

Economics of Public Transport

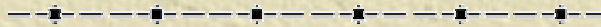



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Dr. Sanjay K. Singh

Department of Humanities and Social Sciences

Indian Institute of Technology Kanpur





What is economics? Deals with efficient allocation of scarce resources

What is public transport? Transport for hire and reward is public transport e.g., within passenger transport, rail, bus, and taxi services.

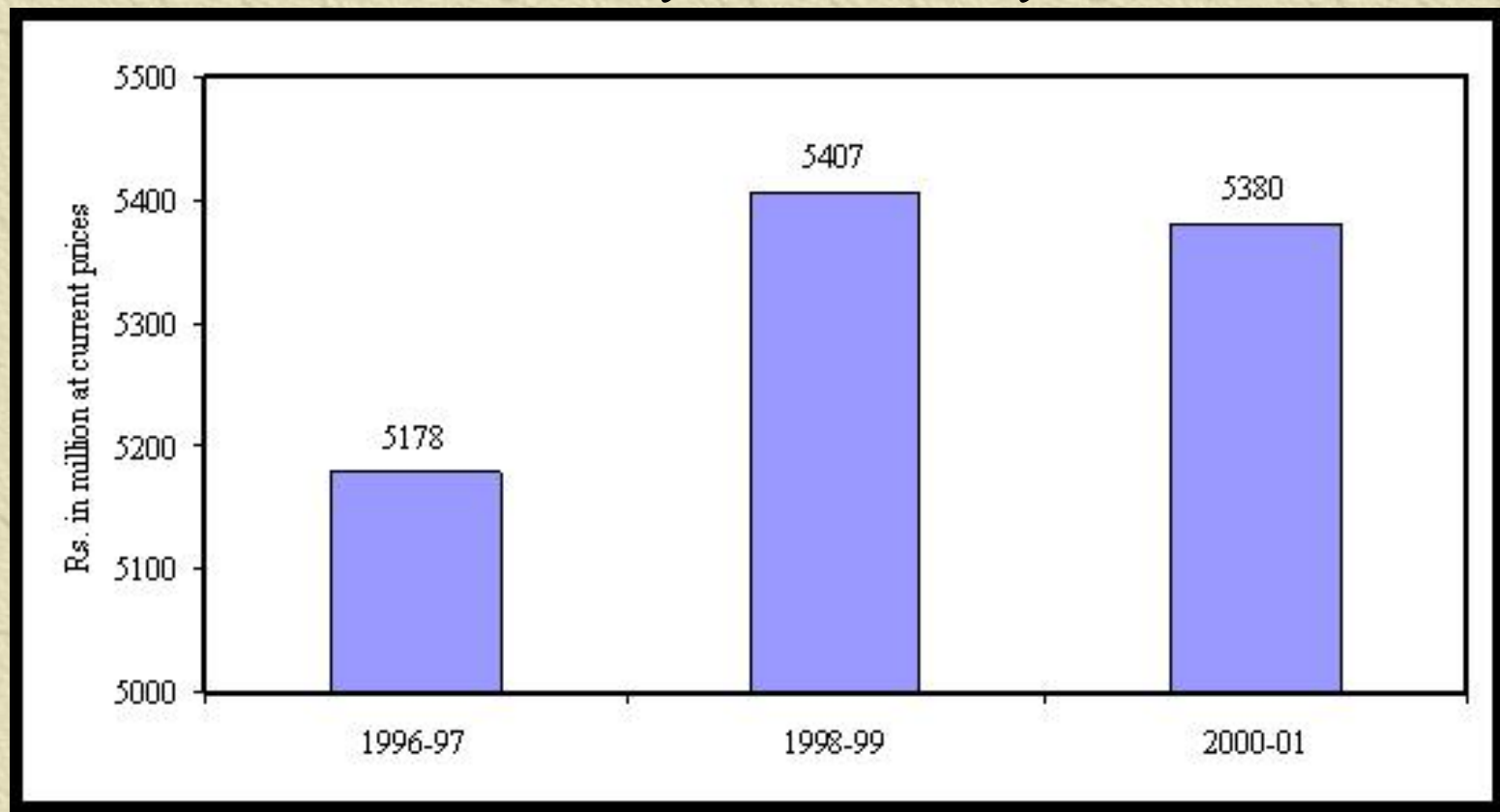
Objective –

To show how economic analysis may be used as an aid to decision making in the management of public transport systems.

Crisis in publicly owned UBCs in India

Losses incurred by UBCs during recent years have crossed the mark of Rs. 5 billion per year. On an average, every bus-km operated by these companies resulted in a loss of around Rs. 4.27.

Losses incurred by UBCs over the years



Number of employees per operational bus

	2001-02	1997-98	Percentage increase from 1997-98 to 2001-02
BEST	12.0	12.2	-1.4
BMTC	6.3	7.1	-11.4
AMTS	11.0	9.4	16.8
PMT	10.4	10.1	2.6
TMTU	11.0	12.5	-12.1
PCMT	16.4	14.1	16.4
KMTU	11.1	10.9	1.6

Employee cost share w.r.t. total operating cost (in percentage)

	2001-02	1997-98	Increase from 1997-98 to 2001-02
BEST	74.2	77.0	-2.8
BMTC	47.6	55.3	-7.7
AMTS	48.8	47.6	1.2
PMT	52.9	47.4	5.4
TMTU	53.1	47.8	5.3
PCMT	59.1	58.2	0.9
KMTU	42.9	47.9	-5.0

Total operating cost = total cost – taxes

Bus-Km per employee

	2001-02	1997-98	Percentage increase from 1997-98 to 2001-02
BEST	6378	6053	5.4
BMTC	13182	6906	90.9
AMTS	6530	7900	-17.3
PMT	8402	9007	-6.7
TMTU	7784	5380	44.7
PCMT	5765	7309	-21.1
KMTU	8367	8130	2.9

Bus-Km per bus held

	2001-02	1997-98	Percentage increase from 1997-98 to 2001-02
BEST	69261	69539	-0.4
BMTC	79400	44748	77.3
AMTS	52241	60716	-14.0
PMT	69901	77629	-10.0
TMTU	73712	59401	24.1
PCMT	49276	67228	-26.7
KMTU	82500	75957	8.6

Fleet utilization (in percentage)

	2001-02	1997-98	Increase from 1997-98 to 2001-02
BEST	90.2	94.1	-3.9
BMTC	95.7	91.3	4.4
AMTS	72.5	81.3	-8.8
PMT	80.1	85.1	-5.0
TMTU	86.4	88.5	-2.1
PCMT	52.2	65.4	-13.2
KMTU	89.0	85.7	3.3

Bus-Km per litre of diesel

	2001-02	1997-98	Percentage increase from 1997-98 to 2001-02
BEST	2.99	3.01	-0.7
BMTC	4.33	3.86	12.2
AMTS	3.51	3.49	0.6
PMT	3.26	3.39	-3.9
TMTU	3.27	3.30	-0.8
PCMT	3.62	3.58	1.1
KMTU	3.44	3.38	1.8

Operating cost per bus-km (in Rs. at constant 2001-02 prices)

	2001-02	1997-98	Percentage increase from 1997-98 to 2001-02
BEST	34.7	31.1	11.5
BMTC	14.1	15.7	-10.5
AMTS	26.1	19.9	31.3
PMT	19.1	17.9	6.6
TMTU	22.0	21.4	2.8
PCMT	19.3	14.7	31.9
KMTU	18.6	16.6	11.8

Operating cost per pass.-km (in Rs. at constant 2001-02 prices)

	2001-02	1997-98	Percentage increase in operating cost per pass.-km from 1997-98 to 2001-02	Percentage increase in average fare per pass.-km from 1997-98 to 2001-02
BEST	0.85	0.75	13.8	15.3
BMTC	0.37	0.39	-4.6	11.3
AMTS	0.72	0.46	54.4	22.6
PMT	0.64	0.51	25.1	21.8
TMTU	0.52	0.47	10.5	3.6
PCMT	0.81	0.48	69.9	32.5
KMTU	0.72	0.70	3.3	4.8

Financial profit per bus-km (in Rs. at constant 2001-02 prices)

	2001-02	1997-98	Increase from 1997-98 to 2001-02
BEST	-6.7	-5.2	-1.6
BMTC	1.2	-1.0	2.3
AMTS	-8.7	-3.6	-5.0
PMT	-3.3	-2.4	-1.0
TMTU	-2.0	0.1	-2.1
PCMT	-6.0	-2.2	-3.8
KMTU	-1.3	-3.1	1.8

Financial profit = total rev. – total cost

Economic profit per bus-km (in Rs. at constant 2001-02 prices)

	2001-02	1997-98	Increase from 1997-98 to 2001-02
BEST	-6.6	-6.3	-0.3
BMTC	0.5	-1.8	2.3
AMTS	-9.4	-3.8	-5.6
PMT	-3.2	-2.6	-0.6
TMTU	-0.3	1.1	-1.4
PCMT	-6.7	-2.4	-4.3
KMTU	-3.0	-2.9	-0.1

Economic profit = traffic rev. – total operating cost

Possible causes of financial crisis in UBCs

- Highly regulated and politically motivated fare policy leading to sub-optimal fare rates (either too high or too low);
 - What is the current policy? Subsidize basic public transport for the poor and allow differentiated services at relatively higher prices.
 - What is suggested by the worldwide experience? Blanket fare controls often destroy public transport and public transport fare policies should be part of a comprehensive policy.
 - What should be policy? Concentrate on financial sustainability; encourage differentiated services; and provide targeted subsidies and finance subsidies directly (not through cross-subsidies).

