CHAPTER 7 ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 7 ECONOMIC AND FINANCIAL ANALYSIS

7.1 Premises of the Study

7.1.1 Benefit Considered

Six kinds of benefits, listed below, were considered in the economic and financial analysis.

(1) Benefits due to increase in POH number
(2) Benefits due to reduction in POH cycle time
(3) Savings in POH
(4) Savings in brake block production
(5) Savings in laminated spring production

Besides these benefits, such benefits as those mentioned below should also be given due regard.

(1) Savings in maintenance at depot
(2) Increased fare revenue
(3) Savings in external and internal space at the workshop
(4) Environmental improvement in the workshop
(5) Reduction in injuries due to accidents at the workshop
(6) Savings in user cost

However, it is very difficult to grasp these benefits quantitatively, and besides, there may be a fear of double counting of benefits. Therefore, the last six benefits are ignored in this study.

7.1.2 Financial Statements

In an ordinary financial study, several financial statements, such as the balance sheet, profit and loss statement, money flow, and so on, are required. But, in this study, these statements were not prepared, because it is difficult to assume a financially self-supporting system for the project. In the end, only the cash flow tables were prepared.

7.1.3 Evaluation Period

The evaluation period was assumed to be the 15 years after opening for use, because the time frame of 15 years coincides with the life span of the machinery which is the main constituent of the investment proposals.

The residual value at the end of the evaluation period was regarded as a portion of the benefits.

7.1.4 Equipment Lifetimes

The lifetimes are assumed to be as follows.

15 years for machinery
60 years for structures
36 years for the unit exchange spare parts for locomotives
25 years for the unit exchange spare parts for coaches
40 years for the unit exchange spare parts for wagons

7.1.5 Beginning of the Project

The construction begins from 1990.

7.1.6 Exchange Rate

The exchange rate used for project costs is as follows.

1.00 US$ = 12.87, Rs. = 146.10 Yen

Above rate (on June 24th, 1987) may be considered representative of the past half year.

7.1.7 Import Tax

For evaluation of machinery to be imported, an 85% import tax is applied considering the latest tax revision. An import tax is counted out in any economic analysis, and rightly so.

7.1.8 Conversion Factor

As for the Indian income tax, the minimum is 0% and the maximum is 50%. The average is generally believed to be 10%. Therefore, the conversion factor which converts financial value to economic value is determined to be 0.9.

7.2 Project Cost

The investment and the investment schedule are shown in Tables 7.2.1 - 7.2.4.

The normal amount includes a 10% engineering fee and a 5% contingency. Therefore, in sensitivity analysis, a further 10% contingency is added.

Incremental maintenance cost due to the project is shown in Table 7.2.5.

Table 7.2.1 Jamalpur Project Cost

(Millions of Rs.)

			Domestic Currency	Foreign Currency	Total
Equipment	POH	①	107.35	63.58	170.93
	Brake Blocks	②	27.39	70.16	97.55
	Laminated Springs	③	8.98	0	8.98
	Education	④	7.61	0.29	8.14
	Sub-Total ①+②+③+④	⑤	151.33	134.03	285.36
Import Tax F⑤x0.85		⑥	113.93	0	113.93
Others	Engineering Fee ⑤x0.1	⑦	15.13	13.4	28.53
	Spare Parts	⑧	33.25	0	33.25
	Education Cost in Abroad	⑨	0	2.1	2.1
	Sub-Total ⑦+⑧+⑨	⑩	48.38	15.5	63.88
Contingency (⑤+⑩) x 0.05		⑪	9.99	7.48	17.47
Grand Total ⑤+⑥+⑩+⑪		⑫	323.63	157.01	480.64

Table 7.2.2 Perambur Project Cost (Phase I)

(Millions of Rs.)

			Domestic Currency	Foreign Currency	Total
Equipment	POH	①	253.85	89.2	343.05
	Brake Blocks	②	0	0	0
	Laminated Springs	③	0	0	0
	Education	④	5.35	0.26	5.61
	Sub-Total ①+②+③+④	⑤	259.20	89.46	348.66
Import Tax F⑤x0.85		⑥	76.04	0	76.04
Others	Engineering Fee ⑤x0.1	⑦	25.92	8.95	34.87
	Spare Parts	⑧	8.3	0	8.3
	Education Cost in Abroad	⑨	0	0.79	0.79
	Sub-Total ⑦+⑧+⑨	⑩	34.22	9.74	43.96
Contingency (⑤+⑩) x 0.05		⑪	14.67	4.96	19.63
Grand Total ⑤+⑥+⑩+⑪		⑫	384.13	104.16	488.29

Table 7.2.3 Perambur Project Cost (Phase II)

(Millions of Rs.)

			Domestic Currency	Foreign Currency	Total
Equipment	POH	①	79.50	27.95	107.45
	Brake Blocks	②	0	0	0
	Laminated Springs	③	0	0	0
	Education	④	0	0	0
	Sub-Total ①+②+③+④	⑤	79.50	27.95	107.45
Import Tax F⑤x0.85		⑥	23.76	0	23.76
Others	Engineering Fee ⑤x0.1	⑦	7.95	2.8	10.75
	Spare Parts	⑧	1.94	0	1.94
	Education Cost in Abroad	⑨	0	0.79	0.79
	Sub-Total ⑦+⑧+⑨	⑩	9.89	3.59	13.48
Contingency (⑤+⑩) x 0.05		⑪	4.47	1.58	6.05
Grand Total ⑤+⑥+⑩+⑪		⑫	117.62	33.12	150.74

Table 7.2.4 Perambur Total Project Cost

(Millions of Rs.)

			Domestic Currency	Foreign Currency	Total
Equipment	POH	①	333.35	117.15	450.50
	Brake Blocks	②	0	0	0
	Laminated Springs	③	0	0	0
	Education	④	5.35	0.26	5.61
	Sub-Total ①+②+③+④	⑤	338.7	117.41	456.11
Import Tax F⑤x0.85		⑥	99.8	0	99.8
Others	Engineering Fee ⑤x0.1	⑦	33.87	11.74	45.61
	Spare Parts	⑧	10.24	0	10.24
	Education Cost in Abroad	⑨	0	1.58	1.58
	Sub-Total ⑦+⑧+⑨	⑩	44.11	13.33	57.44
Contingency (⑤+⑩) x 0.05		⑪	19.14	6.54	25.68
Grand Total ⑤+⑥+⑩+⑪		⑫	501.75	137.28	639.03

Table 7.2.5 Incremental Maintenance Cost

Year	Jamalpur Project	Perambur Project
1990	0	0
91	0	0
92	0.18	0
93	1.93	4.60
94	1.93	4.60
95	4.43	5.03
96		5.47
97		5.90
98		5.90
99		
2000		
1		
2		
3		
4		
5		
6		
2007	4.43	5.90

7.3 Benefits of the Project

7.3.1 Benefits due to the POH Project

Both Model A (the Indian model) and Model B (the Japanese model) were used to estimate the benefits.

(1) Model A

To estimate the benefits of the POH workshop modernisation project, the Indian Railways developed the following model.

$$B1 = (T - TW) \cdot CPW \cdot \frac{1}{365} \cdot X \quad \text{..... (7.3.1.1)}$$

$$B2 = (\frac{X}{Z} - \frac{X}{L}) \cdot (CPW - CP) \cdot D - CW \cdot (CPW - CP) \quad \text{..... (7.3.1.2)}$$

B1 : one-time saving due to a reduction in POH cycle time (millions of Rs.)

B2 : recurring savings due to additional POH capacity (millions of Rs./year)

T : POH cycle time "without" (days/POH)

TW : POH cycle time "with" (days/POH)

CP : annual POH capacity "without" (vehicles/year)

CPW: annual POH capacity "with" (vehicles/year)

X : cost of a new vehicle (millions of Rs./vehicle)

Z : Lifetime of a new asset "without" POH (years)

L : Lifetime of a new asset "with" POH (years)

D : POH time interval (years)

CW : cost per POH "with" (millions of Rs./POH)

(Refer to Table 7.3.2 - Table 7.3.4)

In equation (7.3.1.1), "(T-TW)•CPW" means the incremental vehicle-days worked due to POH cycle time reduction. Then it is divided by 365 and is converted to incremental vehicle-years worked. In other words, equation (7.3.1.1) estimates the number of new vehicles that is equivalent to the reduction in POH cycle time.

In the equation (7.3.1.2), "$(\frac{X}{Z} - \frac{X}{L})$" means the savings in depreciation cost. These savings will last for the full POH interval D.

(2) Model B

The Japanese Study Team developed the following model.

$$BCIy = \left\{ X \cdot \frac{R \cdot (1+R)^{L}}{(1+R)^{L}-1} \right\} \cdot \left\{ \sum_{t=0}^{D-1} (1+DR)^{-t} \right\} \cdot (QWy-Qy) \quad \ldots\ldots\ldots (7.3.1.3)$$

$$BCTy = (T-TW) \cdot \frac{Qy}{365} \cdot \left\{ X \cdot \frac{R \cdot (1+R)^{L}}{(1+R)^{L}-1} \right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.3.1.4)$$

$$BCRy = Qy \cdot C - QWy \cdot CW \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.3.1.5)$$

BCIy: benefits due to POH increase in year y (millions of Rs./year)

BCTy: benefits due to reduction in POH cycle time (millions of Rs./year)

BCRy: benefits due to reduction in POH cost (millions of Rs./year)

X : cost of a new vehicle (millions of Rs./vehicle)

L : lifetime of a new vehicle (years)

R : standard interest rate or general market interest rate (R=0.06)

D : POH time interval (years)

Qy : number of POH in year y "without"

QWy : number of POH in year y "with" (vehicles/year)

DR : discount rate

T : POH cycle time "without" (days/POH)

TW : POH cycle time "with" (days/POH)

C : POH cost "without" (millions of Rs./POH)

CW : POH cost "with" (millions of Rs./POH)

(Refer to Table 7.3.2 - Table 7.3.4)

1) The Benefits due to the increased number of POH

If a piece of rolling stock, at the expiration of its POH interval, cannot be overhauled due to lack of POH capacity, its operation has to be suspended. In this case, equation (7.3.1.3) assumes that a new substitute will be leased from somewhere.

In equation (7.3.1.3), $X \cdot \left\{ \frac{R \cdot (1+R)^{L}}{(1+R)^{L}-1} \right\}$ means the standard rental fee in such a case. This rental fee is made up for by an increase in POH capacity, and the savings last for the POH interval D.

The total amount of savings may be expressed as follows,

$$\left\{X \cdot \frac{R \cdot (1+R)^{L}}{(1+R)^{L}-1}\right\} \cdot D$$

and the present value of the above amount accumulated up to the POH year is

$$\left\{X \cdot \frac{R \cdot (1+R)^{L}}{(1+R)^{L}-1}\right\} \cdot \left\{\sum_{t=0}^{D-1} (1+DR)^{-t}\right\}$$

2) The benefits due to a reduction in POH cycle time
In equation (7.3.1.4), (T-TW)·Qy means the incremental vehicle-days worked due to POH cycle time reduction. The incremental vehicle-days cannot be expressed by (T-TW)·QWy, because it is impossible to calculate (T-TW) as for the incremental POH portion (QWy-Qy). $(T-TW) \cdot \frac{Qy}{365}$ means the incremental vehicle-years worked, which is multiplied by the rental fee.

3) The benefits due to the savings in POH cost
Equation (7.3.1.5) estimates the savings in POH cost. Usually QWy is larger than Qy, and BCRy may be negative in some cases. The negative BCRy may be considered a part of the project cost.

(3) Input Data and Output Result
The data for benefit estimation is shown in Tables 7.3.1 - 7.3.4
The result of estimating benefits is shown in Table 7.4.2 - 7.4.17.

Table 7.3.1 Input Data

Input Data / Project	Construction period (years)	Evaluation period (years)	First years of construction
Jamalpur	5	15	1990
Parambur	7	15	1990
Laminated springs	2	15	1990
Brake Blocks	3	15	1990

Table 7.3.2 Input Data for Jamalpur

Item			Jamalpur
WDM	POH cycle time (days)	without with	31 19.8
	Cost per POH (millions of Rs.)	without with	0.7 0.665
	POH capacity (vehicles/year)	without with	48 103
	POH interval (years) Price of a new asset (millions of Rs./vehicle) Lifetime with POH (years) Average age (years) Lifetime without POH (years)		6 12 36 12.5 12
WDS	POH cycle time (days)	without with	31 19.8
	Cost per POH (millions of Rs.)	without with	0.4 0.38
	POH capacity (vehicles/year)	without with	24 30
	POH interval (years) Price of a new asset (millions of Rs./vehicle) Lifetime with POH (years) Average age (years) Lifetime without POH (years)		5 6.5 36 12.5 12

Table 7.3.3 Input Data for Perambur

Item			Perambur
Coach	POH cycle time (days)	without with	17.6 13.8 (14.8)
	Cost per POH (millions of Rs.)	without with	0.06 0.055
	POH capacity (vehicles/year)	without with	2000 3000 (2450)
	POH interval (years) Price of a new asset (millions of Rs./vehicle) Lifetime with POH (years) Average age (years) Lifetime without POH (years)		1.4 1.5 25 18.3 6
Bogie wagon	POH cycle time (days)	without with	5.1 4.9
	Cost per POH (millions of Rs.)	without with	0.03 0.027
	POH capacity (vehicles/year)	without with	990 1920
	POH interval (years) Price of a new asset (millions of Rs./vehicle) Lifetime with POH (years) Average age (years) Lifetime without POH (years)		3.5 0.55 40 14.7 10
4-wheeler wagon	POH cycle time (days)	without with	9.2 6.5
	Cost per POH (millions of Rs.)	without with	0.015 0.013
	POH capacity (vehicles/year)	without with	3380 1600
	POH interval (years) Price of a new asset (millions of Rs./vehicle) Lifetime with POH (years) Average age (years) Lifetime without POH (years)		3.5 0.22 40 18.3 10

Note: Figures in Parentheses are the result of phase I.

