IOPM.

sectors 1-7 : No changes overtime.

sector 8 : 10% increase in every period (5 years)

sectors 9-27 : 15% decline in every period (5 years)

(9) $L_t^{J,skill}$, $L_t^{O,skill}$: Skilled labor force

The regionally available skilled labor forces for Java and Outside Java are both divided into 2 groups;

Group 1 : sectors 1-5 & 20-27

Group 2 : sectors 6-19

The growth rate of total labor force in each region is assumed to be common 5.5%. However, the growth rate of labor force in the sectors of group 1 is assumed to be lower 5% so that the remaining group 2 takes the higher growth rate.

The initial (1993) endowments of regional skilled labor force for each sector were calculated from the 1993 output and the labor coefficient vectors.

(10) $R\$_t$: Foreign currency reserves at the end of periods.

The foreign currency reserves at the end of periods are set to 0(\$) for current versions.

(11) g_1 : The GDP growth rate of the First Period (Repelita VI)

The GDP growth rate for the first period is set to adjust the solution to the recent past performance and the ongoing last year (1998) situation of the economy. The rate was figured out based on the BPS statistics and the IMF forecasts at the spring of 1998. For description, see chapter 3.2.1.

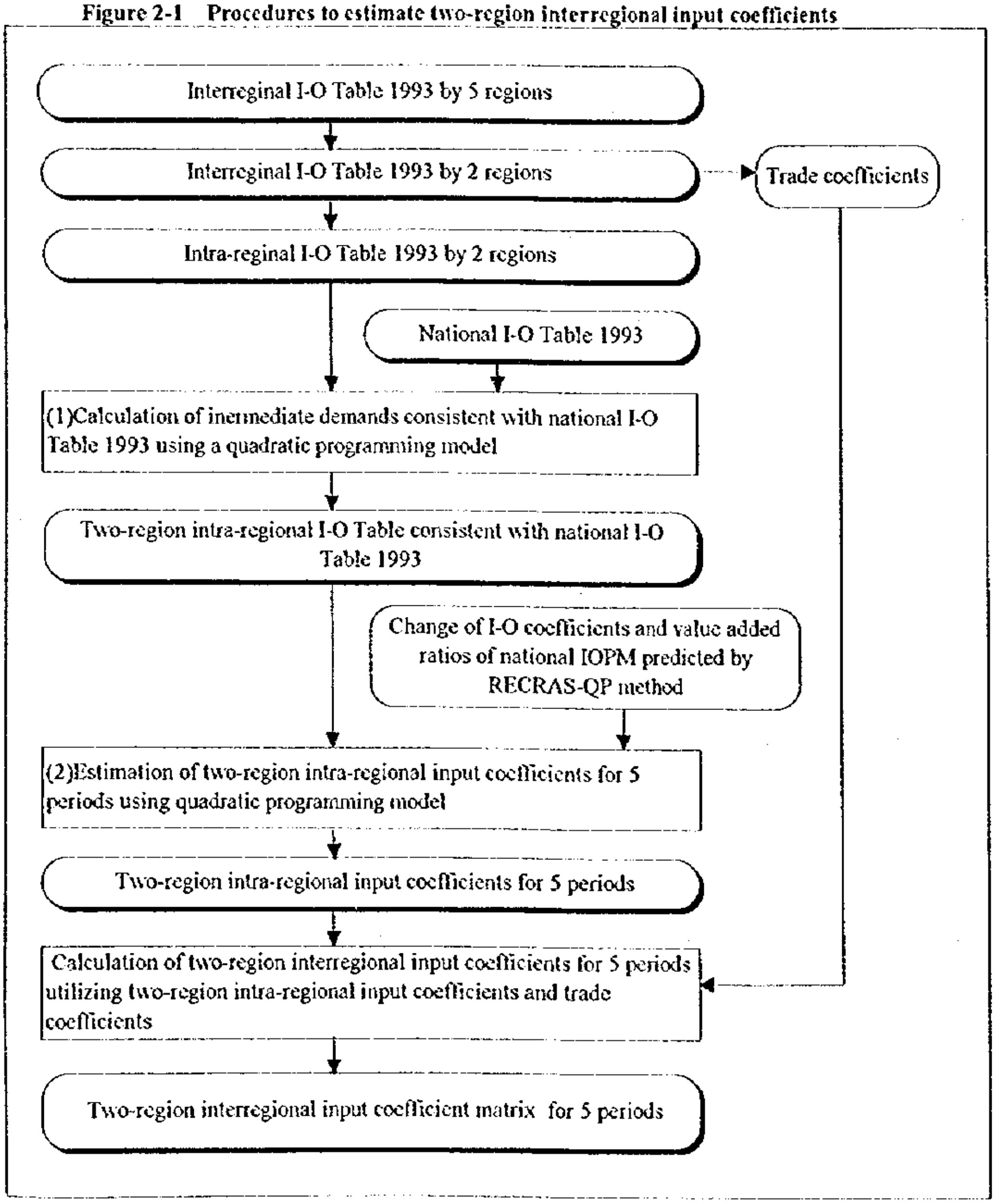
(12) d : Depreciation rate

The depreciation rate of the capital stocks are set to 4. 74% per period as in the national IOPM.

2.3.2 Estimation of Two-Region Interregional Input Coefficients

Two-region interregional input coefficients to the future periods are estimated based on two-region interregional I-O Table 1993 by quadratic programming model. And two-region interregional I-O Table 1993, which is consistent in terms of figures with national I-O Table 1993, is constructed by using intermediate demand data in two-region intra-regional I-O Table derived from interregional I-O Table 1993 by 5 regions constructed by the Team.Figure2-1 shows procedures of estimation.