Possible causes of financial crisis ... contd.

- Lack of innovative pricing strategies;
- High incidence of tax burden;
- Inflexible labor market (hiring and firing is difficult);
- Operate along loss making routes and provide concessional travel facility as a part of their social obligations;
- Low productivity (e.g., CSTC in Kolkata) (How to improve? By reducing staff to bus ratio; increasing bus utilization (bus-km per day); introducing one man operation; using smaller capacity vehicle along low-density routes; hiring of buses; increasing fuel efficiency through training to drivers; etc.
- Operating at sub-optimal scale;
- Lack of variety of services;
- Possibility of revenue leakage;
- Poor passenger information system;
- Lack of marketing approach; etc.

Let us now focus on the linkages between productivity and profitability in UBCs (say in MTUs)

Change in economic profit can be written as:

$$\frac{\pi_T}{\pi_{T-1}} = \frac{R_T / C_T}{R_{T-1} / C_{T-1}} = \frac{(P_T Y_T) / (W_T X_T)}{(P_{T-1} Y_{T-1}) / (W_{T-1} X_{T-1})} \quad (1)$$

Equation (1) can be rewritten as:

$$\frac{\pi_T}{\pi_{T-1}} = \left(\frac{Y_T / X_T}{Y_{T-1} / X_{T-1}} \right) \left(\frac{P_T / W_T}{P_{T-1} / W_{T-1}} \right) \quad (2) \text{ That is,}$$

$$\frac{\pi_T}{\pi_{T-1}} = \left(\frac{TFP_T}{TFP_{T-1}} \right) \left(\frac{PR_T}{PR_{T-1}} \right) \quad (3)$$

Table. Profitability of MTUs during 2000-01 (in Rs. million).

	Accounting profit	Economic profit
BEST	-1736.63	-1875.45
BMTC	121.57	2.21
AMTS	-521.05	-539.68
PMT	-132.73	-140.26
TMTU	-34.20	-3.51
PCMT	-50.48	-51.49
KMTU	-2.59	-33.06

Table. Changes in profitability of MTUs from 1990-91 to 2000-01.

	Accounting profitability (Total rev. to total cost ratio)		Economic profitability (Traffic rev. to operating cost ratio)	
	1990-91	2000-01	1990-91	2000-01
BEST	0.79	0.80	0.75	0.78
BMTC	0.94 (97-98)	1.05	0.89 (97-98)	1.00
AMTS	0.77	0.62	0.69	0.60
PMT	0.92	0.87	0.91	0.86
TMTU	0.95	0.91	1.03	0.99
PCMT	0.94	0.78	0.96	0.77
KMTU	0.98	0.98	1.01	0.70

Measuring productivity of sample undertakings

$$\ln\left(\frac{TFP_T}{TFP_{T-1}}\right) = \sum_i \left(\frac{\mathfrak{R}_{iT} + \mathfrak{R}_{iT-1}}{2}\right) \ln\left(\frac{Y_{iT}}{Y_{iT-1}}\right) - \sum_j \left(\frac{S_{jT} + S_{jT-1}}{2}\right) \ln\left(\frac{X_{jT}}{X_{jT-1}}\right)$$

(4)

where T and $T-1$ are adjacent time periods, the Y_{iT} are output indices, the X_{jT} are input indices, the \mathfrak{R}_{iT} are output revenue shares, and the S_{jT} are input cost shares.

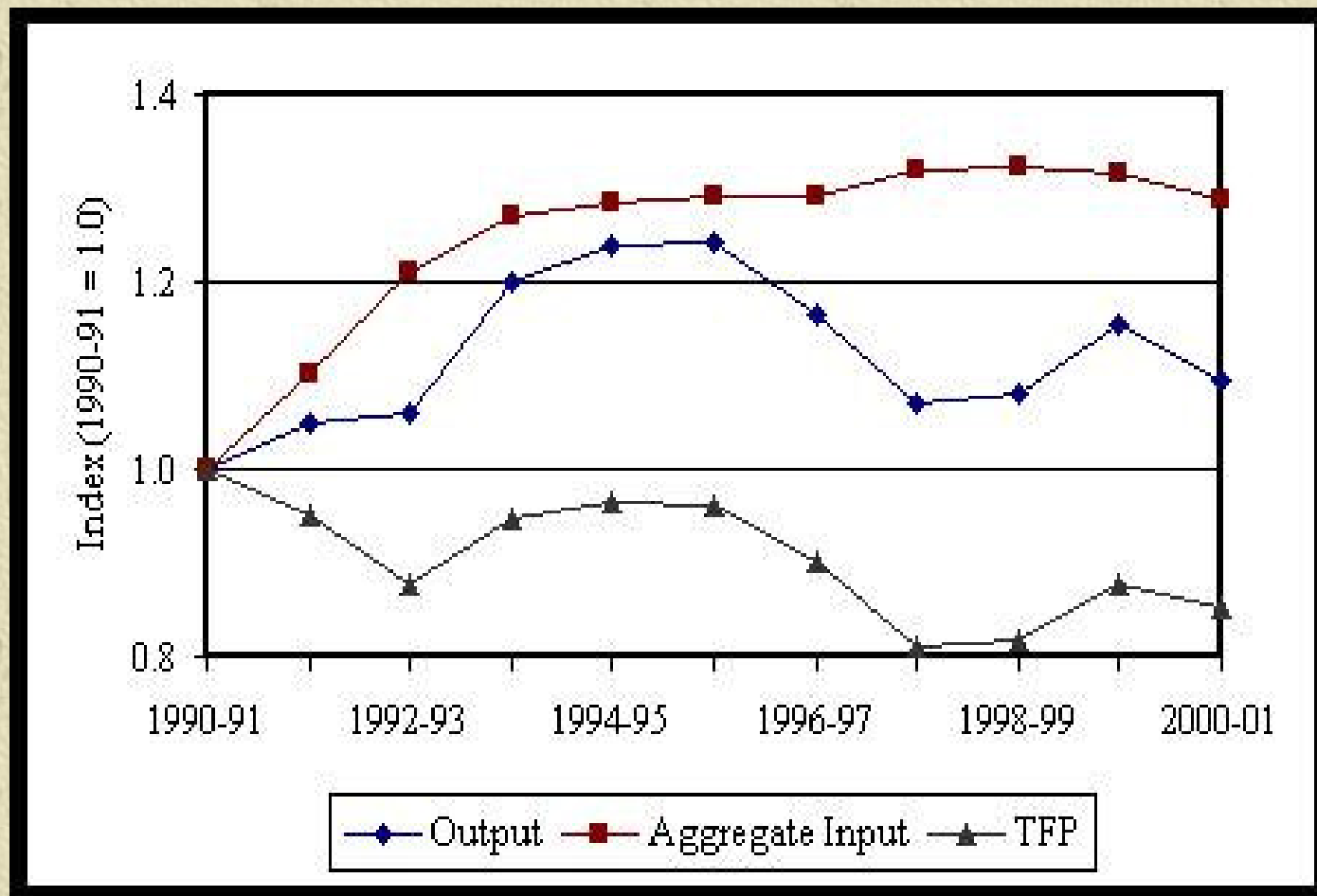
For this analysis,

$$\ln\left(\frac{TFP_T}{TFP_{T-1}}\right) = \ln\left(\frac{Y_T}{Y_{T-1}}\right) - \sum_j \left(\frac{S_{jT} + S_{jT-1}}{2}\right) \ln\left(\frac{X_{jT}}{X_{jT-1}}\right)$$