Table 7.3.4 Estimated No. of POH

Year	Without project					With project				
	Jamalpur		Perambur			Jamalpur		Perambur		
	WDM	WDS	Coach	Bogie wagon	4-wheeler wagon	WDM	WDS	Coach	Bogie wagon	4-wheeler wagon
1990	48	24	2000	990	2876	48	24	2000	990	2876
91					2749	48	24	2000	990	2749
92					2621	48	24	2000	990	2621
93					2493	48	24	2235	1459	2493
94					2366	48	24	2344	1524	2366
95					2238	80	28	2450	1590	2238
96					2111	85	28	2450	1656	2111
97					1983	89	29	2672	1722	1983
98					1855	94	29	2781	1788	1855
99					1728	98	30	2871	1857	1728
2000					1600	103	30	3000	1920	1600
1										
2										
3										
4										
5										
6										
7	48	24	2000	990	1600	103	30	3000	1920	1600

7.3.2 Benefits due to Brake Blocks Project

Annual cost savings due to the project are as follows (Rs.).

		Savings per tonne
1	Direct personnel cost :	436
2	Indirect personnel cost:	742
3	Direct material cost :	118
4	Indirect material cost :	-671
	Total Savings per ton :	624

Total annual savings in brake blocks production cost
= 624 Rs. x 16,000 tonnes = 9,985,920 Rs.

7.3.3 Benefits due to Laminated Spring Project

Annual cost savings due to the project are as follows (thousands of Rs.).

1	Savings in personnel cost	:	2214
2	Savings in power cost	:	441
3	Savings on repairs	:	-82
4	Savings on depreciation	:	-595
5	Savings in other costs	:	-263
	Total Savings	:	1715

7.4 Result of Analysis

7.4.1 Financial Analysis

The result of financial analysis is shown in Table 7.4.1, Table 7.4.2 - Table 7.4.5 and Tables 7.4.10 - 7.4.13.

In financial analysis, the cost in foreign currency includes an 85% import tax, and all the costs and benefits bear so-called transfer portion, for example, income tax.

85% import tax suppresses the rate of return considerably. Neverthless, even in the worst case, the internal rate of return shows 12%, and this fact assures a bright future for the projects.

7.4.2 Economic Analysis

The result of the economic analysis is shown in Table 7.4.1, Tables 7.4.6 - 7.4.9 and Tables 7.4.14 - 7.4.17.

In the economic analysis, the cost does not include the 85% import tax. Furthermore, the so-called transfer portion is excluded from all the costs and benefits by a converstion factor (0.9).

By eliminating the 85% import tax, the internal rate of return increases considerably compared with the financial analysis.

Usually, the benefits in economic analysis mean social benefits. That is to say, the total of supplier (the IR) benefits and user (passenger and freight shipper) benefit. But in this study, the "without project" case assumes the vehicle shortage will be made up by the purchase or lease of new cars. Therefore, the "with project" case gives no benefits to users. Only the supplier, the Indian Railways, receives benefits due to savings in purchase costs or rental fee for new vehicles.

Therefore, in the economic analysis, only supplier benefits are taken into consideration.

7.5 Project Evaluation

The real interest rate in India is assumed to be about 12% annually, and the dividend rate which the IR pays to the government 6%. Therefore, each of the two projects may be feasible from both the economic and the financial standpoints.

7.6 Sensitivity Analysis

The sensitivity analysis evaluates the projects from a conservative view-point. In this study, 10% increase in costs and a 10% decrease in benefits are assumed. The normal cost includes a 5% contingency originally. Therefore, a total 15% contingency is assumed in the cost. Even in the worst case, this contingency may be enough to assure the feasibility of the projects.

Talbe 7.4.1 Internal Rate of Return

			Jamalpur Project (5)	Parambur Project
Model A (1)	Financial IRR	Normal (3)	0.25	0.27
		Sensitivity Analysis (4)	0.21	0.23
	Economic IRR (6)	Normal (3)	0.29	0.30
		Sensitivity Analysis (4)	0.25	0.25
Model B (2)	Financial IRR	Normal (3)	0.17	0.16
		Sensitivity Analysis (4)	0.15	0.12
	Economic IRR (6)	Normal (3)	0.21	0.18
		Sensitivity Analysis (4)	0.18	0.15

Note: (1) Indian Model
(2) Japanese Model
(3) Including 10% engineering fee and 5% contingency
(4) 10% increase in cost and 10% reduction in benefits compared with "normal"
(5) POH + Springs + Brake Blocks
(6) In economic analysis, import tax is deducted from project cost and all value is converted to economic value by conversion factor

Table 7.4.2 Perambur Project Financial Cash Flow by Model A (Base Case)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	ONE TIME SAVING	RECURRING SAVING	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	165.94	0.00	165.94	165.94	0.00	0.00	0.00	0.00	-165.94
1991	160.33	0.00	160.33	126.53	0.00	0.00	0.00	0.00	-292.47
1992	160.33	0.00	160.33	99.85	0.00	0.00	0.00	0.00	-392.32
1993	0.00	4.60	4.60	2.26	0.00	0.00	0.00	0.00	-394.58
1994	50.75	4.60	55.35	21.47	50.03	240.50	290.54	112.67	-303.37
1995	50.75	5.03	55.79	17.07	0.00	240.50	240.50	73.60	-246.84
1996	50.75	5.47	56.22	13.58	0.00	240.50	240.50	58.08	-202.33
1997	0.00	5.90	5.90	1.12	0.00	240.50	240.50	45.84	-157.62
1998	0.00	5.90	5.90	0.89	0.00	240.50	240.50	36.17	-122.34
1999	0.00	5.90	5.90	0.70	0.00	240.50	240.50	28.54	-94.50
2000	0.00	5.90	5.90	0.55	0.00	240.50	240.50	22.53	-72.52
2001	0.00	5.90	5.90	0.44	0.00	240.50	240.50	17.78	-55.18
2002	0.00	5.90	5.90	0.34	0.00	240.50	240.50	14.03	-41.50
2003	0.00	5.90	5.90	0.27	0.00	240.50	240.50	11.07	-30.70
2004	0.00	5.90	5.90	0.21	0.00	240.50	240.50	8.74	-22.18
2005	0.00	5.90	5.90	0.17	0.00	240.50	240.50	6.89	-15.46
2006	0.00	5.90	5.90	0.13	0.00	240.50	240.50	5.44	-10.15
2007	-365.92	5.90	-360.02	-6.43	-14.87	240.50	225.64	4.03	0.30
TOTAL				445.10				445.41	

COST BENEFIT RATIO= 1.00069. FIRR= .2672

Table 7.4.3 Perambur Project Financial Cash Flow by Model A (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	ONE TIME SAVING	RECURRING SAVING	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	182.54	0.00	182.54	182.54	0.00	0.00	0.00	0.00	-182.54
1991	176.37	0.00	176.37	143.84	0.00	0.00	0.00	0.00	-326.38
1992	176.37	0.00	176.37	117.32	0.00	0.00	0.00	0.00	-443.70
1993	0.00	5.06	5.06	2.75	0.00	0.00	0.00	0.00	-446.45
1994	55.83	5.06	60.89	26.94	45.03	216.45	261.48	115.70	-357.69
1995	55.83	5.54	61.37	22.15	0.00	216.45	216.45	78.12	-301.72
1996	55.83	6.01	61.84	18.20	0.00	216.45	216.45	63.71	-256.21
1997	0.00	6.49	6.49	1.56	0.00	216.45	216.45	51.96	-205.81
1998	0.00	6.49	6.49	1.27	0.00	216.45	216.45	42.38	-164.70
1999	0.00	6.49	6.49	1.04	0.00	216.45	216.45	34.56	-131.17
2000	0.00	6.49	6.49	0.85	0.00	216.45	216.45	28.19	-103.82
2001	0.00	6.49	6.49	0.69	0.00	216.45	216.45	22.99	-81.52
2002	0.00	6.49	6.49	0.56	0.00	216.45	216.45	18.75	-63.33
2003	0.00	6.49	6.49	0.46	0.00	216.45	216.45	15.29	-48.49
2004	0.00	6.49	6.49	0.37	0.00	216.45	216.45	12.47	-36.39
2005	0.00	6.49	6.49	0.31	0.00	216.45	216.45	10.17	-26.52
2006	0.00	6.49	6.49	0.25	0.00	216.45	216.45	8.30	-18.48
2007	-402.51	6.49	-396.02	-12.38	-13.38	216.45	203.07	6.35	0.25
TOTAL				508.70				508.96	

COST BENEFIT RATIO= 1.0005 FIRR= .2261

Table 7.4.4 Perambur Project Financial Cash Flow by Model B (Base Case)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT DUE TO POH CAPACITY	BENEFIT DUE TO POH CYCLE TIME	BENEFIT DUE TO POH COST	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	165.94	0.00	165.94	165.94	0.00	0.00	0.00	0.00	0.00	-165.94
1991	160.33	0.00	160.33	138.45	0.00	0.00	0.00	0.00	0.00	-304.39
1992	160.33	0.00	160.33	119.55	0.00	0.00	0.00	0.00	0.00	-423.93
1993	0.00	4.60	4.60	2.96	77.17	2.90	-7.63	72.44	46.64	-380.26
1994	50.75	4.60	55.35	30.77	97.38	2.89	-15.64	84.63	47.05	-363.98
1995	50.75	5.03	55.79	26.78	117.32	2.87	-23.50	96.69	46.41	-344.35
1996	50.75	5.47	56.22	23.30	124.06	2.86	-25.54	101.38	42.02	-325.63
1997	0.00	5.90	5.90	2.11	158.45	2.84	-39.79	121.50	43.49	-284.25
1998	0.00	5.90	5.90	1.82	178.76	2.83	-47.82	133.77	41.34	-244.74
1999	0.00	5.90	5.90	1.57	199.20	2.81	-55.91	146.11	38.99	-207.32
2000	0.00	5.90	5.90	1.36	219.52	2.80	-63.94	158.37	36.49	-172.19
2001	0.00	5.90	5.90	1.17	219.52	2.80	-63.94	158.37	31.51	-141.85
2002	0.00	5.90	5.90	1.01	219.52	2.80	-63.94	158.37	27.21	-115.65
2003	0.00	5.90	5.90	0.88	219.52	2.80	-63.94	158.37	23.50	-93.03
2004	0.00	5.90	5.90	0.76	219.52	2.80	-63.94	158.37	20.29	-73.50
2005	0.00	5.90	5.90	0.65	219.52	2.80	-63.94	158.37	17.52	-56.63
2006	0.00	5.90	5.90	0.56	219.52	2.80	-63.94	158.37	15.13	-42.07
2007	-365.92	5.90	-360.02	-29.69	219.52	2.80	-63.94	158.37	13.06	0.69
TOTAL				489.96					490.65	

COST BENEFIT RATIO= 1.0014 FIRR= .1581

Table 7.4.5 Perambur Project Financial Cash Flow by Model B (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT DUE TO POH CAPACITY	BENEFIT DUE TO POH CYCLE TIME	BENEFIT DUE TO POH COST	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	182.54	0.00	182.54	182.54	0.00	0.00	0.00	0.00	0.00	-182.54
1991	176.37	0.00	176.37	157.30	0.00	0.00	0.00	0.00	0.00	-339.84
1992	176.37	0.00	176.37	140.30	0.00	0.00	0.00	0.00	0.00	-480.14
1993	0.00	5.06	5.06	3.59	70.74	2.61	-9.39	63.96	45.38	-438.35
1994	55.83	5.06	60.89	38.53	89.11	2.60	-18.15	73.57	46.55	-430.32
1995	55.83	5.54	61.37	34.63	107.24	2.59	-26.75	83.08	46.89	-418.07
1996	55.83	6.01	61.84	31.13	113.49	2.57	-28.94	87.13	43.86	-405.34
1997	0.00	6.49	6.49	2.91	144.62	2.56	-44.56	102.62	46.07	-362.18
1998	0.00	6.49	6.49	2.60	163.09	2.55	-53.35	112.29	44.96	-319.81
1999	0.00	6.49	6.49	2.32	181.66	2.53	-62.19	122.01	43.58	-278.56
2000	0.00	6.49	6.49	2.07	200.13	2.52	-70.97	131.67	41.94	-238.68
2001	0.00	6.49	6.49	1.84	200.13	2.52	-70.97	131.67	37.41	-203.11
2002	0.00	6.49	6.49	1.64	200.13	2.52	-70.97	131.67	33.37	-171.39
2003	0.00	6.49	6.49	1.47	200.13	2.52	-70.97	131.67	29.76	-143.10
2004	0.00	6.49	6.49	1.31	200.13	2.52	-70.97	131.67	26.54	-117.86
2005	0.00	6.49	6.49	1.17	200.13	2.52	-70.97	131.67	23.67	-95.36
2006	0.00	6.49	6.49	1.04	200.13	2.52	-70.97	131.67	21.11	-75.28
2007	-402.51	6.49	-396.02	-56.64	200.13	2.52	-70.97	131.67	18.83	0.19
TOTAL				549.75					549.94	

COST BENEFIT RATIO= 1.00034 FIRR= .1212

Table 7.4.6 Perambur Project Economic Cash Flow by Model A (Base Case)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	129.50	0.00	129.50	129.50	0.00	0.00	0.00	0.00	-129.50
1991	124.50	0.00	124.50	95.92	0.00	0.00	0.00	0.00	-225.42
1992	124.50	0.00	124.50	73.91	0.00	0.00	0.00	0.00	-299.33
1993	0.00	4.10	4.10	1.88	0.00	0.00	0.00	0.00	-301.21
1994	39.50	4.50	44.00	15.51	261.00	0.00	261.00	91.98	-224.74
1995	39.50	4.90	44.40	12.06	216.00	0.00	216.00	58.65	-178.14
1996	39.50	5.30	44.80	9.37	216.00	0.00	216.00	45.19	-142.33
1997	0.00	5.30	5.30	0.85	216.00	0.00	216.00	34.81	-108.37
1998	0.00	5.30	5.30	0.66	216.00	0.00	216.00	26.82	-82.20
1999	0.00	5.30	5.30	0.51	216.00	0.00	216.00	20.67	-62.04
2000	0.00	5.30	5.30	0.39	216.00	0.00	216.00	15.92	-46.51
2001	0.00	5.30	5.30	0.30	216.00	0.00	216.00	12.27	-34.54
2002	0.00	5.30	5.30	0.23	216.00	0.00	216.00	9.45	-25.32
2003	0.00	5.30	5.30	0.18	216.00	0.00	216.00	7.28	-18.22
2004	0.00	5.30	5.30	0.14	216.00	0.00	216.00	5.61	-12.74
2005	0.00	5.30	5.30	0.11	216.00	0.00	216.00	4.32	-8.53
2006	0.00	5.30	5.30	0.08	216.00	0.00	216.00	3.33	-5.28
2007	-284.61	5.30	-279.31	-3.32	203.00	0.00	203.00	2.41	0.45
TOTAL				338.27				338.72	