Figure 2-1 Procedures to estimate two-region interregional input coefficients



(1)Calculation of two-region intra-regional I-O Table 1993 consist with national I-O Table 1993

Intermediate demand of two-region intra-regional I-O Table underlying interregional Table by 2 regions constructed by JICA study team are not consistent with those of national I-O Table 1993.Therefore we have calculated intermediate demands of two-region intra-regional I-O Table using quadratic programming model as shown in Figure2-2.

Figure2-2. QP model to calculate two-region intermediate demands

$$\min \sum_{i=1}^{N}\sum_{j=1}^{N}\left(IM_{ij}^{(Java)} - \widetilde{IM}_{ij}^{(Java)}\right)^2 + \sum_{i=1}^{N}\sum_{j=1}^{N}\left(IM_{ij}^{(OutsideJava)} - \widetilde{IM}_{ij}^{(OutsideJava)}\right)^2$$

subject to:

$$\sum_{i=1}^{N} IM_{ij}^{(Java)} = \sum_{i=1}^{N} \widetilde{IM}_{ij}^{(Java)} \quad \text{for each } i$$

$$\sum_{j=1}^{N} IM_{ij}^{(Java)} = \sum_{j=1}^{N} \widetilde{IM}_{ij}^{(Java)} \quad \text{for each } j$$

$$\sum_{i=1}^{N} IM_{ij}^{(OutsideJava)} = \sum_{i=1}^{N} IM_{ij}^{(OutsideJava)} \quad \text{for each } i$$

$$\sum_{j=1}^{N} IM_{ij}^{(OutsideJava)} = \sum_{j=1}^{N} \widetilde{IM}_{ij}^{(OutsideJava)} \quad \text{for each } j$$

$$IM_{ij}^{(Java)} + IM_{ij}^{(OutsideJava)} = IM_{ij}^{(Total)} \quad \text{for each } i \text{ and } j$$

and subject to:

$$IM_{11}^{(Java)} = \widetilde{IM}_{11}^{(Java)}$$

$$0.75 \cdot \widetilde{IM}_{ij}^{(Java)} \le IM_{ij}^{(Java)} \le 1.5 \cdot \widetilde{IM}_{ij}^{(Java)} \quad (i = j)$$

$$0.1 \cdot \widetilde{IM}_{ij}^{(Java)} \le IM_{ij}^{(Java)} \le 3.0 \cdot \widetilde{IM}_{ij}^{(Java)} \quad (i \ne j)$$

$$0.5 \cdot \widetilde{IM}_{ij}^{(OutsideJava)} \le IM_{ij}^{(OutsideJava)} \le 1.5 \cdot \widetilde{IM}_{ij}^{(OutsideJava)} \quad (i = j)$$

$$0.1 \cdot \widetilde{IM}_{ij}^{(OutsideJava)} \le IM_{ij}^{(OutsideJava)} \le 5.0 \cdot \widetilde{IM}_{ij}^{(OutsideJava)} \quad (i \ne j)$$

Where

$\widetilde{IM}_{ij}^{(Java)}$: Intermediate demands of Java calculated by a member of the Team.