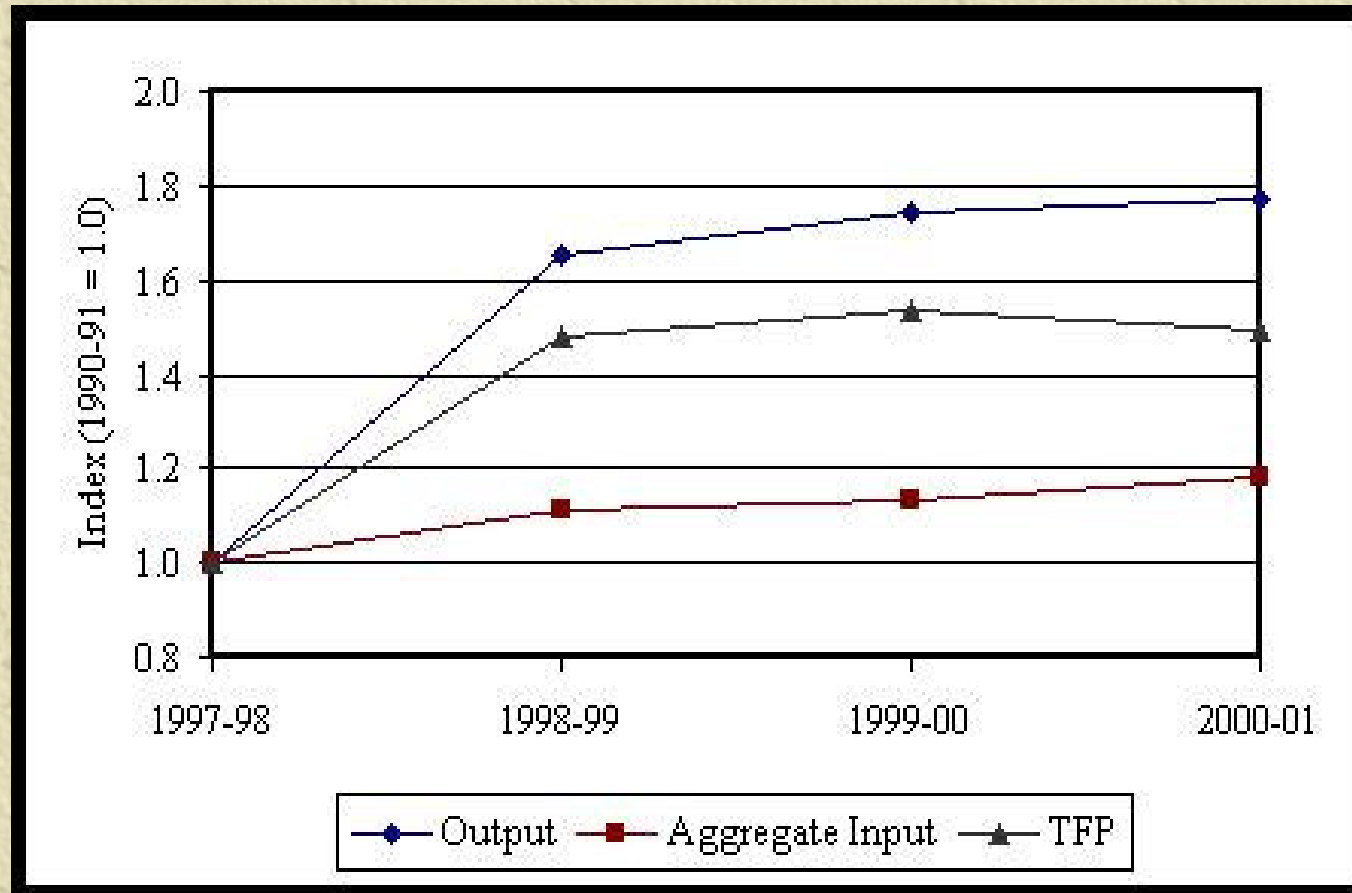
(5)

where j = labor, diesel, and bus.