COST BENEFIT RATIO= 1.00134 EIRR= .2979

Table 7.4.7 Perambur Project Economic Cash Flow by Model A (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	142.45	0.00	142.45	142.45	0.00	0.00	0.00	0.00	-142.45
1991	136.95	0.00	136.95	109.25	0.00	0.00	0.00	0.00	-251.70
1992	136.95	0.00	136.95	87.16	0.00	0.00	0.00	0.00	-338.86
1993	0.00	4.51	4.51	2.29	0.00	0.00	0.00	0.00	-341.15
1994	43.45	4.95	48.40	19.60	234.90	0.00	234.90	95.14	-265.61
1995	43.45	5.39	48.84	15.78	194.40	0.00	194.40	62.82	-218.58
1996	43.45	5.83	49.28	12.70	194.40	0.00	194.40	50.11	-181.17
1997	0.00	5.83	5.83	1.20	194.40	0.00	194.40	39.98	-142.39
1998	0.00	5.83	5.83	0.96	194.40	0.00	194.40	31.89	-111.45
1999	0.00	5.83	5.83	0.76	194.40	0.00	194.40	25.44	-86.77
2000	0.00	5.83	5.83	0.61	194.40	0.00	194.40	20.30	-67.08
2001	0.00	5.83	5.83	0.49	194.40	0.00	194.40	16.19	-51.37
2002	0.00	5.83	5.83	0.39	194.40	0.00	194.40	12.92	-38.84
2003	0.00	5.83	5.83	0.31	194.40	0.00	194.40	10.31	-28.85
2004	0.00	5.83	5.83	0.25	194.40	0.00	194.40	8.22	-20.87
2005	0.00	5.83	5.83	0.20	194.40	0.00	194.40	6.56	-14.51
2006	0.00	5.83	5.83	0.16	194.40	0.00	194.40	5.23	-9.43
2007	-313.07	5.83	-307.24	-6.60	182.70	0.00	182.70	3.92	1.09
TOTAL				387.96				389.04	

COST BENEFIT RATIO= 1.0028 EIRR= .2535

Table 7.4.8 Perambur Project Economic Cash Flow by Model B (Base Case)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	129.50	0.00	129.50	129.50	0.00	0.00	0.00	0.00	-129.50
1991	124.50	0.00	124.50	105.53	0.00	0.00	0.00	0.00	-235.03
1992	124.50	0.00	124.50	89.44	0.00	0.00	0.00	0.00	-324.47
1993	0.00	4.10	4.10	2.50	65.00	0.00	65.00	39.58	-287.39
1994	39.50	4.50	44.00	22.71	76.00	0.00	76.00	39.23	-270.87
1995	39.50	4.90	44.40	19.42	87.00	0.00	87.00	38.06	-252.23
1996	39.50	5.30	44.80	16.61	91.00	0.00	91.00	33.74	-235.10
1997	0.00	5.30	5.30	1.67	109.00	0.00	109.00	34.26	-202.51
1998	0.00	5.30	5.30	1.41	120.00	0.00	120.00	31.97	-171.95
1999	0.00	5.30	5.30	1.20	132.00	0.00	132.00	29.81	-143.34
2000	0.00	5.30	5.30	1.01	143.00	0.00	143.00	27.37	-116.99
2001	0.00	5.30	5.30	0.86	143.00	0.00	143.00	23.20	-94.65
2002	0.00	5.30	5.30	0.73	143.00	0.00	143.00	19.66	-75.72
2003	0.00	5.30	5.30	0.62	143.00	0.00	143.00	16.67	-59.67
2004	0.00	5.30	5.30	0.52	143.00	0.00	143.00	14.13	-46.07
2005	0.00	5.30	5.30	0.44	143.00	0.00	143.00	11.97	-34.54
2006	0.00	5.30	5.30	0.38	143.00	0.00	143.00	10.15	-24.77
2007	-284.61	5.30	-279.31	-16.80	143.00	0.00	143.00	8.60	0.64
TOTAL				377.75				378.39	

COST BENEFIT RATIO= 1.00169 EIRR= .1798

Table 7.4.9 Perambur Project Economic Cash Flow by Model B (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	INVEST-MENT AMOUNT	MAINTE-NANCE COST	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	142.45	0.00	142.45	142.45	0.00	0.00	0.00	0.00	-142.45
1991	136.95	0.00	136.95	119.23	0.00	0.00	0.00	0.00	-261.68
1992	136.95	0.00	136.95	103.81	0.00	0.00	0.00	0.00	-365.49
1993	0.00	4.51	4.51	2.98	58.50	0.00	58.50	38.61	-329.86
1994	43.45	4.95	48.40	27.81	68.40	0.00	68.40	39.30	-318.37
1995	43.45	5.39	48.84	24.43	78.30	0.00	78.30	39.17	-303.63
1996	43.45	5.83	49.28	21.46	81.90	0.00	81.90	35.67	-289.43
1997	0.00	5.83	5.83	2.21	98.10	0.00	98.10	37.20	-254.44
1998	0.00	5.83	5.83	1.92	108.00	0.00	108.00	35.65	-220.72
1999	0.00	5.83	5.83	1.68	118.80	0.00	118.80	34.14	-188.25
2000	0.00	5.83	5.83	1.46	128.70	0.00	128.70	32.20	-157.50
2001	0.00	5.83	5.83	1.27	128.70	0.00	128.70	28.04	-130.74
2002	0.00	5.83	5.83	1.11	128.70	0.00	128.70	24.41	-107.43
2003	0.00	5.83	5.83	0.96	128.70	0.00	128.70	21.25	-87.15
2004	0.00	5.83	5.83	0.84	128.70	0.00	128.70	18.50	-69.48
2005	0.00	5.83	5.83	0.73	128.70	0.00	128.70	16.11	-54.10
2006	0.00	5.83	5.83	0.64	128.70	0.00	128.70	14.02	-40.71
2007	-313.07	5.83	-307.24	-29.15	128.70	0.00	128.70	12.21	0.64
TOTAL				425.83				426.47	

COST BENEFIT RATIO= 1.00151 EIRR= .1486

Table 7.4.10 Consolidated Financial Cash Flow for Total Jamalpur Project by Model A (Base case)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR SPRING	PROJECT COST FOR B.BLOCK	TOTAL PROJECT COST	TOTAL PROJECT COST IN PRESENT VALUE	BENEFIT FROM POH	BENEFIT FROM SPRING	BENEFIT FROM B.BLOCK	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	67.56	5.19	57.43	130.17	130.17	0.00	0.00	0.00	0.00	0.00	-130.17
1991	57.71	5.19	57.43	120.32	96.47	0.00	0.86	3.33	4.19	3.36	-223.28
1992	57.71	0.18	57.43	115.32	74.12	0.00	1.72	6.66	8.37	5.38	-292.02
1993	57.71	0.18	1.75	59.64	30.73	0.00	1.72	9.99	11.70	6.03	-316.73
1994	57.71	0.18	1.75	59.64	24.64	0.00	1.72	9.99	11.70	4.83	-336.53
1995	2.50	0.18	1.75	4.43	1.47	234.00	1.72	9.99	245.70	81.39	-256.61
1996	2.50	0.18	1.75	4.43	1.18	192.00	1.72	9.99	203.70	54.10	-203.69
1997	2.50	0.18	1.75	4.43	0.94	192.00	1.72	9.99	203.70	43.37	-161.27
1998	2.50	0.18	1.75	4.43	0.76	192.00	1.72	9.99	203.70	34.77	-127.25
1999	2.50	0.18	1.75	4.43	0.61	192.00	1.72	9.99	203.70	27.68	-99.98
2000	2.50	0.18	1.75	4.43	0.49	192.00	1.72	9.99	203.70	22.35	-78.11
2001	2.50	0.18	1.75	4.43	0.39	192.00	1.72	9.99	203.70	17.92	-60.58
2002	2.50	0.18	1.75	4.43	0.31	192.00	1.72	9.99	203.70	14.37	-46.53
2003	2.50	0.18	1.75	4.43	0.25	192.00	1.72	9.99	203.70	11.52	-35.26
2004	2.50	0.18	1.75	4.43	0.20	192.00	1.72	9.99	203.70	9.23	-26.23
2005	2.50	0.18	1.75	4.43	0.16	192.00	1.72	9.99	203.70	7.40	-18.99
2006	2.50	0.18	1.75	4.43	0.13	192.00	1.72	9.99	203.70	5.94	-13.18
2007	2.50	0.18	1.75	4.43	0.10	192.00	1.72	9.99	203.70	4.76	-8.53
2008	2.50	0.18	1.75	4.43	0.08	192.00	1.72	9.99	203.70	3.82	-4.79
2009	-118.74	-3.19	-32.71	-154.63	-2.32	167.00	1.72	9.99	178.70	2.68	0.21
TOTAL					360.86					361.09	

COST BENEFIT RATIO= 1.00059 FIRR= .2473

Table 7.4.11 Consolidated Financial Cash Flow for Total Jamalpur Project by Model A (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR SPRING	PROJECT COST FOR B.BLOCK	TOTAL PROJECT COST	TOTAL PROJECT COST IN PRESENT VALUE	BENEFIT FROM POH	BENEFIT FROM SPRING	BENEFIT FROM B.BLOCK	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	74.32	5.70	63.17	143.19	143.19	0.00	0.00	0.00	0.00	0.00	-143.19
1991	63.48	5.70	63.17	132.35	109.22	0.00	0.77	3.00	3.77	3.11	-249.30
1992	63.48	0.20	63.17	126.85	86.38	0.00	1.54	5.99	7.53	5.13	-330.55
1993	63.48	0.20	1.93	65.60	36.87	0.00	1.54	8.99	10.53	5.92	-361.50
1994	63.48	0.20	1.93	65.60	30.42	0.00	1.54	8.99	10.53	4.88	-387.04
1995	2.75	0.20	1.93	4.87	1.86	210.60	1.54	8.99	221.13	84.62	-304.28
1996	2.75	0.20	1.93	4.87	1.54	172.80	1.54	8.99	183.33	57.90	-247.92
1997	2.75	0.20	1.93	4.87	1.27	172.80	1.54	8.99	183.33	47.78	-201.41
1998	2.75	0.20	1.93	4.87	1.05	172.80	1.54	8.99	183.33	39.43	-163.04
1999	2.75	0.20	1.93	4.87	0.86	172.80	1.54	8.99	183.33	32.54	-131.37
2000	2.75	0.20	1.93	4.87	0.71	172.80	1.54	8.99	183.33	26.85	-105.23
2001	2.75	0.20	1.93	4.87	0.59	172.80	1.54	8.99	183.33	22.16	-83.66
2002	2.75	0.20	1.93	4.87	0.49	172.80	1.54	8.99	183.33	18.28	-65.86
2003	2.75	0.20	1.93	4.87	0.40	172.80	1.54	8.99	183.33	15.09	-51.18
2004	2.75	0.20	1.93	4.87	0.33	172.80	1.54	8.99	183.33	12.45	-39.06
2005	2.75	0.20	1.93	4.87	0.27	172.80	1.54	8.99	183.33	10.27	-29.06
2006	2.75	0.20	1.93	4.87	0.23	172.80	1.54	8.99	183.33	8.48	-20.80
2007	2.75	0.20	1.93	4.87	0.19	172.80	1.54	8.99	183.33	7.00	-13.99
2008	2.75	0.20	1.93	4.87	0.15	172.80	1.54	8.99	183.33	5.77	-8.37
2009	-130.61	-3.51	-35.98	-170.10	-4.42	150.30	1.54	8.99	160.83	4.18	0.23
TOTAL					411.60					411.83	

COST BENEFIT RATIO= 1.00056 FIRR= .2118

Table 7.4.12 Consolidated Financial Cash Flow for Total Jamalpur Project by Model B (Base case)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR SPRING	PROJECT COST FOR B.BLOCK	TOTAL PROJECT COST	TOTAL PROJECT COST IN PRESENT VALUE	BENEFIT FROM POH	BENEFIT FROM SPRING	BENEFIT FROM B.BLOCK	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	67.56	5.19	57.43	130.17	130.17	0.00	0.00	0.00	0.00	0.00	-130.17
1991	57.71	5.19	57.43	120.32	102.44	0.00	0.86	3.33	4.19	3.56	-229.04
1992	57.71	0.00	57.43	115.14	83.45	0.00	1.72	6.66	8.37	6.07	-306.43
1993	57.71	0.00	0.00	57.71	35.61	0.00	1.72	9.99	11.70	7.22	-334.82
1994	57.71	0.00	0.00	57.71	30.32	0.00	1.72	9.99	11.70	6.15	-358.99
1995	4.25	0.00	0.00	4.25	1.90	86.10	1.72	9.99	97.80	43.74	-317.15
1996	4.25	0.00	0.00	4.25	1.62	98.40	1.72	9.99	110.10	41.92	-276.84
1997	4.25	0.00	0.00	4.25	1.38	109.30	1.72	9.99	121.00	39.22	-238.99
1998	4.25	0.00	0.00	4.25	1.17	121.50	1.72	9.99	133.20	36.76	-203.41
1999	4.25	0.00	0.00	4.25	1.00	132.40	1.72	9.99	144.10	33.86	-170.55
2000	4.25	0.00	0.00	4.25	0.85	144.00	1.72	9.99	155.70	31.15	-140.25
2001	4.25	0.00	0.00	4.25	0.72	144.60	1.72	9.99	156.30	26.62	-114.36
2002	4.25	0.00	0.00	4.25	0.62	144.60	1.72	9.99	156.30	22.66	-92.31
2003	4.25	0.00	0.00	4.25	0.52	144.60	1.72	9.99	156.30	19.29	-73.54
2004	4.25	0.00	0.00	4.25	0.45	144.60	1.72	9.99	156.30	16.42	-57.57
2005	4.25	0.00	0.00	4.25	0.38	144.60	1.72	9.99	156.30	13.98	-43.96
2006	4.25	0.00	0.00	4.25	0.32	144.60	1.72	9.99	156.30	11.90	-32.38
2007	4.25	0.00	0.00	4.25	0.28	144.60	1.72	9.99	156.30	10.14	-22.52
2008	4.25	0.00	0.00	4.25	0.23	144.60	1.72	9.99	156.30	8.63	-14.13
2009	-116.99	-3.37	-34.46	-154.81	-7.28	144.60	1.72	9.99	156.30	7.35	0.49
TOTAL					386.15					386.65	