$\widetilde{IM}_{ij}^{(OutsideJava)}$: Intermediate demands of Outside Java calculated by a member of the Team.

(2)Estimation of two-region intra-regional input coefficients for 5 periods

After preparation for two-region intra-regional I-O Table consistent with national I-O Table 1993,we have estimated two-region intra-regional input coefficients in the future with reference to the change of input coefficients and value added ratios of national IOPM using quadratic programming model.Figure2-3 shows the model to estimate two-region intra-regional input coefficients at the t-th period. By repeating this process for the forecast periods, input coefficients with stable and smooth change can be forecasted.

Figure2-3.QP model to forecast two-region intra-regional input coefficients at each period

(i)Java

$$\min \sum_{i=1}^{N}\sum_{j=1}^{N}\left(a_{ij,t}^{(Java)} - \gamma_{ij,t}\cdot a_{ij,t-1}^{(Java)}\right)^2$$

subject to:

$$\sum_{i=1}^{N} a_{ij,t}^{(Java)} = 1 - v_{j,t}^{(Java)}$$

and subject to:

$$\underline{m}\cdot\gamma_{ij,t}\cdot a_{ij,t-1}^{(Java)} \le a_{ij}^{(Java)} \le \overline{m}\cdot\gamma_{ij,t}\cdot a_{ij,t-1}^{(Java)}$$

$$*\ \underline{m} = 0.9, \overline{m} = 1.1 \ for\ i=j\ and\ \underline{m} = 0.8, \overline{m} = 1.2\ for\ i\neq j$$

(ii)Outside Java

$$\min \sum_{i=1}^{N}\sum_{j=1}^{N}\left(a_{ij,t}^{(OutsideJava)} - \gamma_{ij,t}\cdot a_{ij,t-1}^{(OutsideJava)}\right)^2$$

subject to:

$$\sum_{i=1}^{N} a_{ij,t}^{(OutsideJava)} = 1 - v_{j,t}^{(OutsideJava)}$$

and subject to:

$$\underline{n}\cdot\gamma_{ij,t}\cdot a_{ij,t-1}^{(OutsideJava)} \le a_{ij}^{(Java)} \le \overline{n}\cdot\gamma_{ij,t}\cdot a_{ij,t-1}^{(OutsideJava)}$$

$$*\underline{n} = 0.75, \overline{n} = 1.5\ for\ i=j\ and\ \underline{n} = 0.4, \overline{n} = 2.5\ for\ i\neq j$$

Where

$\gamma_{ij,t}$: The Change of input coefficients of national IOPM

$$\gamma_{ij,t} = \frac{a_{ij,t}^{(National)}}{a_{ij,t-1}^{(National)}}$$

$v_{j,t}^{(Java)}$: Value added ratio of Java at the t-th period.

$v_{j,t}^{(Outside\ Java)}$: Value added ratio of Outside Java at the t-th period.

$a_{ij,t}^{(National)}$: Input coefficient of national IOPM predicted by RECRAS-QP method.

Trade coefficients for intermediate demand are used to distribute two-region intra-regional input coefficients resulted from the above quadratic programming model between Java and Outside Java.

2.4 Explanation of Optimum Solutions of Two-Region IOPM

2.4.1 Optimum solutions of Two-Region IOPM

(1) Assumptions of Each Case

Two-region IOPM enable us to calculate various optimum solution under the different combination of objective function, structural constraint, and other side-condition. Here we take up 2 cases, case0 and case0-1, and explain essence of respective cases. The difference in case is assumption of skilled labor constraint. Assumption of skilled labor Skilled labor constraint of each cases is as in the following;

Case0 : Skilled labor constraint is divided into two parts, one for sectors(1-5,20-27) and another for sectors(6-19).

Case0-1 : Skilled labor constraint is set by 2 regional group, Java and Outside Java, and is divided into two parts, one for sectors(1-5,20-27) and another for sectors(6-19).