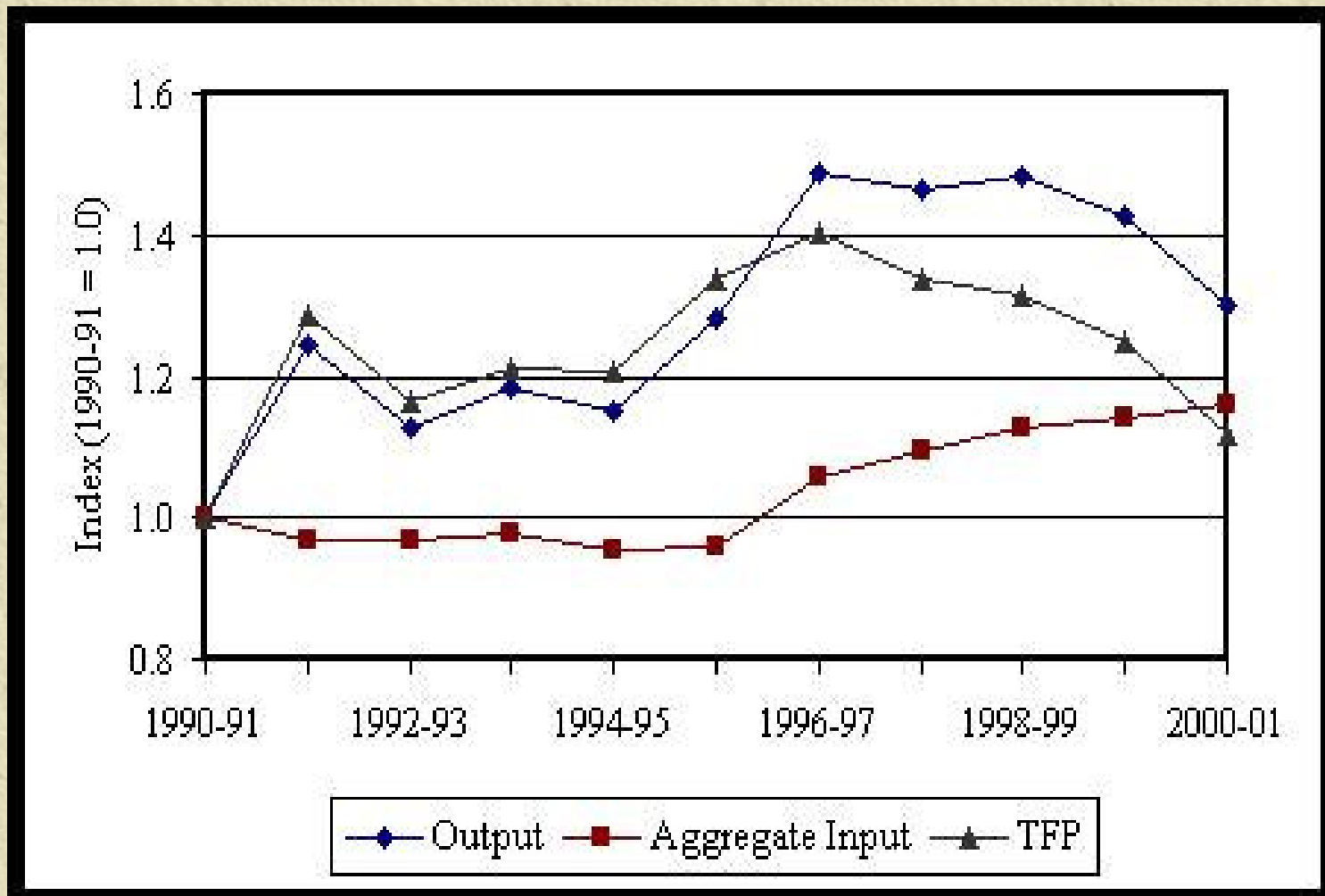
Productivity of BEST



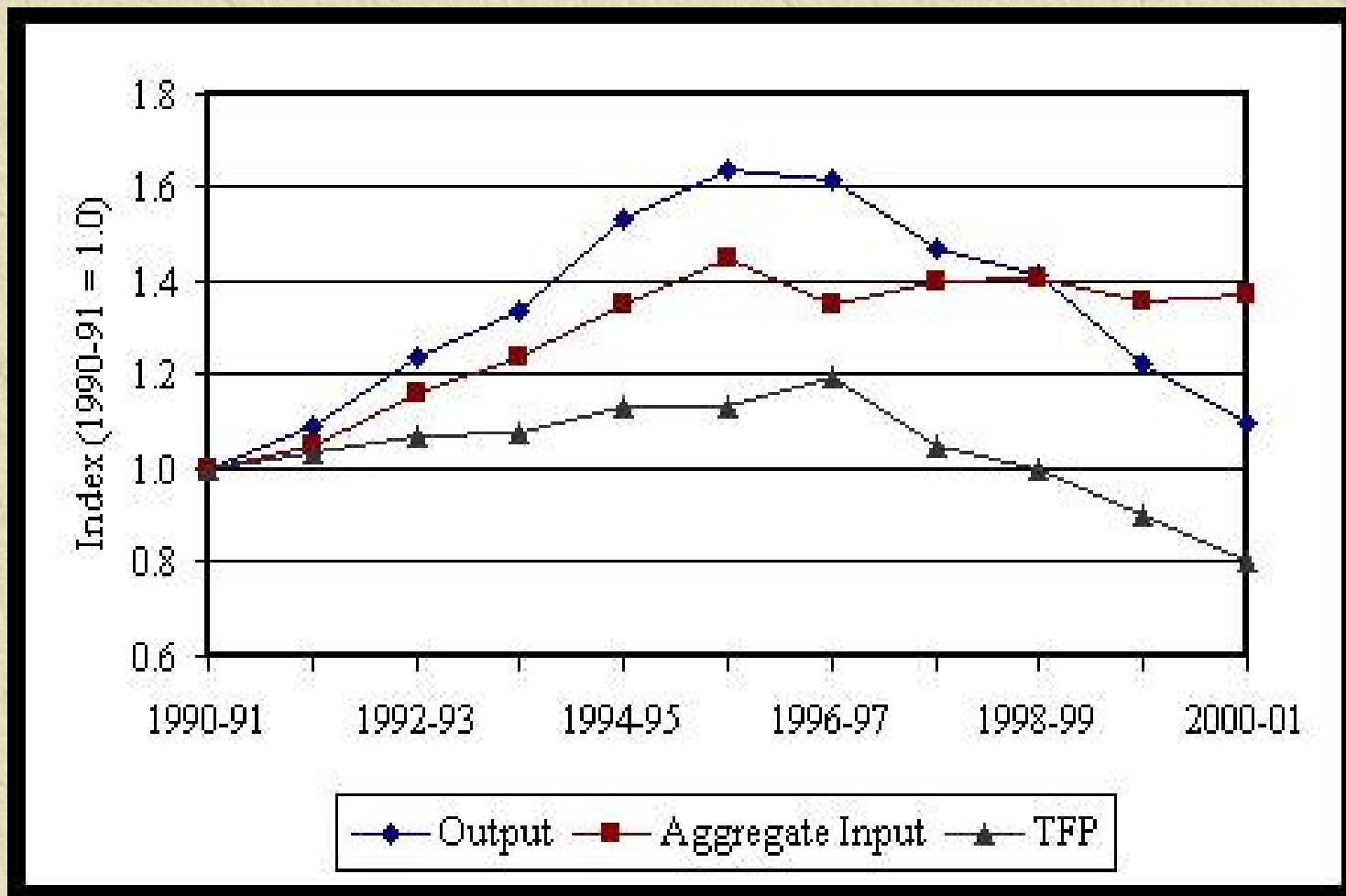
Productivity of BMTC



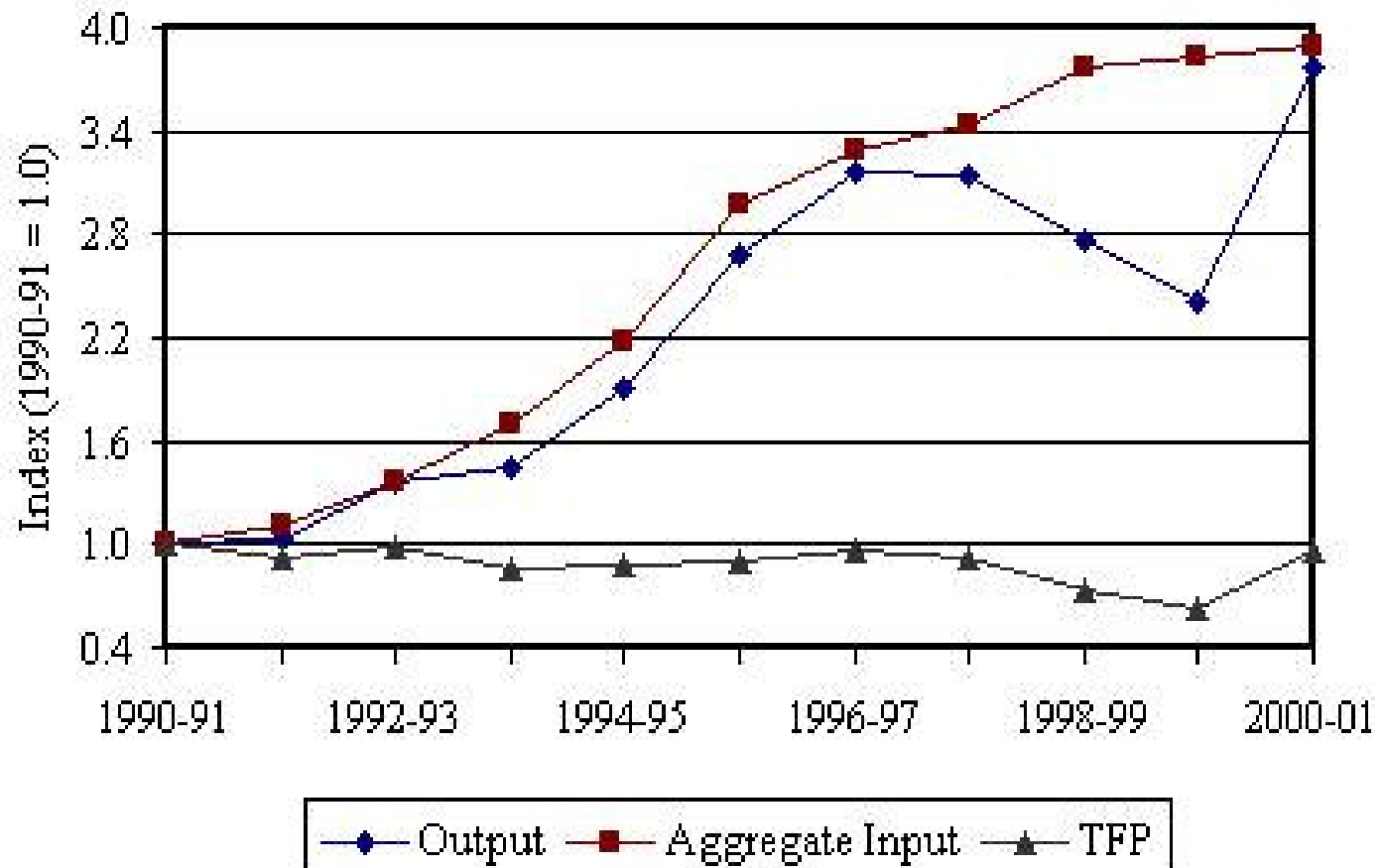
Productivity of AMTS



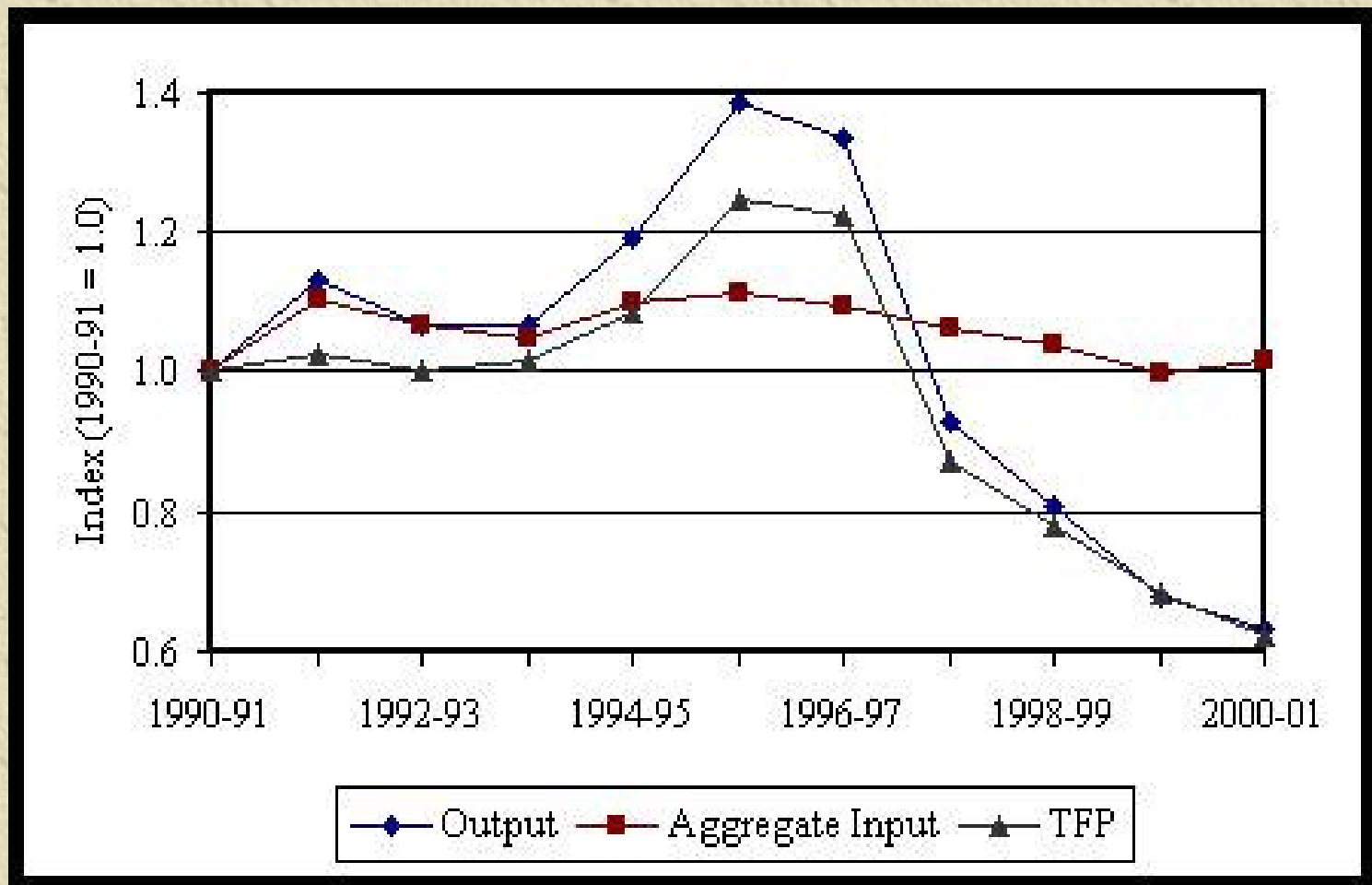
Productivity of PMT



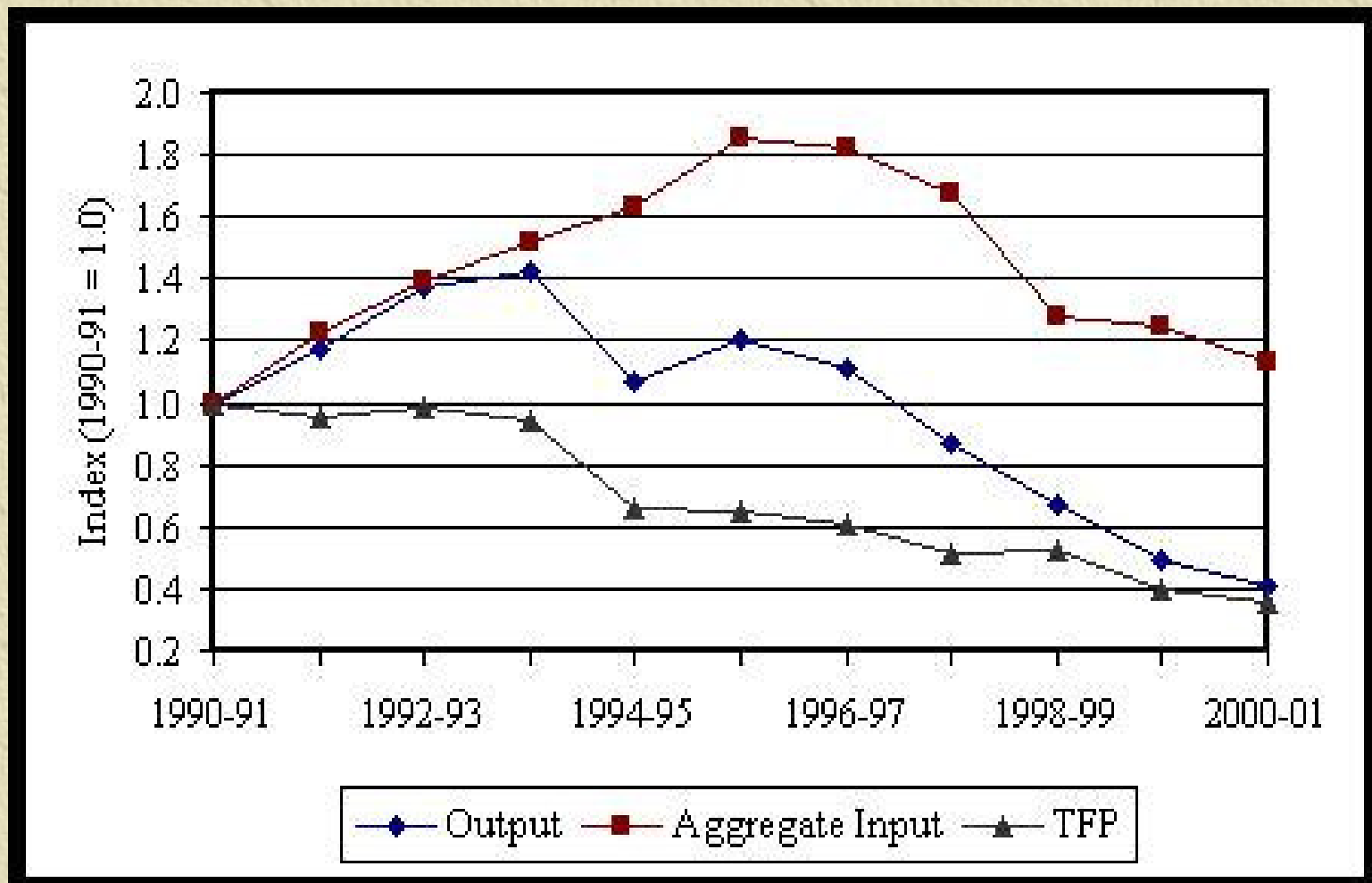
Productivity of TMTU



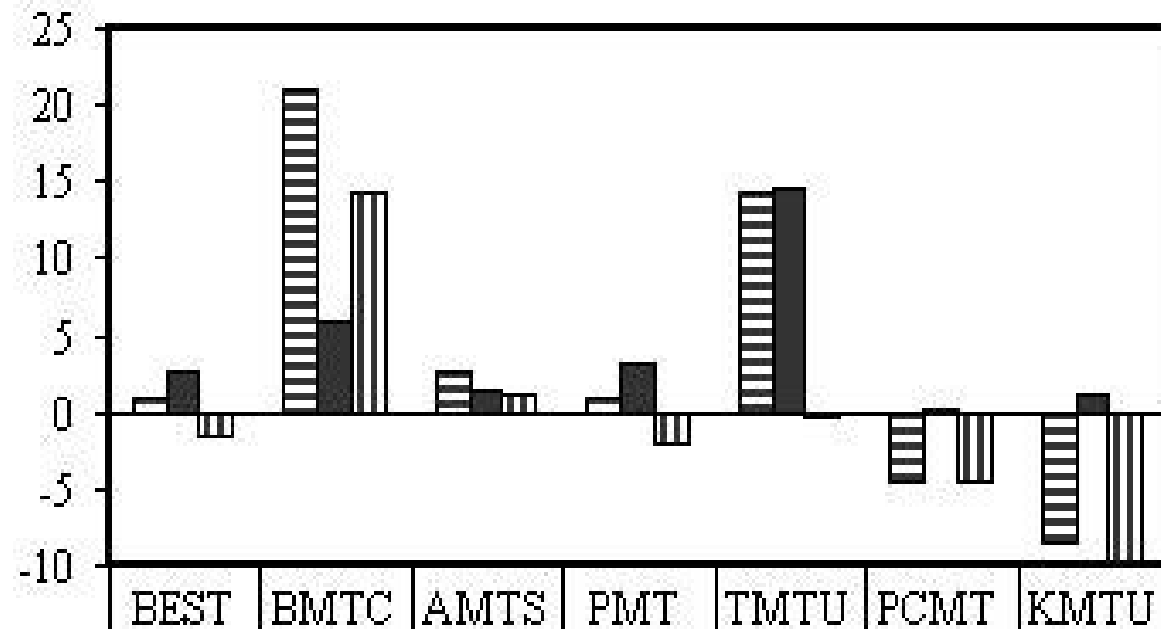