COST BENEFIT RATIO= 1.00128 FIRR= .1746

Table 7.4.13 Consolidated Financial Cash Flow for Total Jamalpur Project by Model B (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR SPRING	PROJECT COST FOR B.BLOCK	TOTAL PROJECT COST	TOTAL PROJECT COST IN PRESENT VALUE	BENEFIT FROM POH	BENEFIT FROM SPRING	BENEFIT FROM B.BLOCK	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	74.32	5.70	63.17	143.19	143.19	0.00	0.00	0.00	0.00	0.00	-143.19
1991	63.48	5.70	63.17	132.35	115.38	0.00	0.77	3.00	3.77	3.28	-255.28
1992	63.48	0.00	63.17	126.65	96.25	0.00	1.54	5.99	7.53	5.73	-345.81
1993	63.48	0.00	0.00	63.48	42.06	0.00	1.54	8.99	10.53	6.98	-380.89
1994	63.48	0.00	0.00	63.48	36.66	0.00	1.54	8.99	10.53	6.08	-411.47
1995	4.68	0.00	0.00	4.68	2.35	77.49	1.54	8.99	88.02	44.32	-369.51
1996	4.68	0.00	0.00	4.68	2.05	88.56	1.54	8.99	99.09	43.49	-328.06
1997	4.68	0.00	0.00	4.68	1.79	98.37	1.54	8.99	108.90	41.67	-288.18
1998	4.68	0.00	0.00	4.68	1.56	109.35	1.54	8.99	119.88	39.99	-249.75
1999	4.68	0.00	0.00	4.68	1.36	119.16	1.54	8.99	129.69	37.71	-213.40
2000	4.68	0.00	0.00	4.68	1.19	129.60	1.54	8.99	140.13	35.52	-179.06
2001	4.68	0.00	0.00	4.68	1.03	130.14	1.54	8.99	140.67	31.09	-149.01
2002	4.68	0.00	0.00	4.68	0.90	130.14	1.54	8.99	140.67	27.10	-122.81
2003	4.68	0.00	0.00	4.68	0.79	130.14	1.54	8.99	140.67	23.63	-99.96
2004	4.68	0.00	0.00	4.68	0.68	130.14	1.54	8.99	140.67	20.60	-80.05
2005	4.68	0.00	0.00	4.68	0.60	130.14	1.54	8.99	140.67	17.96	-62.69
2006	4.68	0.00	0.00	4.68	0.52	130.14	1.54	8.99	140.67	15.65	-47.56
2007	4.68	0.00	0.00	4.68	0.45	130.14	1.54	8.99	140.67	13.65	-34.37
2008	4.68	0.00	0.00	4.68	0.40	130.14	1.54	8.99	140.67	11.90	-22.87
2009	-128.69	-3.71	-37.90	-170.30	-12.55	130.14	1.54	8.99	140.67	10.37	0.05
TOTAL					436.65					436.71	

COST BENEFIT RATIO= 1.00012 FIRR= .1471

Table 7.4.14 Consolidated Economic Cash Flow for Total Jamalpur Project by Model A (Base case)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR BRAKE BLOCK AND SPRING	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	51.99	41.16	93.15	93.15	0.00	0.00	0.00	0.00	-93.15
1991	43.48	41.16	84.64	65.55	3.77	0.00	3.77	2.92	-155.79
1992	43.48	36.66	80.14	48.07	7.54	0.00	7.54	4.52	-199.33
1993	43.48	1.74	45.22	21.01	10.53	0.00	10.53	4.89	-215.45
1994	43.48	1.74	45.22	16.27	10.53	0.00	10.53	3.79	-227.93
1995	2.25	1.74	3.99	1.11	221.38	0.00	221.38	61.68	-167.36
1996	2.25	1.74	3.99	0.86	183.06	0.00	183.06	39.50	-128.71
1997	2.25	1.74	3.99	0.67	183.06	0.00	183.06	30.59	-98.79
1998	2.25	1.74	3.99	0.52	183.06	0.00	183.06	23.69	-75.61
1999	2.25	1.74	3.99	0.40	183.06	0.00	183.06	18.35	-57.66
2000	2.25	1.74	3.99	0.31	183.06	0.00	183.06	14.21	-43.75
2001	2.25	1.74	3.99	0.24	183.06	0.00	183.06	11.01	-32.99
2002	2.25	1.74	3.99	0.19	183.06	0.00	183.06	8.52	-24.65
2003	2.25	1.74	3.99	0.14	183.06	0.00	183.06	6.60	-18.19
2004	2.25	1.74	3.99	0.11	183.06	0.00	183.06	5.11	-13.19
2005	2.25	1.74	3.99	0.09	183.06	0.00	183.06	3.96	-9.32
2006	2.25	1.74	3.99	0.07	183.06	0.00	183.06	3.07	-6.32
2007	2.25	1.74	3.99	0.05	183.06	0.00	183.06	2.38	-3.99
2008	2.25	1.74	3.99	0.04	183.06	0.00	183.06	1.84	-2.19
2009	-106.86	-24.93	-131.79	-1.03	160.71	0.00	160.71	1.25	0.08
TOTAL				247.81				247.90	

COST BENEFIT RATIO= 1.00034 EIRR= .2912

Table 7.4.15 Consolidated Economic Cash Flow for Total Jamalpur Project by Model A (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR BRAKE BLOCK AND SPRING	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	57.19	45.28	102.47	102.47	0.00	0.00	0.00	0.00	-102.47
1991	47.83	45.28	93.11	74.36	3.39	0.00	3.39	2.71	-174.12
1992	47.83	40.32	88.15	56.23	6.78	0.00	6.78	4.33	-226.02
1993	47.83	1.91	49.74	25.34	9.48	0.00	9.48	4.83	-246.53
1994	47.83	1.91	49.74	20.24	9.48	0.00	9.48	3.86	-262.91
1995	2.48	1.91	4.39	1.43	199.24	0.00	199.24	64.74	-199.60
1996	2.48	1.91	4.39	1.14	164.75	0.00	164.75	42.76	-157.98
1997	2.48	1.91	4.39	0.91	164.75	0.00	164.75	34.15	-124.74
1998	2.48	1.91	4.39	0.73	164.75	0.00	164.75	27.27	-98.19
1999	2.48	1.91	4.39	0.58	164.75	0.00	164.75	21.78	-76.99
2000	2.48	1.91	4.39	0.46	164.75	0.00	164.75	17.40	-60.06
2001	2.48	1.91	4.39	0.37	164.75	0.00	164.75	13.89	-46.54
2002	2.48	1.91	4.39	0.30	164.75	0.00	164.75	11.10	-35.74
2003	2.48	1.91	4.39	0.24	164.75	0.00	164.75	8.86	-27.11
2004	2.48	1.91	4.39	0.19	164.75	0.00	164.75	7.08	-20.22
2005	2.48	1.91	4.39	0.15	164.75	0.00	164.75	5.65	-14.72
2006	2.48	1.91	4.39	0.12	164.75	0.00	164.75	4.51	-10.33
2007	2.48	1.91	4.39	0.10	164.75	0.00	164.75	3.61	-6.82
2008	2.48	1.91	4.39	0.08	164.75	0.00	164.75	2.88	-4.01
2009	-117.55	-27.42	-144.97	-2.02	144.64	0.00	144.64	2.02	0.03
TOTAL				283.39				283.41	

COST BENEFIT RATIO= 1.0001 EIRR= .2521

Table 7.4.16 Consolidated Economic Cash Flow for Total Jamalpur Project by Model B (Base case)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR BRAKE BLOCK AND SPRING	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	51.99	41.16	93.15	93.15	0.00	0.00	0.00	0.00	-93.15
1991	43.48	41.16	84.64	70.10	3.77	0.00	3.77	3.12	-160.13
1992	43.48	36.66	80.14	54.96	7.54	0.00	7.54	5.17	-209.92
1993	43.48	1.74	45.22	25.68	10.53	0.00	10.53	5.98	-229.62
1994	43.48	1.74	45.22	21.27	10.53	0.00	10.53	4.95	-245.94
1995	2.25	1.74	3.99	1.55	88.06	0.00	88.06	34.30	-213.19
1996	2.25	1.74	3.99	1.29	99.05	0.00	99.05	31.95	-182.52
1997	2.25	1.74	3.99	1.07	108.87	0.00	108.87	29.09	-154.50
1998	2.25	1.74	3.99	0.88	119.87	0.00	119.87	26.52	-128.86
1999	2.25	1.74	3.99	0.73	129.69	0.00	129.69	23.76	-105.83
2000	2.25	1.74	3.99	0.61	140.68	0.00	140.68	21.35	-85.09
2001	2.25	1.74	3.99	0.50	140.68	0.00	140.68	17.68	-67.91
2002	2.25	1.74	3.99	0.42	140.68	0.00	140.68	14.64	-53.68
2003	2.25	1.74	3.99	0.34	140.68	0.00	140.68	12.13	-41.90
2004	2.25	1.74	3.99	0.28	140.68	0.00	140.68	10.04	-32.14
2005	2.25	1.74	3.99	0.24	140.68	0.00	140.68	8.32	-24.06
2006	2.25	1.74	3.99	0.20	140.68	0.00	140.68	6.89	-17.37
2007	2.25	1.74	3.99	0.16	140.68	0.00	140.68	5.70	-11.83
2008	2.25	1.74	3.99	0.13	140.68	0.00	140.68	4.72	-7.24
2009	-106.86	-24.93	-131.79	-3.66	140.68	0.00	140.68	3.91	0.34
TOTAL				269.90				270.23	

COST BENEFIT RATIO= 1.00124 EIRR= .2075

Table 7.4.17 Consolidated Economic Cash Flow for Total Jamalpur Project by Model B (with 10% contingency)

(Millions of Rs. in 1987 price)

YEAR	PROJECT COST FOR POH	PROJECT COST FOR BRAKE BLOCK AND SPRING	TOTAL PROJECT COST	TOTAL COST IN PRESENT VALUE	BENEFIT FOR IR	BENEFIT FOR USERS	TOTAL BENEFIT	TOTAL BENEFIT IN PRESENT VALUE	NET PRESENT VALUE
1990	57.19	45.28	102.47	102.47	0.00	0.00	0.00	0.00	-102.47
1991	47.83	45.28	93.11	79.09	3.39	0.00	3.39	2.88	-178.68
1992	47.83	40.32	88.15	63.61	6.78	0.00	6.78	4.89	-237.39
1993	47.83	1.91	49.74	30.49	9.48	0.00	9.48	5.81	-262.07
1994	47.83	1.91	49.74	25.90	9.48	0.00	9.48	4.93	-283.04
1995	2.48	1.91	4.39	1.94	79.25	0.00	79.25	35.06	-249.92
1996	2.48	1.91	4.39	1.65	89.15	0.00	89.15	33.50	-218.08
1997	2.48	1.91	4.39	1.40	97.98	0.00	97.98	31.28	-188.20
1998	2.48	1.91	4.39	1.19	107.88	0.00	107.88	29.25	-160.14
1999	2.48	1.91	4.39	1.01	116.72	0.00	116.72	26.88	-134.27
2000	2.48	1.91	4.39	0.86	126.61	0.00	126.61	24.77	-110.35
2001	2.48	1.91	4.39	0.73	126.61	0.00	126.61	21.04	-90.04
2002	2.48	1.91	4.39	0.62	126.61	0.00	126.61	17.88	-72.78
2003	2.48	1.91	4.39	0.53	126.61	0.00	126.61	15.19	-58.12
2004	2.48	1.91	4.39	0.45	126.61	0.00	126.61	12.90	-45.67
2005	2.48	1.91	4.39	0.38	126.61	0.00	126.61	10.96	-35.09
2006	2.48	1.91	4.39	0.32	126.61	0.00	126.61	9.31	-26.11
2007	2.48	1.91	4.39	0.27	126.61	0.00	126.61	7.91	-18.48
2008	2.48	1.91	4.39	0.23	126.61	0.00	126.61	6.72	-11.99
2009	-117.55	-27.42	-144.97	-6.53	126.61	0.00	126.61	5.71	0.25
TOTAL				306.61				306.86	

COST BENEFIT RATIO= 1.00081 EIRR= .1772

CHAPTER 8 TECHNICAL EVALUATION

CHAPTER 8 TECHNICAL EVALUATION

In addition to benefits identified in the financial and economic analysis, the project is expected to generate the following non-quantifiable benefits and impacts.

(1) Improvement in the levels of service quality
Proper maintenance of rolling stock reduces traffic problems and train accidents caused by rolling stock failures, resulting in a safe and reliable railway operation that improves the quality of service for passengers and goods and stimulates the potential demand for railway services.

(2) Increase in the availability of rolling stock
Higher availability of rolling stock can be realised not only by reducing the POH cycle time in the workshop, but also by sound maintenance which produces higher rolling stock quality. Furthermore, reducing rolling stock failures requires less expense for service recovery.

(3) Increase in the effect of investments in railway infrastructure
Investment in railway infrastructure for improvements such as stronger track, modern signalling devices, powerful overhead equipment and substations will be effectively carried out together with the efficient operation of rolling stock.

(4) Impetus for modernisation of other workshops
Since modernisation of workshops and the increase in POH capacity are required to support programmes to increase transport capacity, the project is expected to serve as a model case to stimulate the modernisation of other workshops.

(5) Increase in employment opportunities in the project area
Employment opportunities will be created by investment in the project and development of workshop activities, contributing to the promotion of regional economic and community development.

(6) Overall decrease in rolling stock maintenance costs for the IR
The project will lead to decrease in maintenance costs at locomotive and car depots related to the workshops. Since the depots account for a significant percentage of the total maintenance cost, this will have a favourable cost impact on the IR. Furthermore, the modernisation of all the workshops will have a dramatic effect on cost reduction; the rolling stock maintenance cost accounts for 21.6% (Rs. 1,047 crores) of the total operating cost of the IR in 1985/86.

(7) Upgrading of maintenance technology at the workshop
The modernisation of the workshop will provide technological advancement in rolling stock maintenance. Furthermore, since railway engineering is, in a sense, based on experience, the improvement of maintenance technology will exchange the overall progress of rolling stock engineering.

(8) Inputs for the development of local industries
The implementation of the project will have an impact on the local industrial sectors through the manufacturing and construction of plants and machinery of a modern design.