The equation of skilled labor constraint of each cases as follows;

Labor constraints of Case0:

$$\mathbf{l}_t^{J,G1}\mathbf{X}_t^{J,G1} + \mathbf{l}_t^{O,G1}\mathbf{X}_t^{O,G1} \leqq L_t^{J,G1} + L_t^{O,G1}$$

$$\mathbf{l}_t^{J,G2}\mathbf{X}_t^{J,G2} + \mathbf{l}_t^{O,G2}\mathbf{X}_t^{O,G2} \leqq L_t^{J,G2} + L_t^{O,G2}$$

Labor constraints of Case0-1:

$$\mathbf{l}_t^{J,G1}\mathbf{X}_t^{J,G1} \leqq L_t^{J,G1}$$

$$\mathbf{l}_t^{J,G2}\mathbf{X}_t^{J,G2} \leqq L_t^{J,G2}$$

$$\mathbf{l}_t^{O,G1}\mathbf{X}_t^{O,G1} \leqq L_t^{O,G1}$$

$$\mathbf{l}_t^{O,G2}\mathbf{X}_t^{O,G2} \leqq L_t^{O,G2}$$

where

$$\mathbf{l}_t^{J,G1} = \left\{l_t^{J,1},\cdots,l_t^{J,5},l_t^{J,20},\cdots,l_t^{J,27}\right\}'$$

$$\mathbf{l}_t^{J,G2} = \left\{l_t^{J,6},l_t^{J,7},\cdots,l_t^{J,18},l_t^{J,19}\right\}'$$

$$\mathbf{l}_t^{O,G1} = \left\{l_t^{O,1},\cdots,l_t^{O,5},l_t^{O,20},\cdots,l_t^{O,27}\right\}'$$

$$\mathbf{l}_t^{O,G2} = \left\{l_t^{O,6},l_t^{O,7},\cdots,l_t^{O,18},l_t^{O,19}\right\}'$$

$$\mathbf{X}_t^{J,G1} = \left\{X_t^{J,1},\cdots,X_t^{J,5},X_t^{J,20},\cdots,X_t^{J,27}\right\}'$$

$$\mathbf{X}_t^{J,G2} = \left\{X_t^{J,6},X_t^{J,7},\cdots,X_t^{J,18},X_t^{J,19}\right\}'$$

$$\mathbf{X}_t^{O,G1} = \left\{X_t^{O,1},\cdots,X_t^{O,5},X_t^{O,20},\cdots,X_t^{O,27}\right\}'$$

$$\mathbf{X}_t^{O,G2} = \left\{X_t^{O,6},X_t^{O,7},\cdots,X_t^{O,18},X_t^{O,19}\right\}'$$

$l_t^{J,i}$:Labor coefficient of i – th sector at t - th period in Java

$l_t^{O,i}$:Labor coefficient of i – th sector at t - th period in Outside Java

$X_t^{J,i}$:Output of i – th sector at t - th period in Java

$X_t^{O,i}$:Output of i – th sector at t - th period in Outside Java

$L_t^{J,G1}$:Skilled labor force of sectors(1 - 5,20 - 27) in Java at t - th period

$L_t^{J,G2}$:Skilled labor force of sectors(6 - 19) in Java at t - th period

$L_t^{O,G1}$:Skilled labor force of sectors(1 - 5,20 - 27) in Outside Java at t - th period

$L_t^{O,G2}$:Skilled labor force of sectors(6 - 19 in Outside Java at t - th period

As to more detailed information for another constraints and parameters, refer to chapter 2.3.

(2) Optimum Solutions of Each Case

Table 2-7 Annual Growth Rate of GDP (Unit:%)

Case	Sector	0-1 (R-VI)	1-2 (R-VII)	2-3 (R-VIII)	3-4 (R-IX)	4-5 (R-X)	0-5 Average
Case0	Java	9.2	9.2	8.8	7.1	4.0	7.6
	Outside Java	8.9	10.3	9.2	10.6	12.0	10.2
	Java + Outside Java	9.1	9.6	9.0	8.6	8.0	8.9
Case0-1	Java	9.3	9.8	9.4	8.4	9.0	9.2
	Outside Java	8.3	9.0	9.2	8.6	7.5	8.5
	Java + Outside Java	8.9	9.5	9.3	8.5	8.4	8.9