Productivity of PCMT



Productivity of KMTU



Average annual growth (in %age)



	BEST	BMTC	AMTS	PMT	TMTU	PCMT	KMTU
Output	0.92	21.02	2.66	0.95	14.20	-4.49	-8.58
Aggregate input	2.55	5.81	1.51	3.19	14.59	0.17	1.28
Productivity	-1.59	14.38	1.14	-2.17	-0.34	-4.65	-9.74

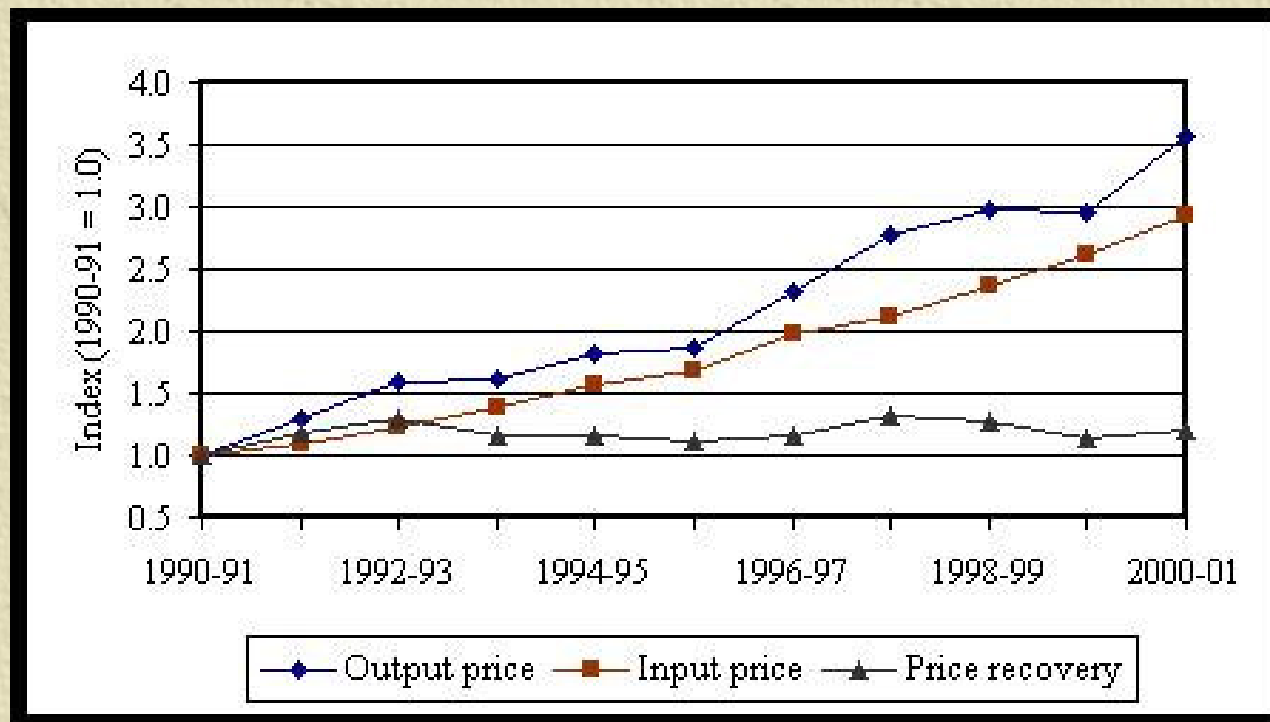
Measuring price recovery of sample undertakings