(9) Improvement in worker's motivation and work safety
Introduction of new technologies and equipment as well as improvement of working environment through the modernisation project will improve work safety and motivation of workers.

(10) Incentive for the modernisation of other workshops
The execution of the project will be an incentive for the modernisation of other workshops. In addition, the project's technology transfer will contribute to the progress of workshop modernisation planning.

CHAPTER 9 CONCLUSION

CHAPTER 9 CONCLUSION

(1) Workshop modernisation ultimately plays a very important role in efficiently augmenting railway transport capacity and higher transport service reliability.
The workshop modernisation project should, therefore, be vigorously promoted.

(2) The extensive modernisation of both Jamalpur and Perambur workshops is evidently imperative and immediate. The earliest possible implementation of the workshop modernisation programme, on the basis of the proposals in this study report, will be needed.

1) The present workload of the two workshops is almost at the limit of their POH capacity. The workshop modernisation should be completed within the shortest possible period to meet the POH requirements in the future.

2) The prospected role of the two workshops and the projected POH workload up to the year 2000 require determined modernisation and improvement both in the facilities and technology of the workshops.

3) The early commencement of the modernisation programme of the two workshops will favourably affect subsequent workshop modernisation.

(3) The amount and period of the investment proposed in the Study is appropriate, and thus, the workshop modernisation plan is feasible from the socioeconomic, managerial and technical viewpoints.

CHAPTER 10 RECOMMENDATIONS

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To successfully implement the project, the following recommendations are proposed.

(1) The Government of India should take necessary measures to secure financial resources for the project.

(2) Considerations should be given at design and implementation stages for maximisation of the effect of the project, taking into account precedents and experiences in the application of new technologies and equipment.

(3) The training should be conducted in accordance with progress of the project so as to improve skills and motivation of workers in a timely manner.

(4) Temporary reassignment of rolling stock to other workshops and other measures to ensure smooth progress of the construction works should be contemplated.

(5) Rolling stock maintenance and repair manuals should be developed to make the best use of new facilities and equipment as well as work flow.

(6) A plan for diversification of operations at the Jamalpur Workshop should be developed with reference to the following.

1) Available facilities and technologies: Machining, metal working, casting, forging and welding

2) Diversification activities
Centralised manufacturing of cranes, traversers, trolleys and other transport equipment, steel frames for building, bridges, electrification poles, steel supports for tunneling, transport pallets, and underframe parts of rolling stock.

(7) Improvements in software aspect, including modeifications of material control system and introduction of total quality control system, should be considered.

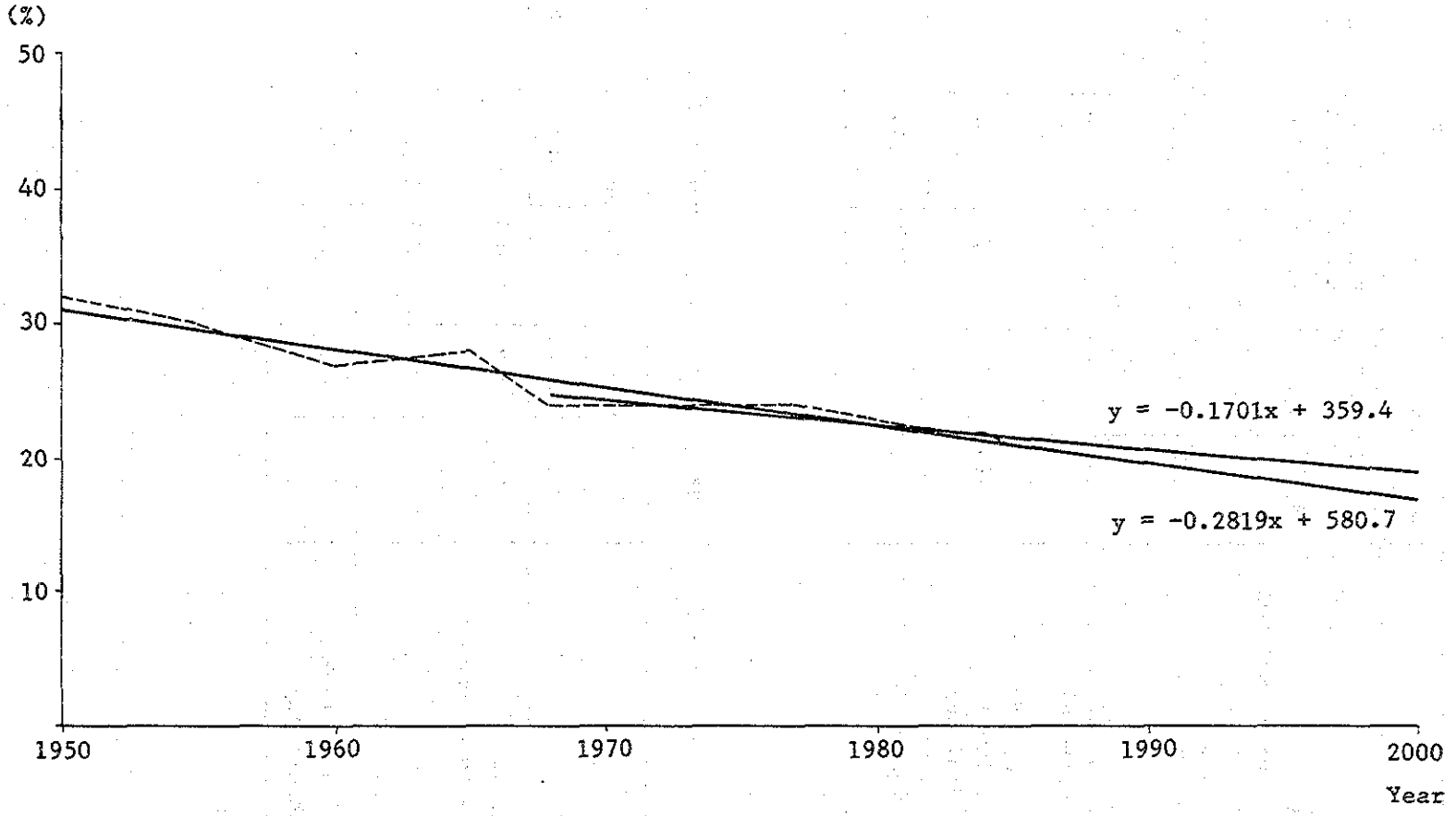
APPENDIX

Appendix I Congestion in Train

	Sub		Non-sub		Remarks
	B.G.	M.G.	B.G.	M.G.	
Traffic (million-passenger-km)	43,920	1,519	154,077	41,000	
Vehicle-kms (million-km)	638	42	4,084	1,180	Other coaches excluded in (Non-sub)
Average No. of passenger (pass./vehicle)	138	72	75	70	
Average No. of seat capacity (EMU) (pass./vehicle)	198	139	70	55	
Occupation ratio (%)	70	51	107	127	

Appendix II Average Vehicle-kms per Vehicle Day

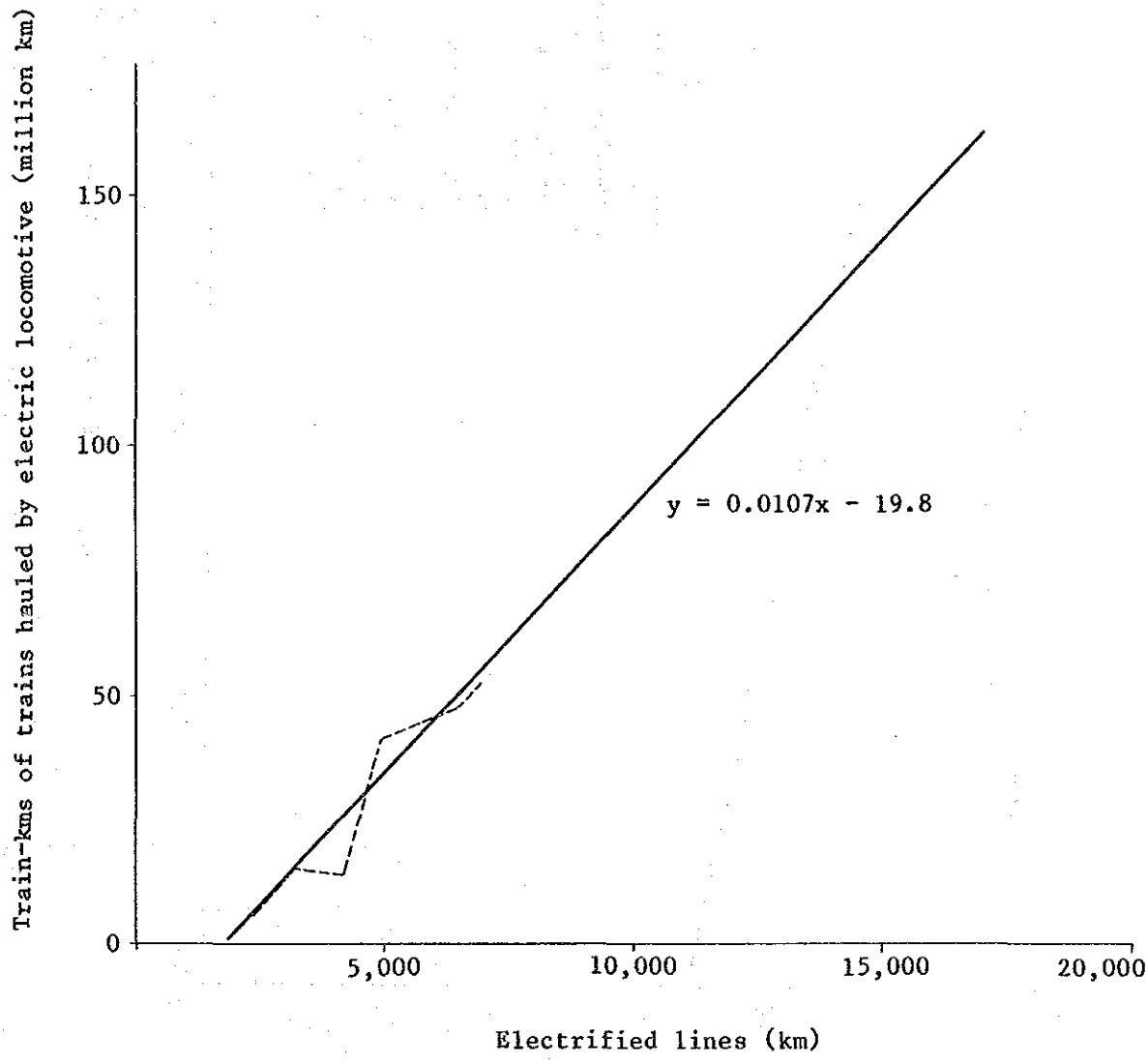
	Sub		Non-sub		Remarks
	B.G.	M.G.	B.G.	M.G.	
Vehicle-kms (million-passenger-km)	638	42	5,105	1,646	
No. of vehicles held (vehicle)	2,760	206	22,377	12,841	
Average vehicle-kms per vehicle day	316	279	312	176	



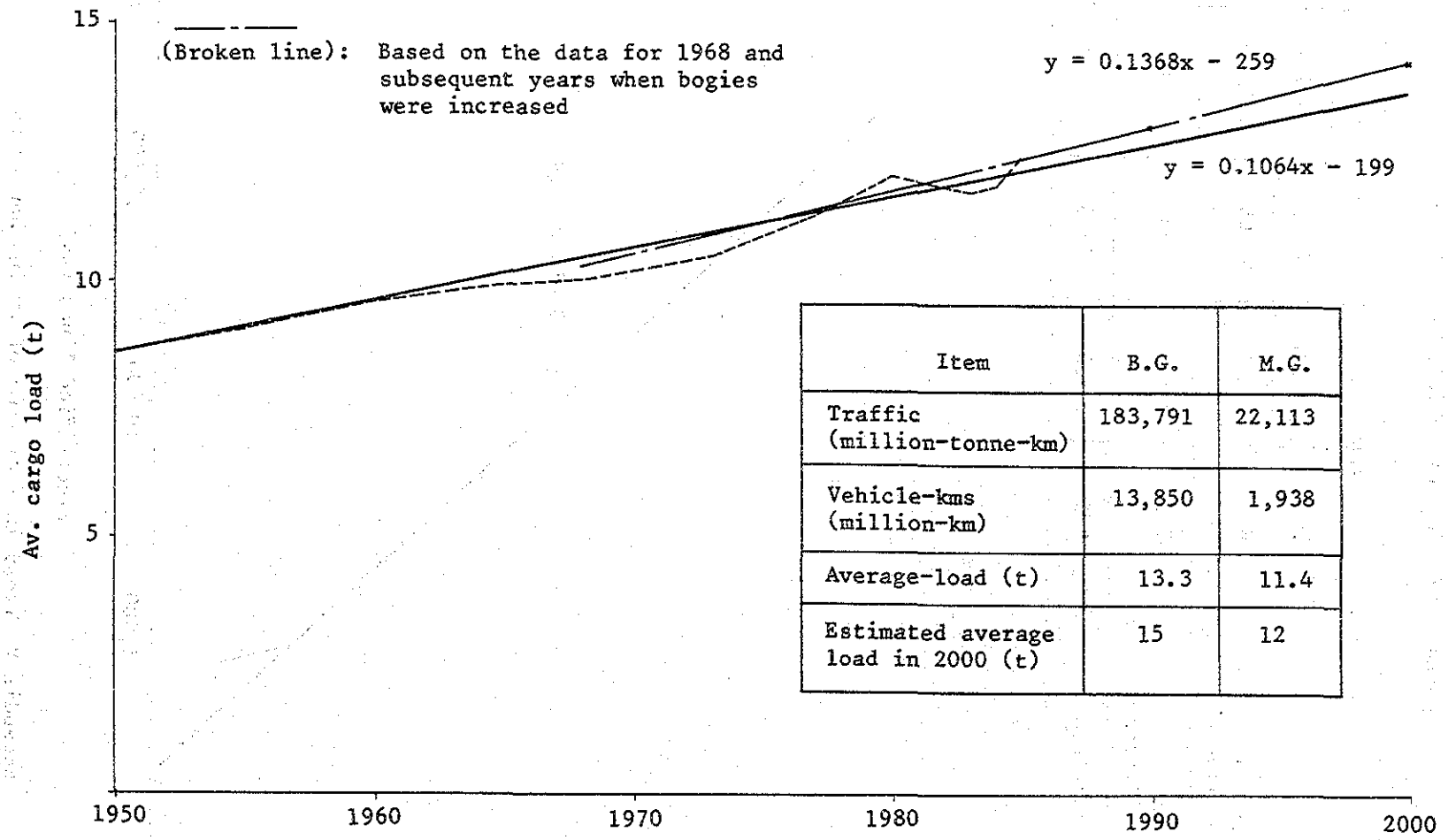
Appendix III Proportion of Other Coaches (Mail Vans, Luggage Vans and Others)