Source: JICA Study Team

Figure 2-4 Annual Growth Rate of GDP

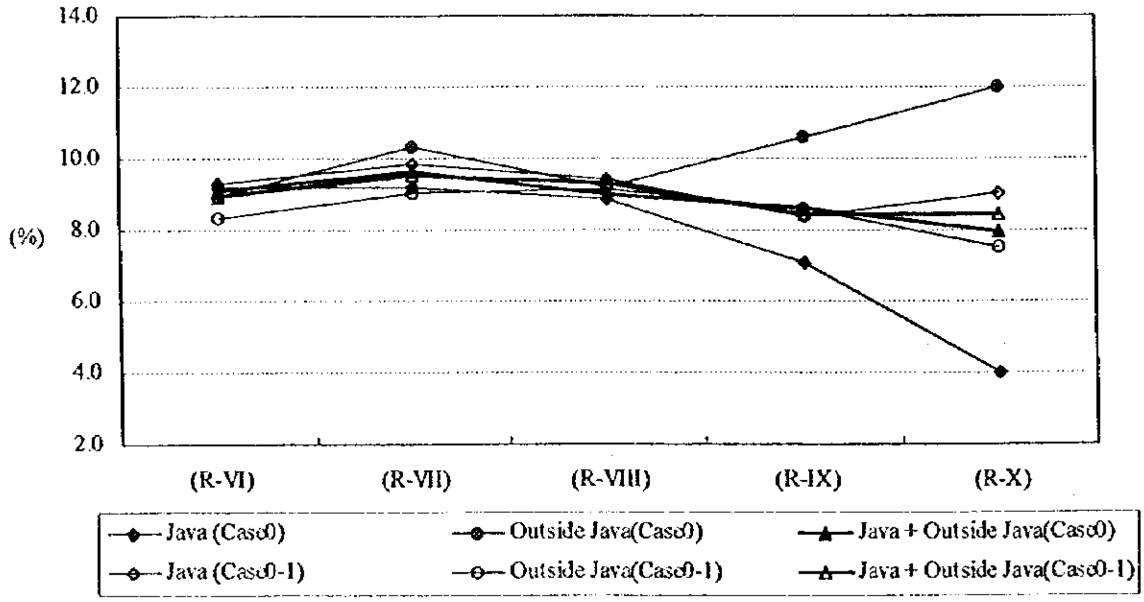


Table 2-8 Annual Growth Rate of GDP Composition in Each Case (Unit:%)

	Sector	Region	0-1 (R-VI)	1-2 (R-VII)	2-3 (R-VIII)	3-4 (R-IX)	4-5 (R-X)	0-5 Average
Consumption	Case0	Java	7.0	9.1	8.5	7.5	7.8	8.0
		Outside Java	8.4	8.9	7.7	6.6	7.3	7.8
		Java + Outside Java	7.5	9.0	8.2	7.2	7.6	7.9
	Case0-1	Java	7.0	9.3	8.2	7.9	7.9	8.1
		Outside Java	9.1	8.4	8.2	6.5	7.4	7.9
		Java + Outside Java	7.7	8.9	8.2	7.4	7.7	8.0
Investment	Case0	Java	7.2	7.1	9.9	4.0	-100.0	-100.0
		Outside Java	12.8	14.8	9.8	15.6	22.2	15.0
		Java + Outside Java	9.3	10.4	9.9	10.3	11.0	10.2
	Case0-1	Java	7.5	10.2	11.6	10.1	9.7	9.8
		Outside Java	9.5	9.6	9.0	9.4	9.8	9.5
		Java + Outside Java	8.2	10.0	10.7	9.9	9.7	9.7
Export	Case0	Java	7.9	7.5	7.5	5.6	-0.5	5.5
		Outside Java	8.1	9.3	10.6	11.7	5.0	8.9
		Java + Outside Java	8.0	8.5	9.3	9.3	3.2	7.6
	Case0-1	Java	7.3	8.2	8.3	4.6	10.1	7.7
		Outside Java	7.9	9.1	10.6	10.9	6.6	9.0
		Java + Outside Java	7.6	8.6	9.6	8.4	7.9	8.4
Import	Case0	Java	5.8	7.3	8.4	7.0	2.5	6.2
		Outside Java	5.1	8.9	8.6	11.0	14.7	9.6
		Java + Outside Java	5.7	7.6	8.4	7.8	5.8	7.1
	Case0-1	Java	5.5	7.8	8.7	8.0	8.5	7.7
		Outside Java	4.7	7.7	8.8	8.4	7.4	7.4
		Java + Outside Java	5.3	7.8	8.8	8.1	8.3	7.6