Price Recovery index = Output price index/Input price index

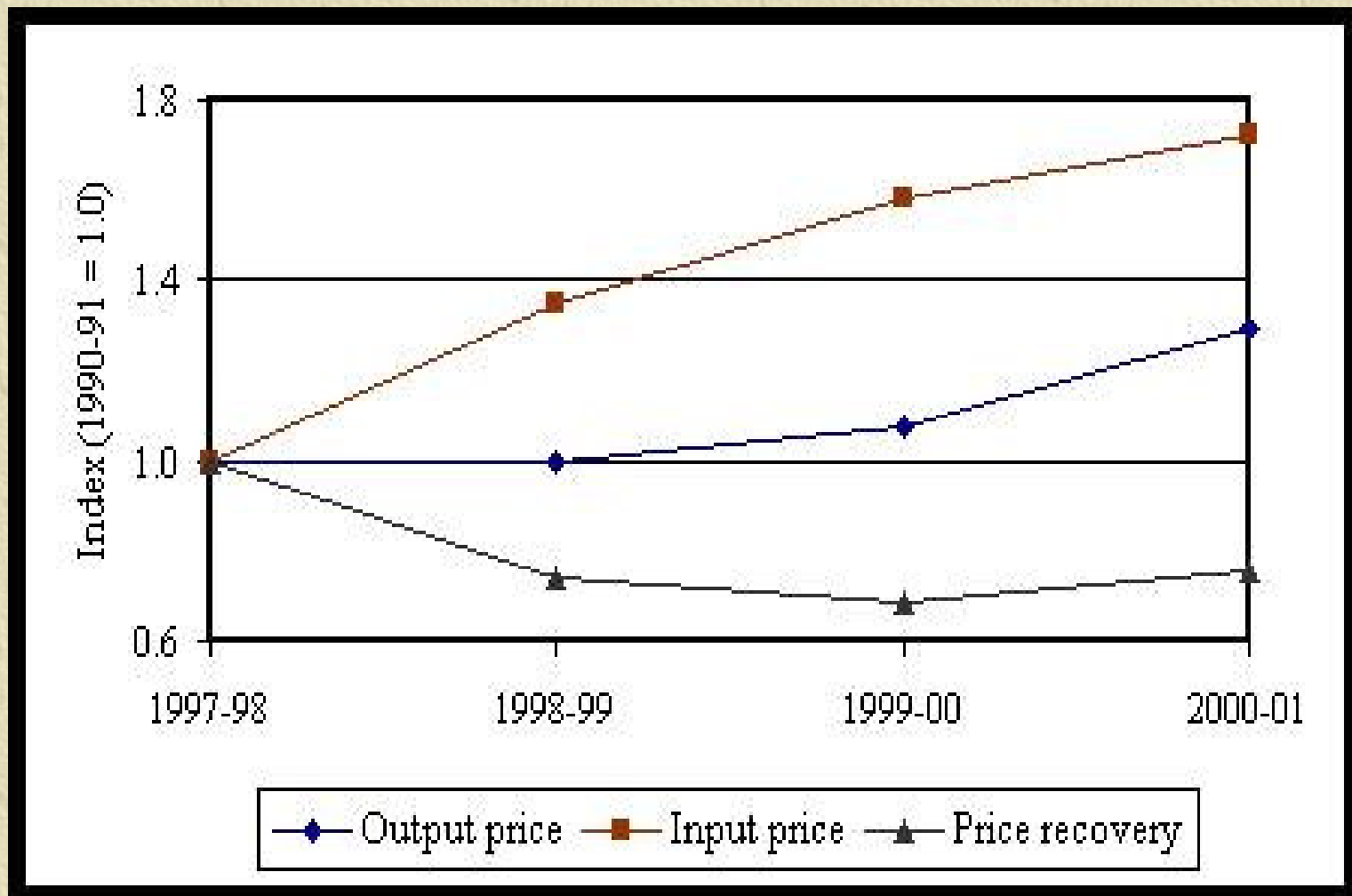
Output price index = Traffic revenue index/Output quantity index