Appendix IV No. of Vehicles per Train

	Sub		Non-sub	
	B.G.	M.G.	B.G.	M.G.
Vehicle-kms (million-km)	638	42	5,105	1,646
Train-kms (million-km)	37.7	2.6	202	90
Vehicles/train	8.5	8.0	12.6	9.1

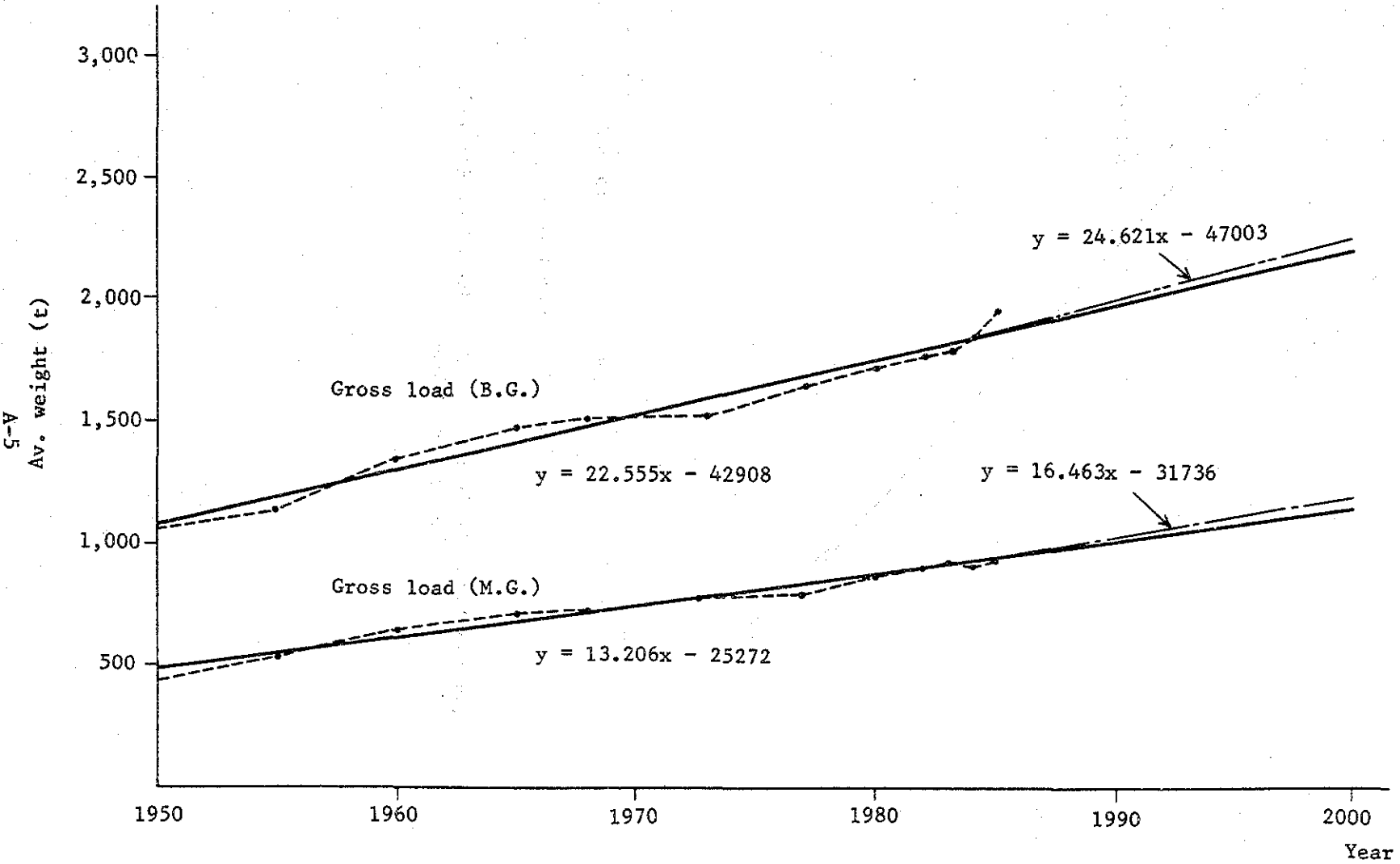


Appendix V Trend in Train-kms of Trains Hauled by Electric Locomotives (Passenger)

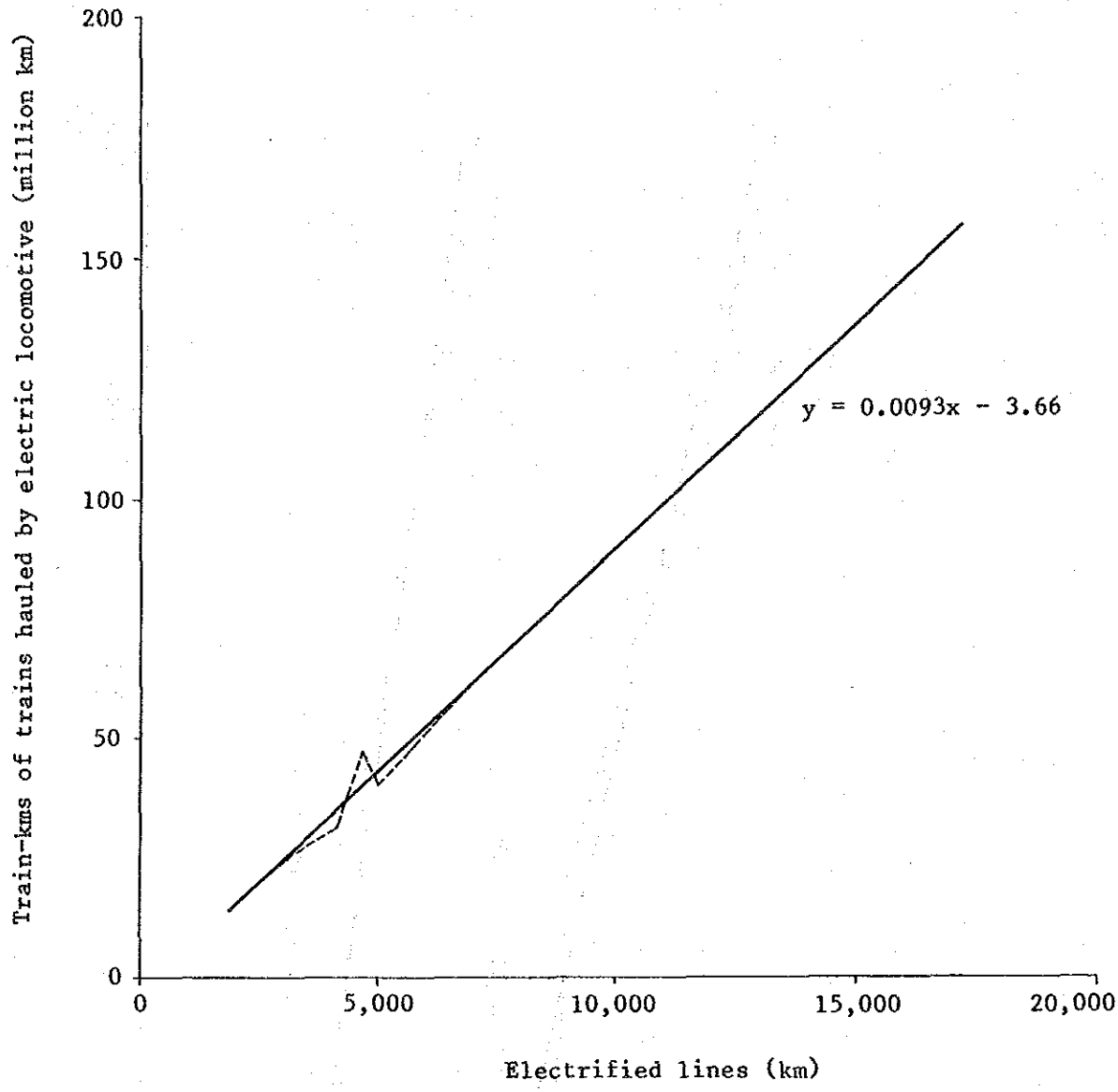


Item	B.G.	M.G.
Traffic (million-tonne-km)	183,791	22,113
Vehicle-kms (million-km)	13,850	1,938
Average-load (t)	13.3	11.4
Estimated average load in 2000 (t)	15	12

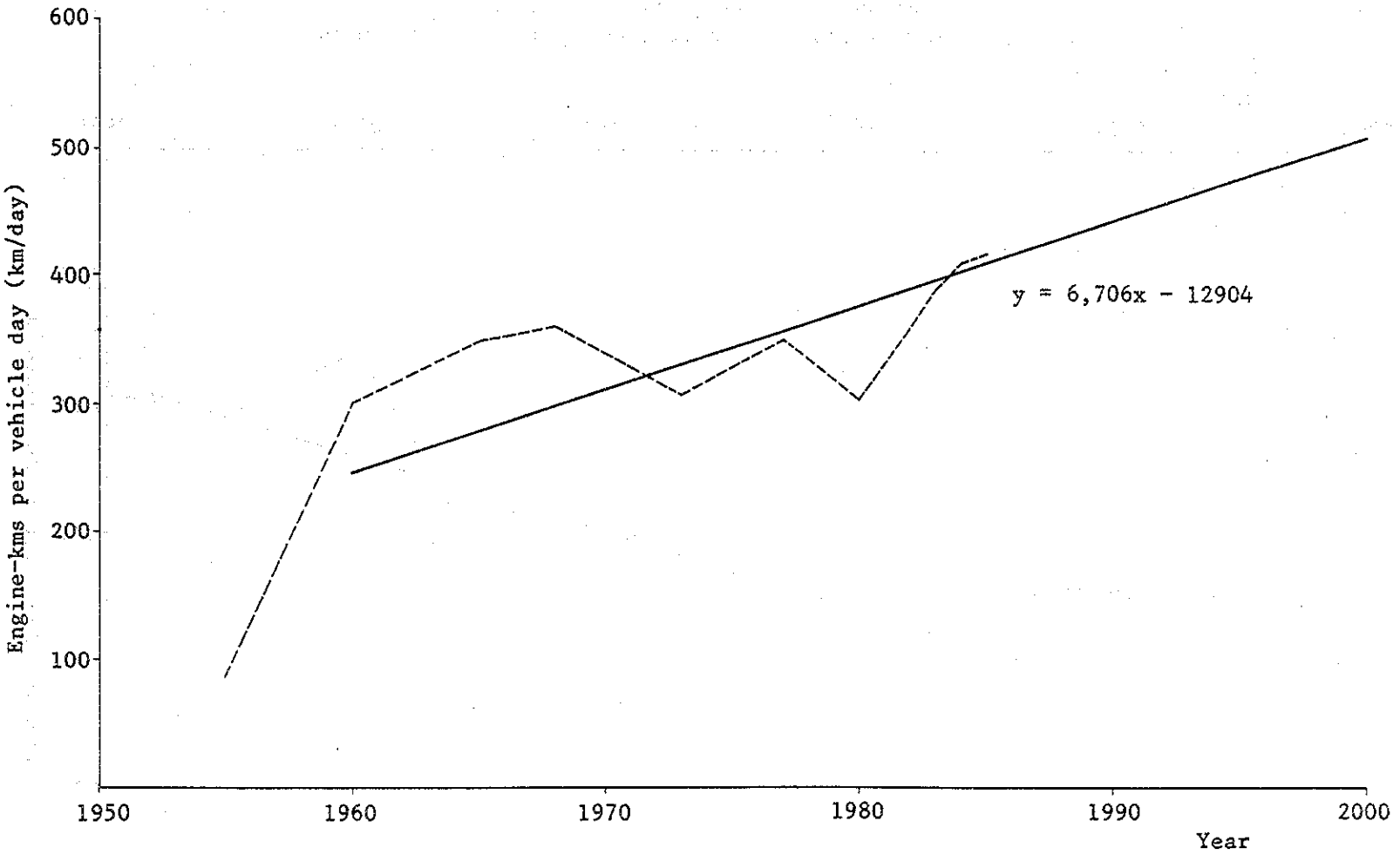
Appendix VI B.G. and M.G. Average Load per Wagon (4-wheeler)