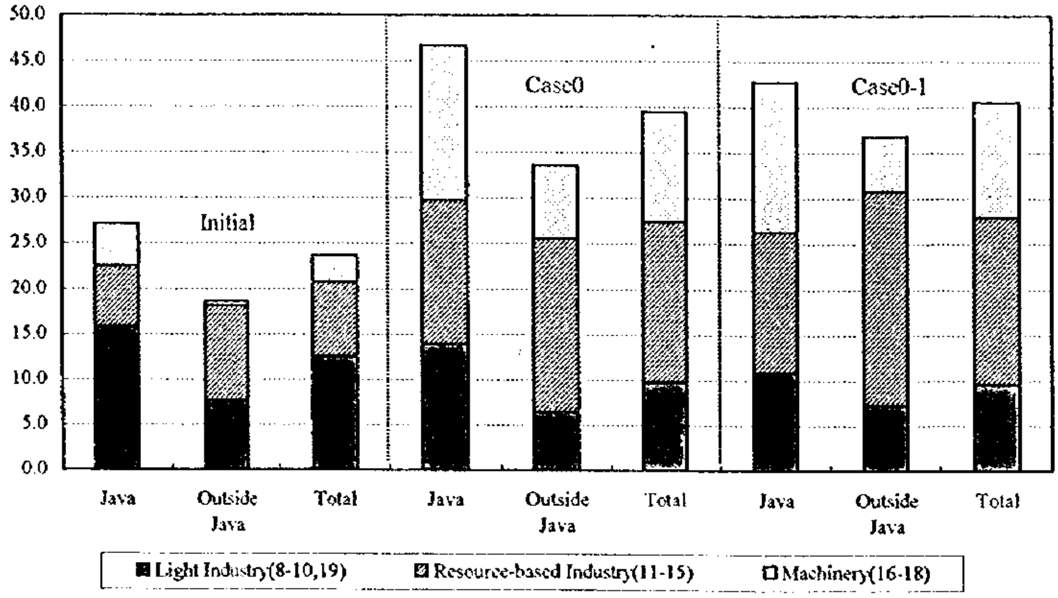
Source: JICA Study Team

Table 2-9 Sectoral Share of GDP at the End of Planning Period (Unit:%)

Sector (IO Code)	Initial			Case0			Case0-1		
	Java	Out Java	Total	Java	Out Java	Total	Java	Out Java	Total
Agriculture(1-5)	16.7	23.9	19.6	5.9	8.6	7.4	4.6	10.8	6.9
Mining(6-7)	2.4	21.9	10.3	0.9	12.9	7.5	1.0	14.6	6.0
Manufacturing(8-19)	27.1	18.6	23.7	46.6	33.6	39.5	42.8	36.8	40.6
Light Industry(8-10,19)	15.8	7.6	12.5	13.9	6.5	9.8	10.9	7.3	9.5
Resource-based Industry(11-15)	6.7	10.5	8.2	15.9	19.1	17.6	15.4	23.6	18.4
Machinery(16-18)	4.6	0.5	2.9	16.9	8.0	12.0	16.4	5.9	12.6
Electricity, Gas & Water(20)	1.5	0.5	1.1	2.4	0.7	1.4	2.0	0.8	1.6
Construction(21)	6.9	8.0	7.4	0.4	17.4	9.7	10.0	7.7	9.1
Services(22-27)	45.5	27.0	38.0	43.8	26.9	34.5	39.7	29.2	35.8
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: JICA Study Team

Figure 2-5 Manufacturing Share of GDP and its Components at the End of Planning Period



(3) Observation

The differences between case0 and case0-1 show the influences of the move of skilled labor force from Java to Outside Java or from Outside Java to Java. The average annual growth rate of GDP in PJPII period was 7.6% (Java), 10.2% (Outside Java) and 8.9% (Indonesia) when the skilled labor is mobile between regions. This is roughly comparable with the average annual growth rate of GDP in national IOPM. However with the limitation of the interregional labor movement, the growth rate of GDP in Java increased to 9.2%, but that of Outside Java decreased to 8.5% while the growth rate of GDP in Indonesia remained same. The fact that the growth rate of GDP is bigger (smaller) than the national average when the labor is (not) freely mobile implies: (i) the increase of interregional resource movement contributes to accelerate the development of the national economy; and (ii) Outside Java has a better potential capacity of development when capital, labor and foreign currency are freely mobile. In a word, the resource allocation is over-concentrated in Java region.