Input price index = Operating cost index/Input quantity index

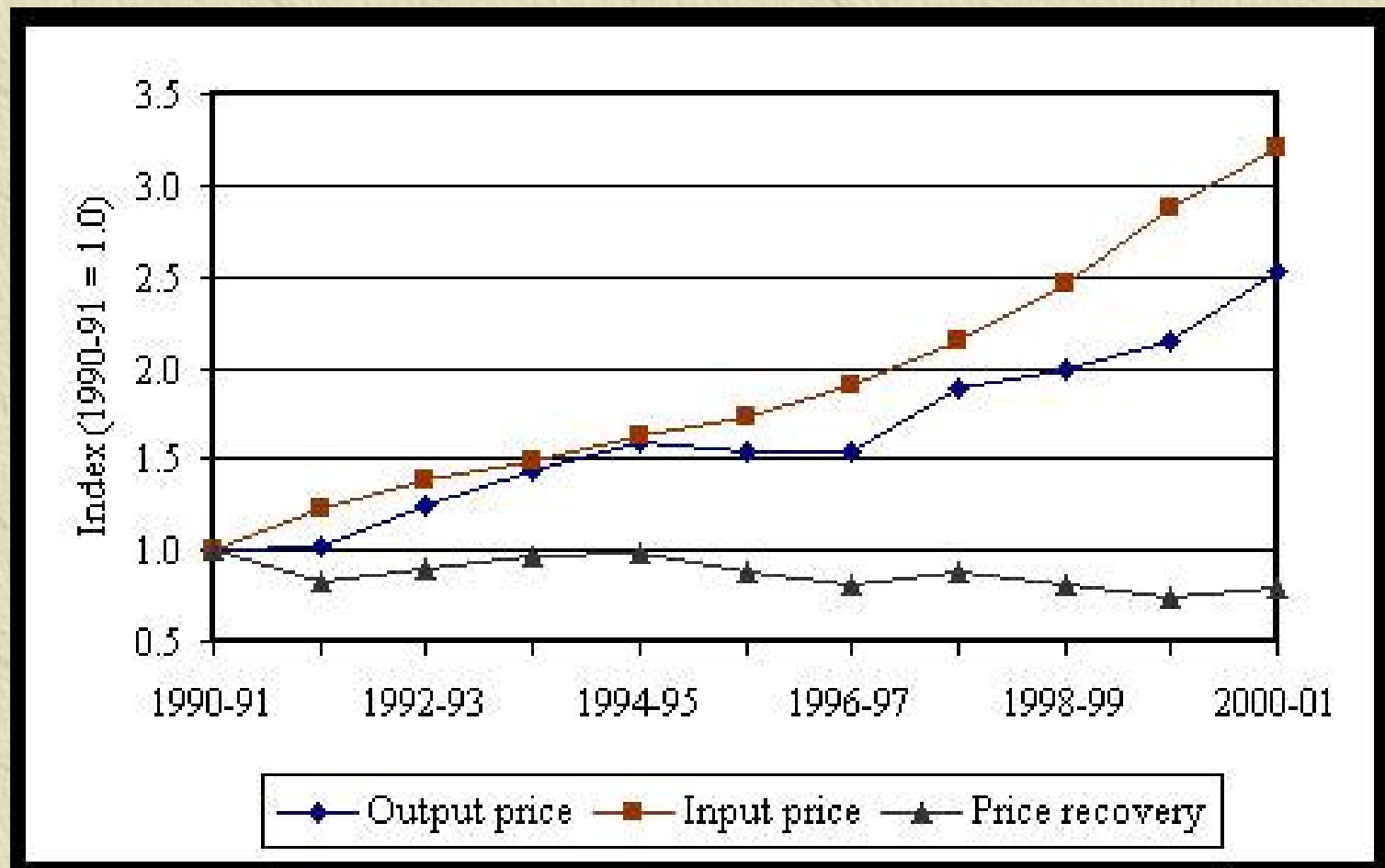
Prices in BEST



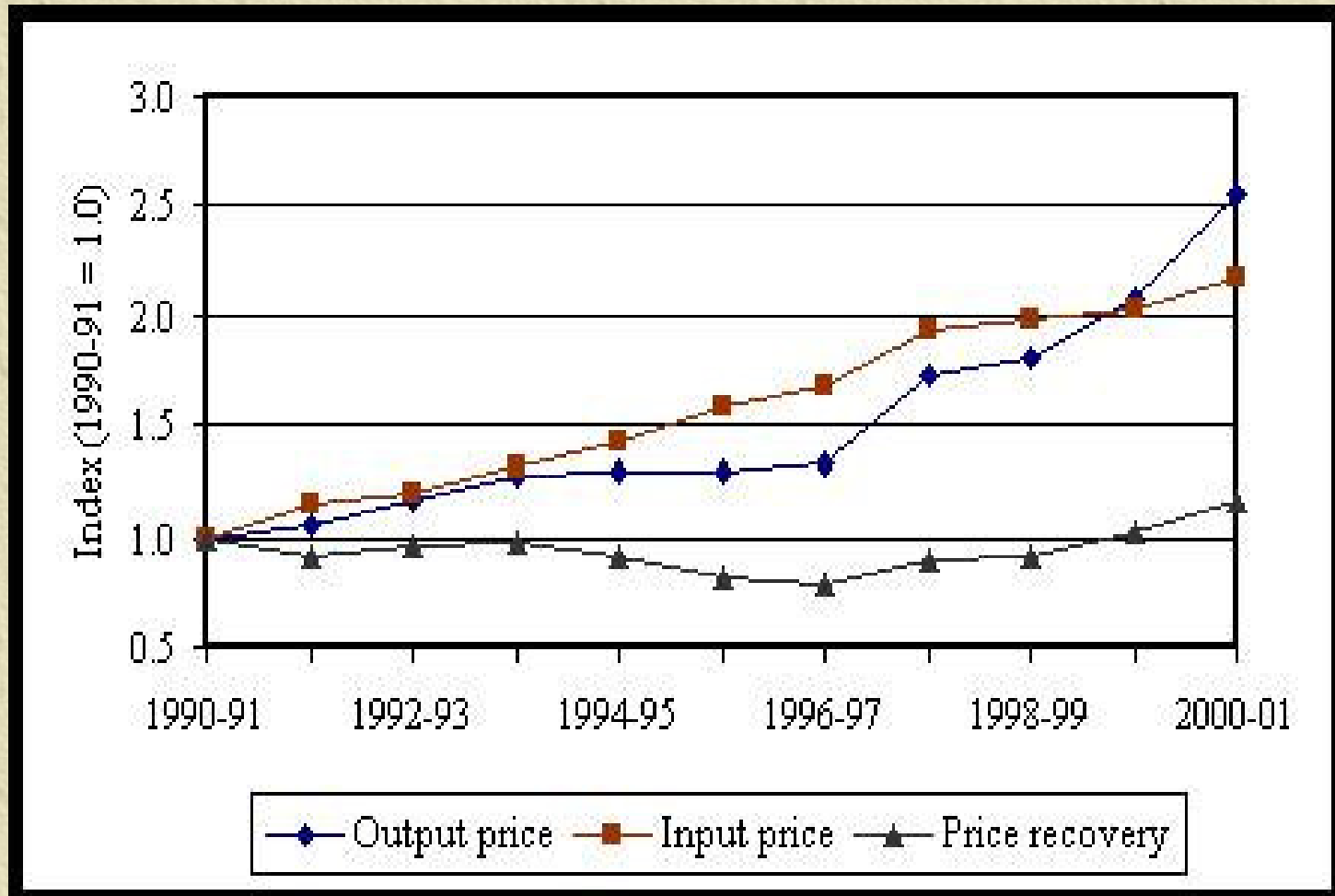
Prices in BMTC



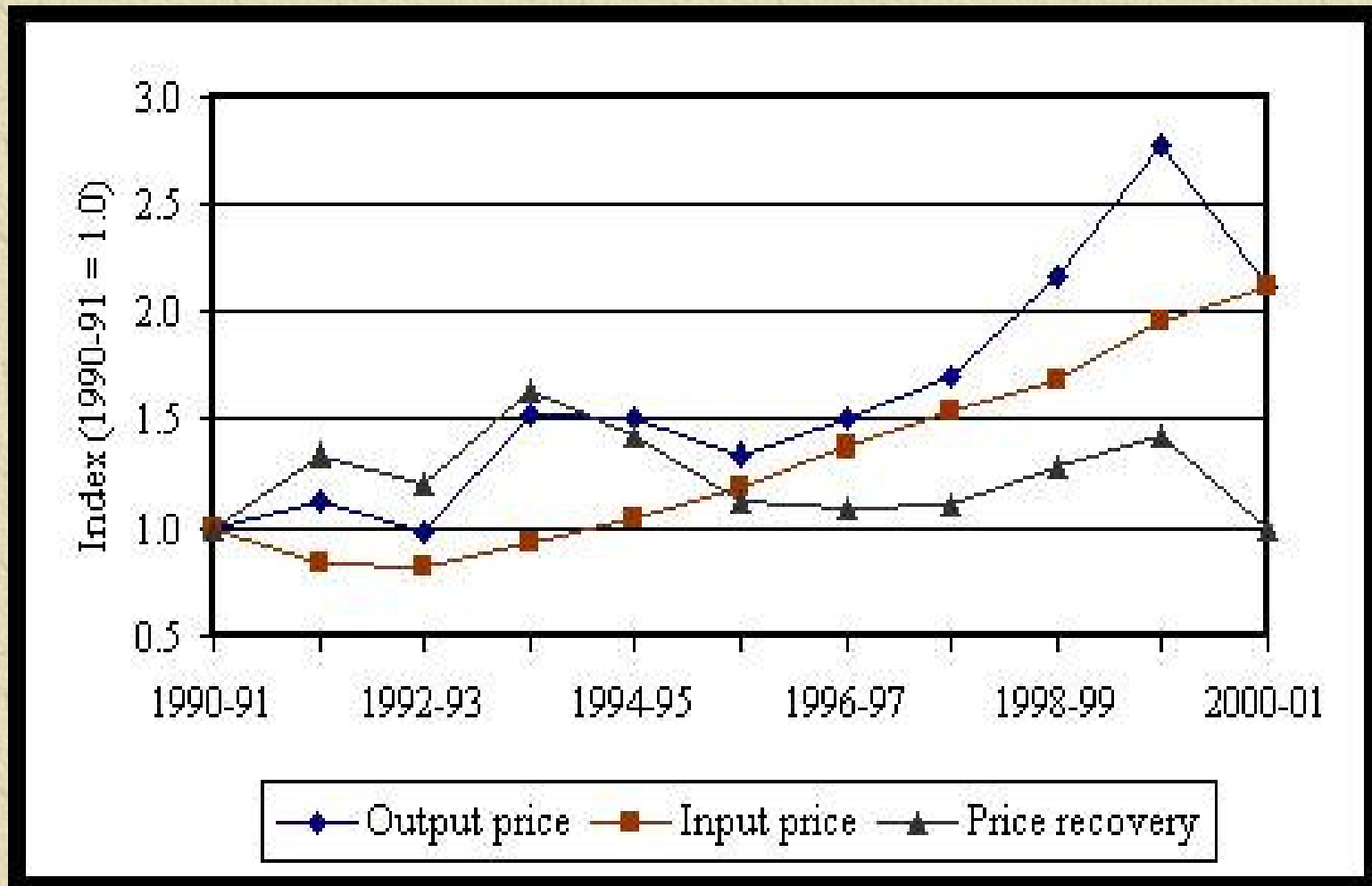