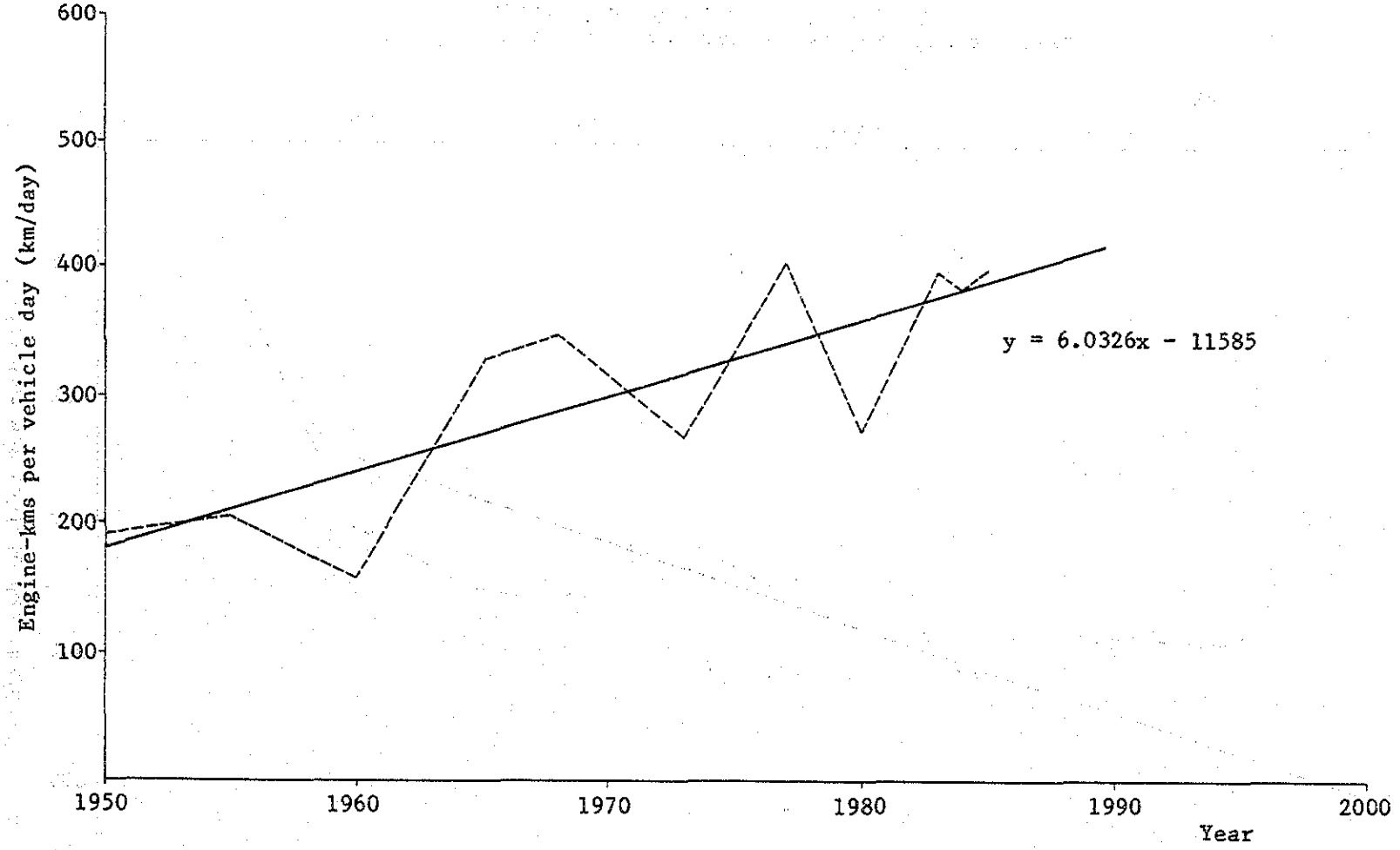
Appendix VII Average Freight Train Load (Tonnes)



Appendix VIII Train-kms of Train Hauled by Electric Locomotive (Goods)



Appendix IX Trend in Engine-kms per Vehicle Day of Diesel Locomotives for Freight Trains (B.G.)



Appendix X Trend in Engine-kms per Vehicle Day of Electric Locomotives for Freight Trains (B.G.)

Appendix 1-(1) Passenger Kilometres
(Total distance travelled by all passengers)

(In millions)

Year	Suburban (all classes)	Non-Suburban					Grand Total
		Upper	Second			Total Non-Suburban	
			Mail/ Exp	Ordy	Total		
1	2	3	4	5	6	7	8
1950/51	6,551	3,790	12,537	43,639	56,176	59,966	66,517
1955/56	8,127	2,973	15,660	35,640	51,300	54,273	62,400
1960/61	11,770	3,454	22,251	40,190	62,441	65,895	77,665
1965/66	17,164	4,220	28,997	45,913	74,910	79,130	96,294
1968/69	19,515	3,978	33,546	49,902	83,448	87,426	106,944
1973/74	28,037	4,328	49,642	53,657	103,299	107,627	135,664
1977/78	39,433	3,977	65,500	67,724	133,244	137,201	176,634
1980/81	41,086	5,140	86,712	75,620	162,332	167,472	208,558
1981/82	43,965	5,514	94,515	76,793	171,308	176,822	220,787
1982/83	45,789	5,578	97,746	77,817	175,563	181,142	226,930
1983/84	42,127	5,460	102,160	73,188	175,348	180,808	222,935
1984/85	44,264	5,916	103,818	72,584	176,402	182,318	226,582
1985/86	45,439	6,945	109,277	78,954	188,231	195,175	240,614

Source: Railway Year Book

Appendix 1-(2) Revenue Earning Freight Traffic

Year	Tonnes (Million)	Index	Tonne kms (Million)	Index	Lead kms	Index
1	2	3	4	5	6	7
1950/51	73.2	100.0	37,565	100.0	513	100.0
1955/56	92.2	126.0	50,435	134.3	541	105.5
1960/61	119.8	163.7	72,333	192.6	603	117.6
1965/66	162.0	221.3	98,978	263.5	611	119.1
1968/69	170.8	233.3	108,129	287.8	633	123.4
1973/74	162.0	221.5	109,391	291.2	675	131.6
1977/78	210.8	288.0	150,250	400.0	713	139.0
1980/81	195.9	267.6	147,652	393.1	754	147.0
1981/82	221.2	302.2	164,253	437.2	743	144.8
1982/83	228.8	312.6	167,781	446.6	733	142.9
1983/84	230.1	314.3	168,849	449.5	734	143.1
1984/85	236.4	322.9	172,632	459.6	730	142.3
1985/86	258.5	353.1	196,600	523.4	761	148.3

Source: Railway Year Book

Appendix 2 Road Traffic Volume

Road traffic volume is obtained by the application of the undermentioned formulae (1) and (2), based on the statistics of the number of cars by type, consumption of petrol by car type, etc.

$TKm(t) = VNm(t) \cdot FURm \cdot ERKm \cdot LFm \cdot CPm$ ..... (1)

where,

TKm(t) : Traffic volume carried by car type m for the year t (Passenger-kms or tonne-kms)

VNm(t) : Number of cars of the car type m for the year t

FURm : Rate of the fleet utilisation for car type m

ERKm : Effective running car-kms per car per annum for the car type m

LFm : Load factor

CPm : Carrying capacity

m : Car type (Bus, cars, truck, ...)

$TKm(t) = COPm(t) \cdot (10^6 \times 10^3) \cdot (1/SGPm) \cdot CKLm \cdot AOCm$ ..... (2)

where,

COPm(t): Quantity of the petrol consumed by car type m for the year t (in million ton)

SGPm : Specific gravity of fuel consumed by car type m

CKLm : Car kilometres produced by one litre of petrol consumed by car type m

AOCm : Average occupancy of car for car type m

The above-mentioned formula (1) is applied for estimating the bus passenger-kms. Formula (2) is applied for estimating the freight tonne-kms and passenger-kms of trucks, cars and two-wheelers.

Appendix 3-(1) Assumptions, Variables and Parameters

1) VNm(t) : Number of cars by car-type (m)

(Thousand)

m \ t	1950/51	1960/61	1970/71	1980/81	1984/85
Passenger car: (1) Bus	34	57	94	154	206
(2) Two-wheelers	27	88	576	2,528	3,512
(3) All other cars	163	351	852	1,926	2,376
Freight cars: (4) Truck	82	168	343	565	763

2) FURm: Rate of bus fleet utilisation 0.80

3) ERKm: Effective car-kms per bus per annum ..... 46,052 kms
(This value is estimated based on the Japanese transportation statistics.)

4) LFm: Load factor of bus 0.75

5) CPm: Carrying capacity of bus 52

6) CPOm(t): Fuel consumption by vehicle-type (m)

(in mil. tonnes)

m \ Fuel type \ t		1977/78	1978/79	1979/80	1980/81	1981/82
Passenger car: Two-wheelers	Petrol	n.a.	n.a.	n.a.	n.a.	0.152
All other cars	ditto	n.a.	n.a.	n.a.	n.a.	1.368
Freight cars: Trucks	Diesel oil	3.350	3.445	3.460	3.924	4.134

7) SGPm:	1.	Specific gravity of petrol	0.8
	2.	Specific gravity of diesel oil	0.9
8) AOCm:	1.	Average occupancy of two-wheelers	1.5 persons
	2.	Average occupancy of all other cars	2.7 persons
	3.	Average occupancy of truck	Based on "Road Development Plan for India"
9) CKLm:		Car-kms per litre by two-wheelers	22 kms
		Car-kms per litre by all other cars	14 kms
		Car-kms per litre by truck	Based on "Road Development Plan for India"
10) Tonne-kms produced by one litre of diesel oil			29.15 tonne-kms

Appendix 4-(1) Domestic Civil Aviation, Passenger Traffic

Items \ Year	1961	1971	1981	1982	1983	1984
Passengers carried (Thousand)	745 (100)	2,056 (276)	5,560 (746)	6,151 (826)	6,822 (916)	7,908 (1,061)
Passengers km (Million)	575 (100)	1,578 (274)	4,458 (775)	5,007 (871)	5,383 (936)	6,131 (1,066)
Seat km available (Million)	804 (100)	2,282 (284)	6,460 (803)	6,933 (862)	7,605 (946)	8,172 (1016)

Source: 1. Director General of Civil Aviation
2. CSO, Monthly Abstract of Statistics, November 1985

Note: Figures in parentheses show indices in percentage.

Appendix 4-(2) Domestic Civil Aviation: Cargo carried

Item \ Year	1961	1971	1981	1982	1983	1984
Cargo carried (Thousand tonnes)	24 (100)	26 (108)	80 (333)	86 (358)	99 (413)	112 (467)
Tonne-kms flown (Million)	8 (100)	16 (200)	44 (550)	48 (600)	54 (675)	61 (763)

Source: 1. Director General of Civil Aviation
2. CSO, Monthly Abstract of Statistics, November 1985

Note: Figures in parentheses show indices in percentage.

Appendix 5 Aggregation of Total Traffic Volume

The passenger-kms and freight tonne-kms by mode and the aggregated total are shown below.

Traffic Volume by Mode and Aggregated Total

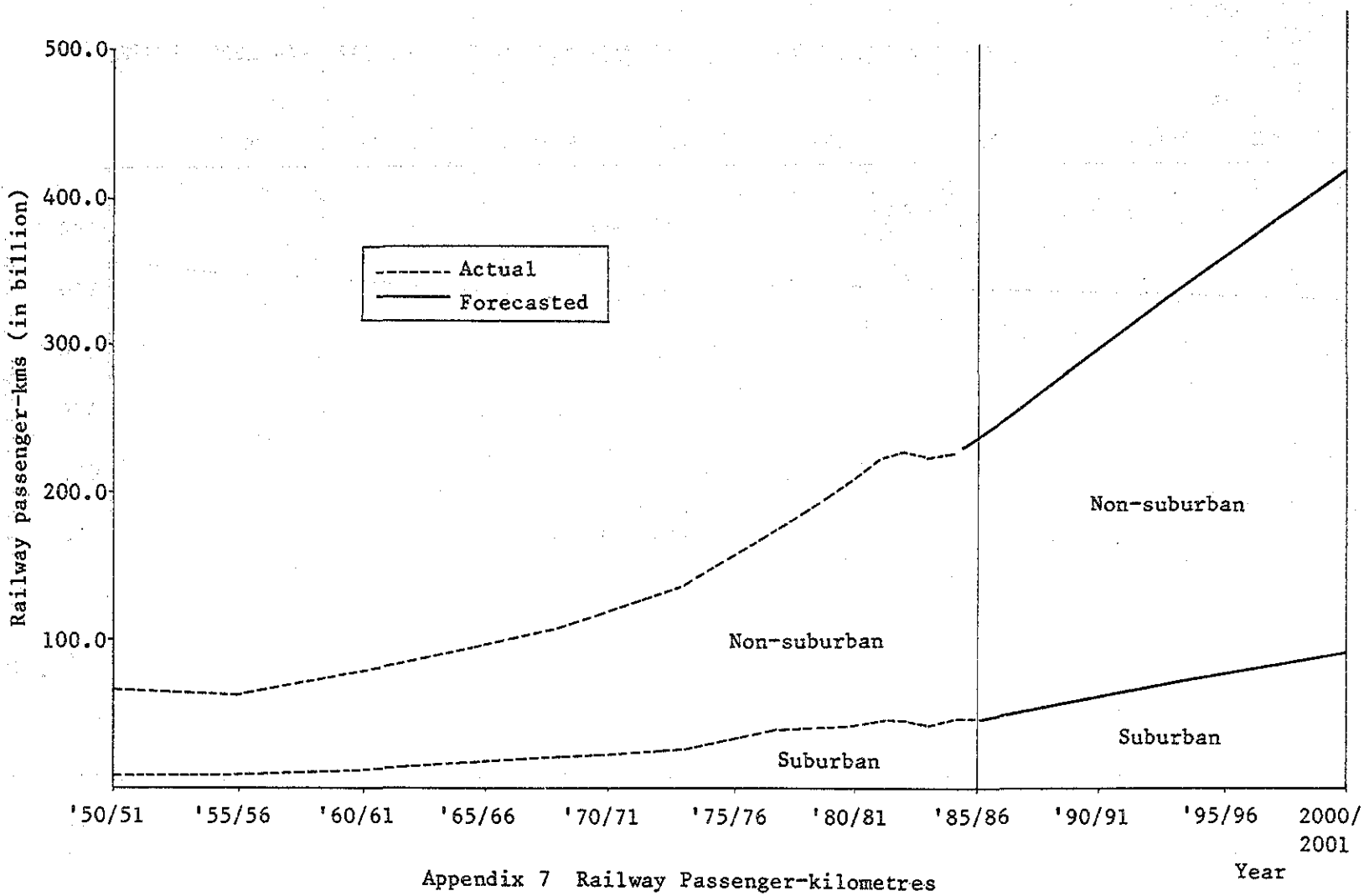
Year	Passenger-kms (in billion)				Tonne-kms (in billion)		
	Railway	Road	Airline	Total*	Railway	Road	Total*
1970/71	-	154.8	-	272.4	-	-	179.6
1971/72	-	-	1.6	288.6	-	-	184.0
1972/73	-	-	-	304.1	-	-	188.6
1973/74	135.7	-	-	320.4	109.4	-	193.5
1974/75	-	-	-	340.2	-	-	208.3
1975/76	-	-	-	358.9	-	-	225.5
1976/77	-	-	-	383.8	-	-	243.5
1977/78	176.6	-	-	407.5	150.3	108.0	258.3
1978/79	-	-	-	430.9	-	111.0	254.9
1979/80	-	-	-	455.5	-	112.0	256.6
1980/81	208.6	269.0	-	478.0	147.7	127.0	274.7
1981/82	220.8	-	4.5	513.8	164.3	133.8	298.1
1982/83	226.9	-	5.0	541.3	167.8	-	307.3
1983/84	222.9	-	5.4	560.0	168.8	-	316.4
1984/85	226.6	355.8	6.1	588.5	172.6	-	338.8

Note: * estimated based on the interpolation and regression analysis for the traffic volume of each mode.

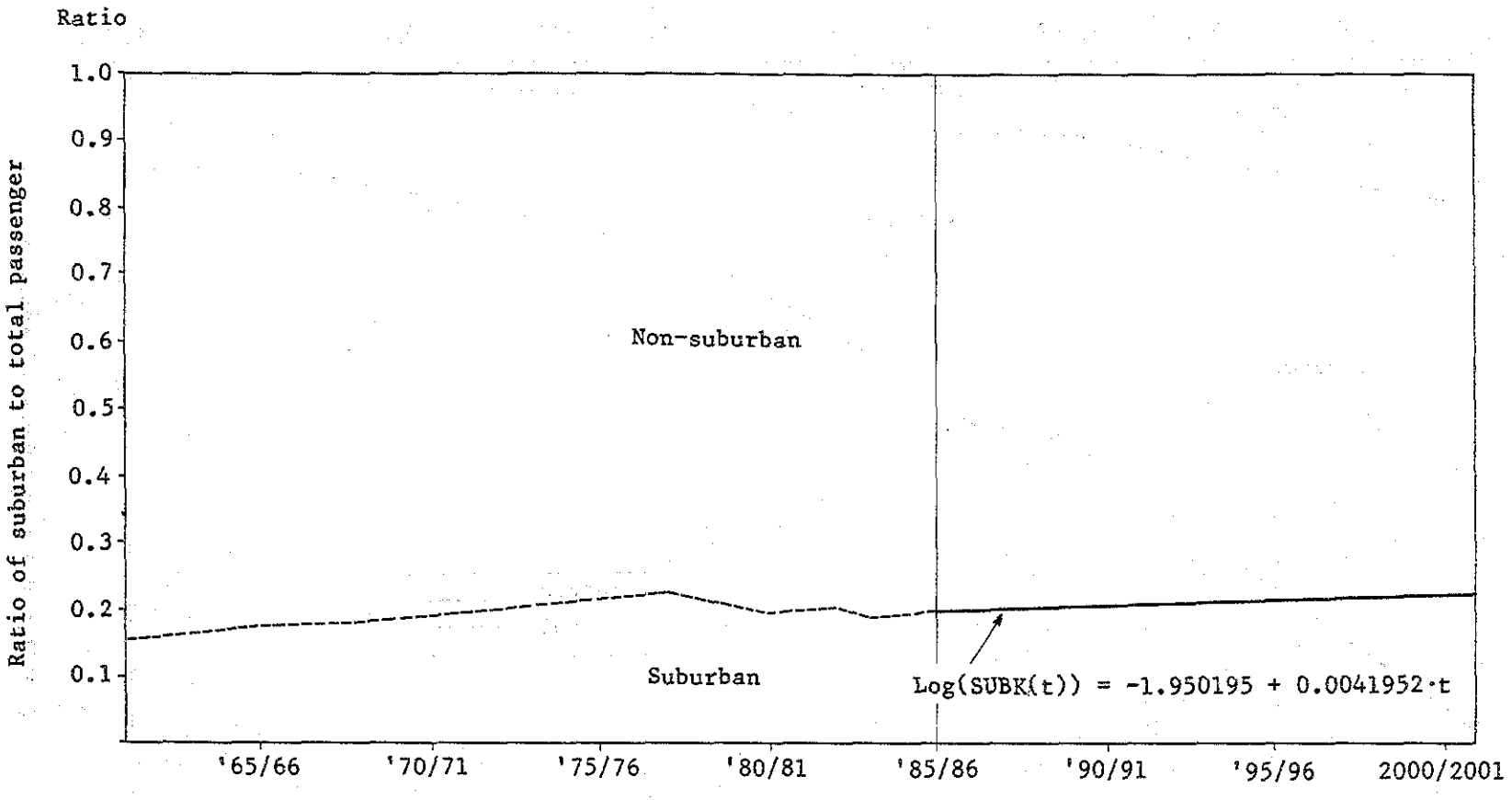
Appendix 6 Socio-economic & Transportation Data

	Population * (in million)		Gross Domestic Product at Factor Cost ** (At 1970-71 prices, Rs. Crores) *			Traffic Volume ***	
	Total	Urban	Agriculture, mining, etc.	Manufacturing construction, etc.	G.D.P.	Passengers (BPK)	Freight (BTK)
1970/71	548	109	17,802	7,594	36,736	272.4	179.6
1971/72	560	113	-	-	-	288.6	184.0
1972/73	573	118	-	-	-	304.1	188.6
1973/74	586	122	-	-	-	320.4	193.5
1974/75	599	127	-	-	-	340.2	208.3
1975/76	613	132	19,934	8,782	42,890	358.9	225.5
1976/77	627	137	18,674	9,575	43,160	383.8	243.5
1977/78	641	143	20,828	10,274	46,920	407.5	258.3
1978/79	655	148	21,441	11,058	49,619	430.9	254.9
1979/80	670	154	18,768	10,804	47,191	455.5	256.6
1980/81	685	160	21,015	10,937	50,623	478.0	274.7
1981/82	699	166	21,951	11,471	53,470	513.8	298.1
1982/83	714	172	21,342	12,091	55,068	541.3	307.3
1983/84	730	178	23,731	12,681	59,541	560.0	316.4
1984/85	745	185	23,644	13,366	61,838	588.5	328.8

* Estimated by the interpolation based on the governmental statistics.
** Source: Economic Survey 1986-87
*** Estimated in this study.



Appendix 7 Railway Passenger-kilometres



Note: SUBK(t): Ratio of the suburban Railway passengers for the year t

'90	0.207
'95	0.212
2000	0.216

Appendix 8 Composition of Suburban and Non-suburban Passenger-kms

Appendix 9 Generated Freight Volume up to the Year 2000/2001

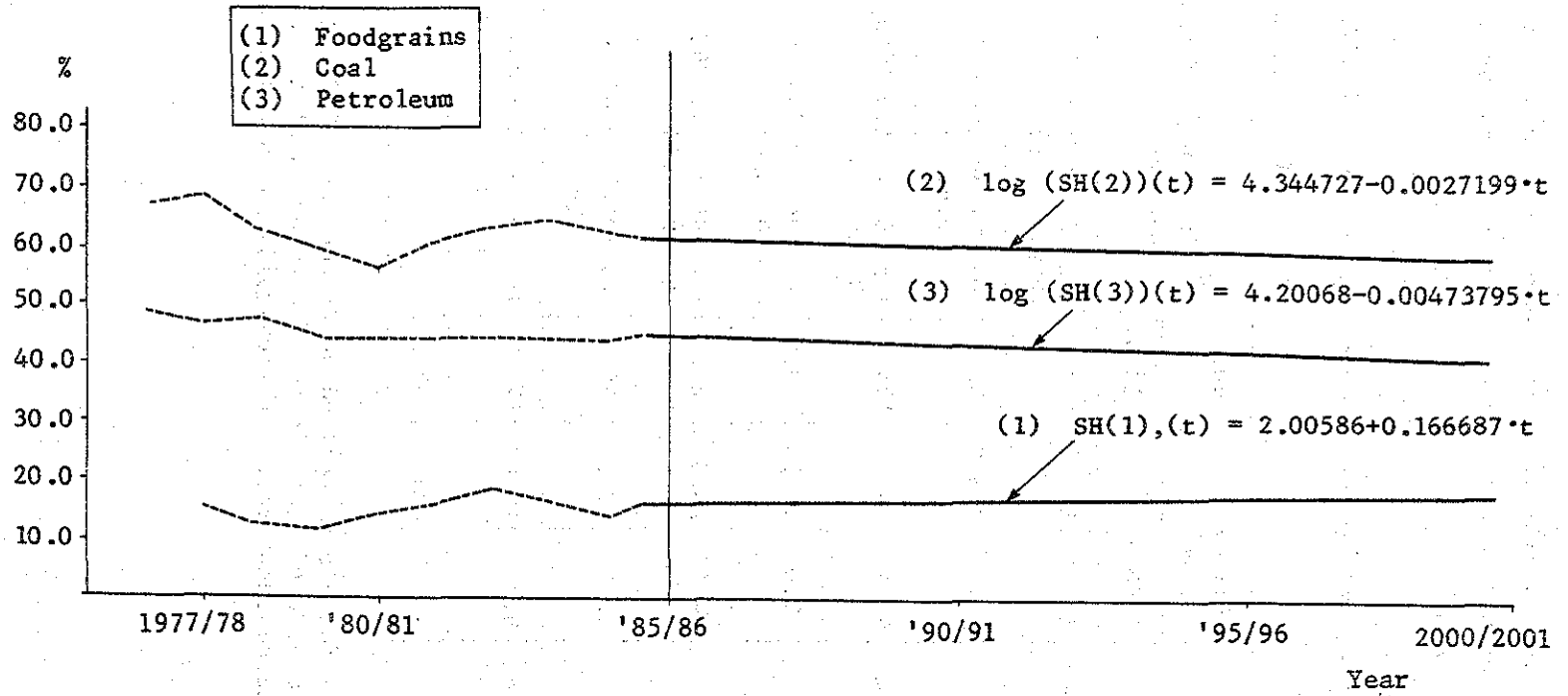
The generated freight volume by commodity obtained by the trend analysis based on the before-stated generated freight volume in the past years is shown below.

Generated Freight Volume up to the Year 2000/2001

(in million tonnes)

	Generated freight volume			Applied formulae for the estimate
	(1984)	1995	2000	
1. Foodgrains	145.5	174.8	192.2	log TD(t)=3.36401 + 0.018946·t (R = 0.7769)
2. Coal and lignite	147.4	238.9	302.5	log TD(t)=0.992676 + 0.0471935·t (R = 0.9956)
3. Petroleum	41.4	78.8	105.0	log TD(t)=-1.081055 + 0.057348·t (R = 0.9951)
4. Iron ore lignite	42.6	50.1	53.8	log TD(t)=2.569336 + 0.014160·t (R = 0.7006)
5. Iron and steel	14.6	23.8	27.1	log TD(t)=-38.02637 + 0.651142·t (R = 0.9124)
6. Cement	29.5	43.7	55.3	log TD(t)=-0.679199 + 0.046919·t (R = 0.9197)
7. Fertiliser (NPK)	8.2	15.6*	17.3*	log TD(t)=-5.728577 + 0.0930381·t (R = 0.9911)*
Total	429.2	625.7	753.2	-

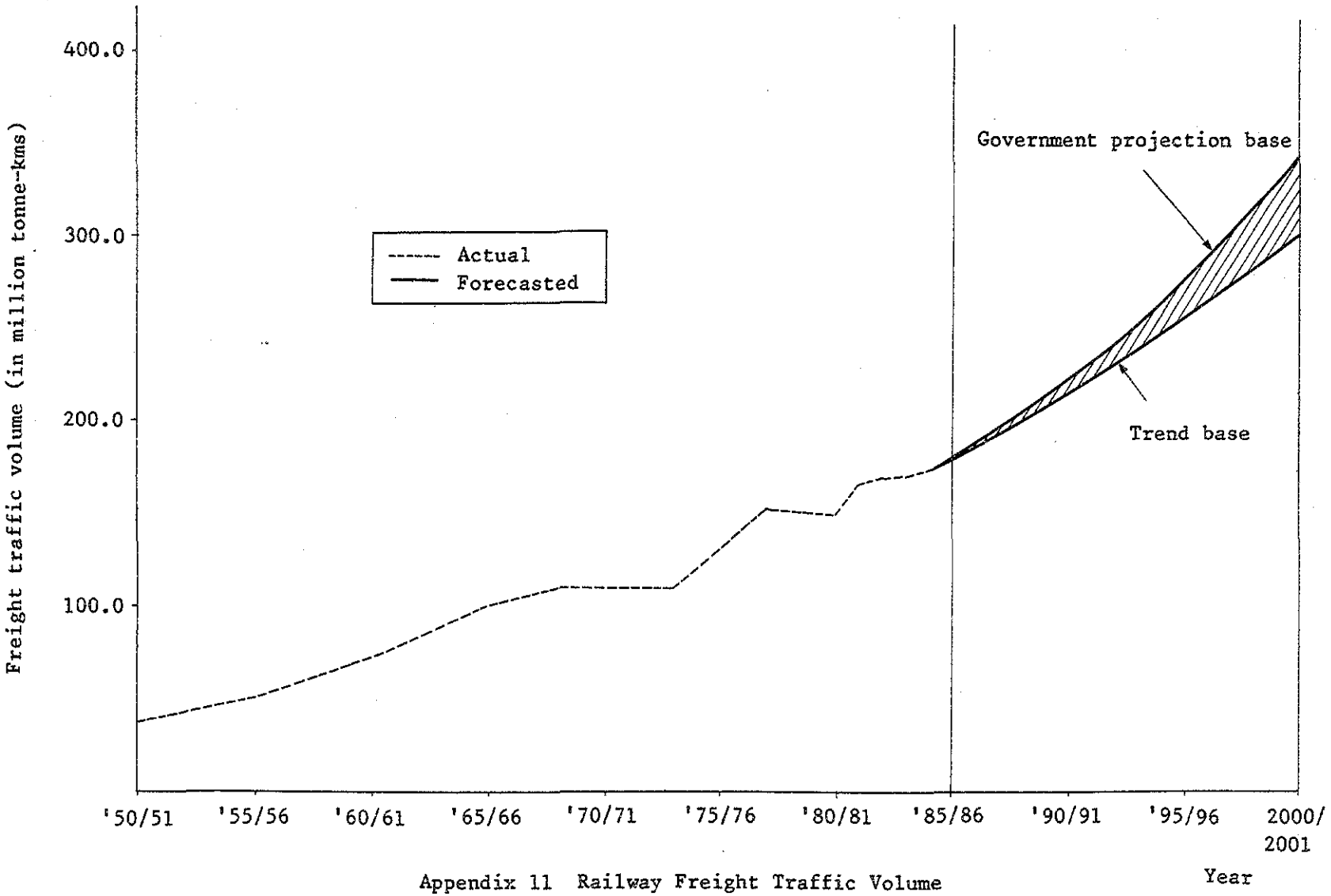
Note: * The formula is applied up to the year 1990. Thereafter the increasement rate is assumed to be equal to the compounded increasement rates of foodgrains and net sown area.



Note: 1. SH(1)(t): The ratio of the (1) foodgrains for the year t.

2. t: Years (85 (1985/86), ..., 95 (1995/96), ...)

Appendix 10 Ratio of Each Railway Traffic Volume to Each Generated Traffic Volume for Main Commodities



Appendix 11 Railway Freight Traffic Volume