Prices in AMTS



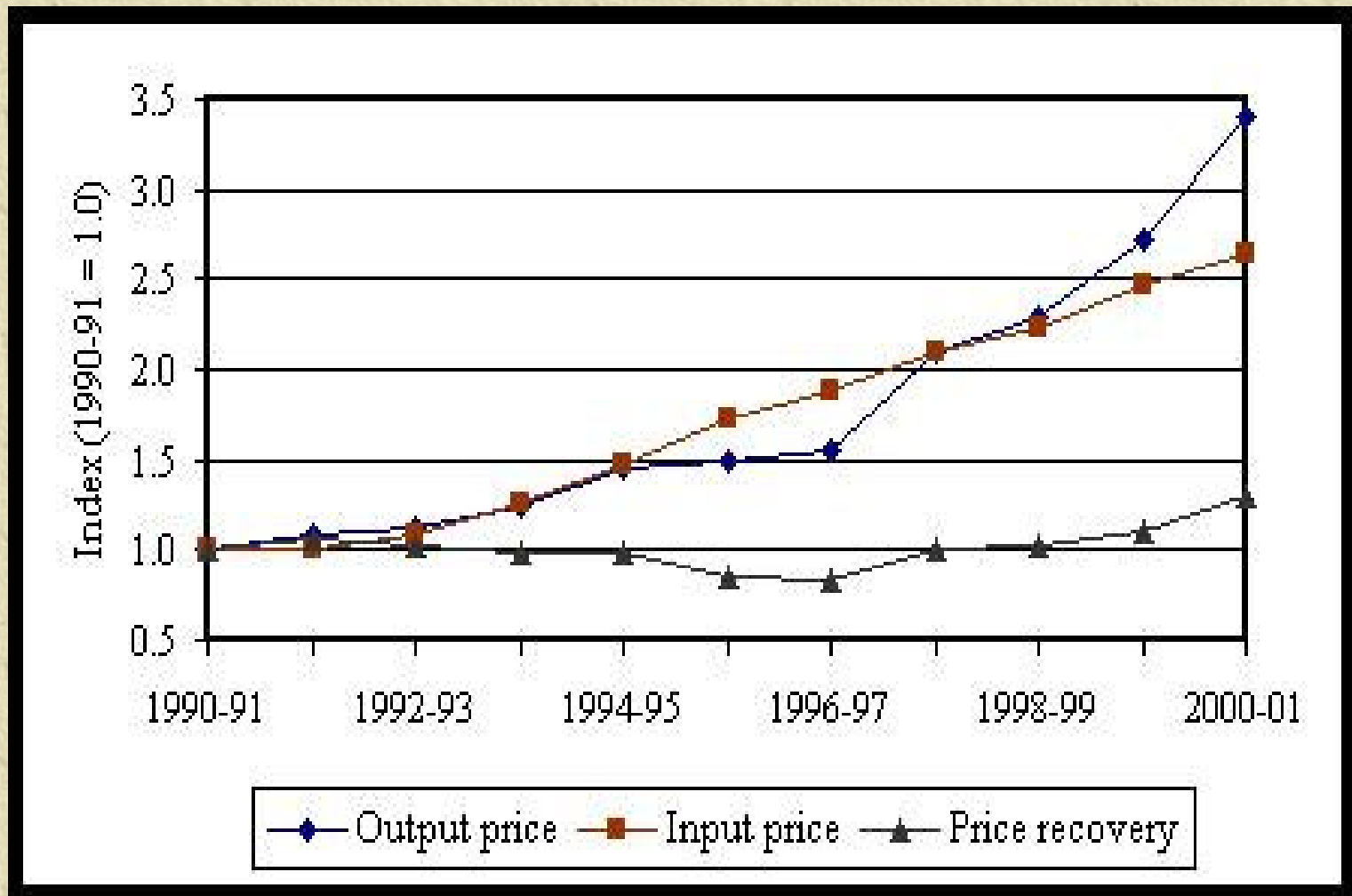
Prices in PMT



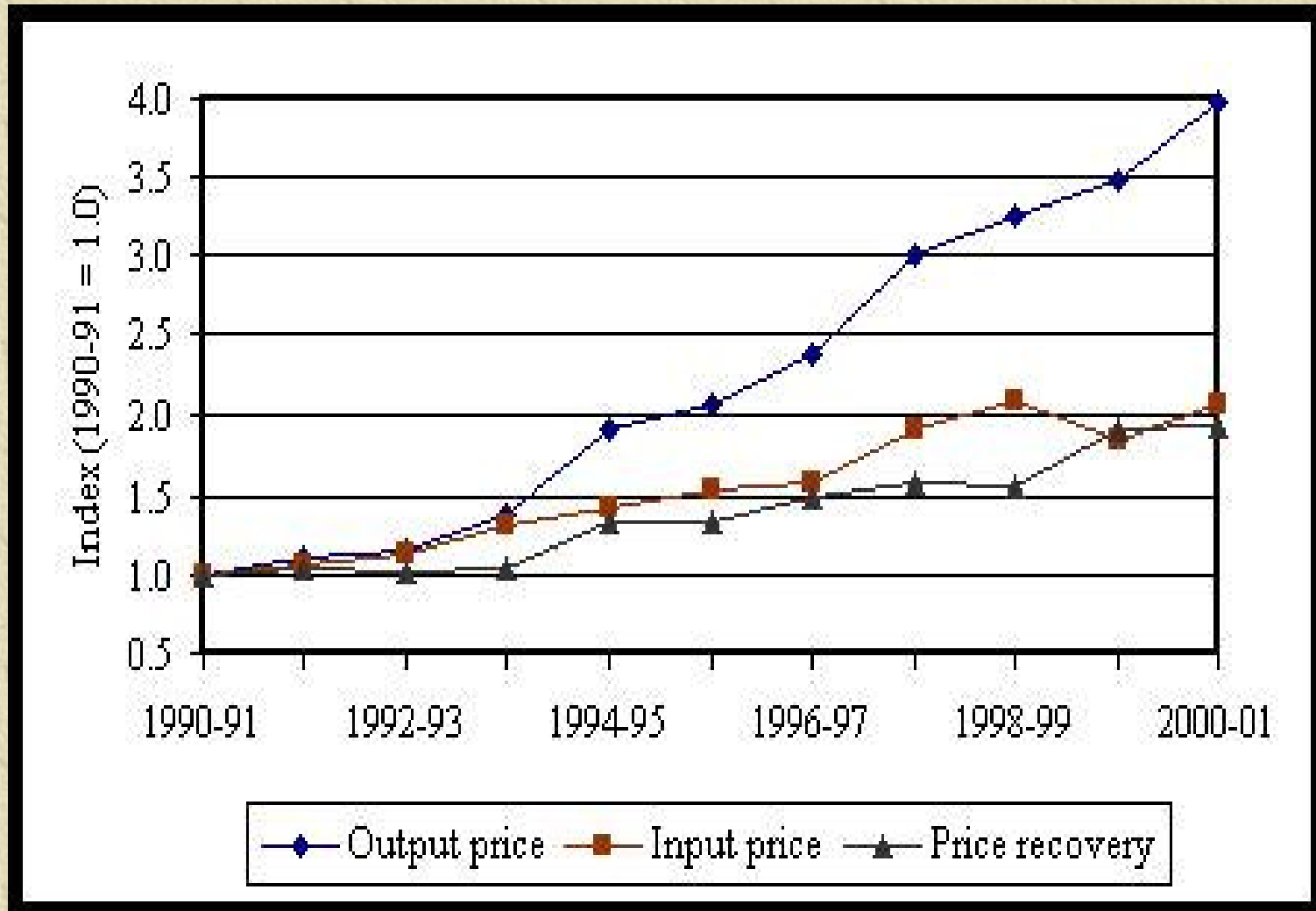
Prices in TMTU



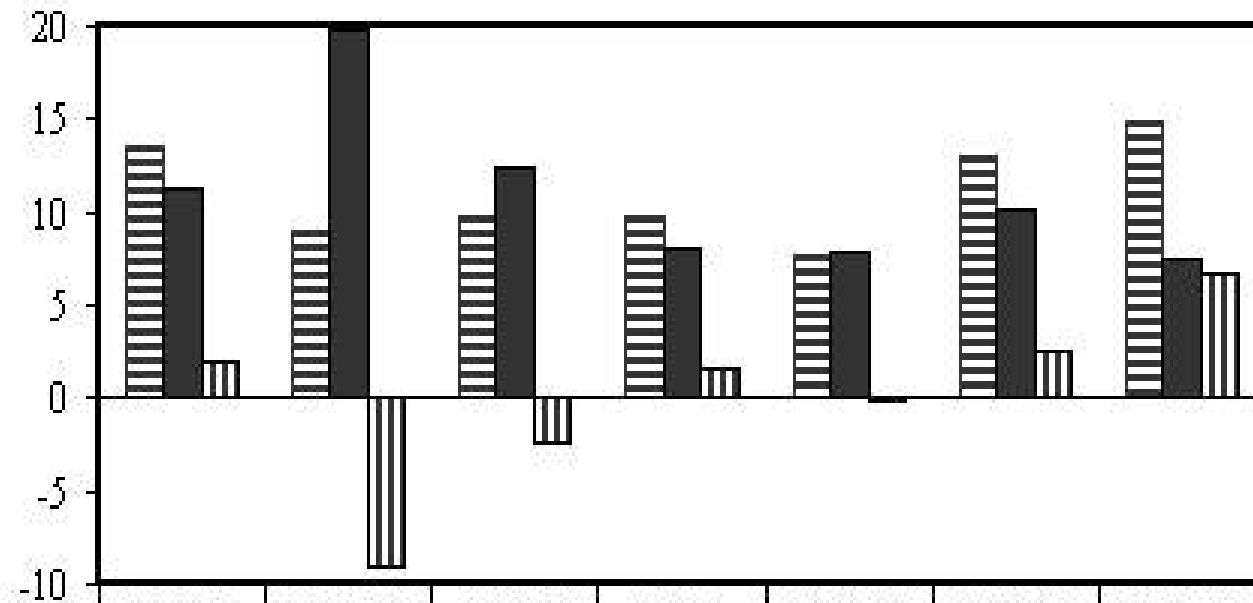
Prices in PCMT



Prices in KMTU



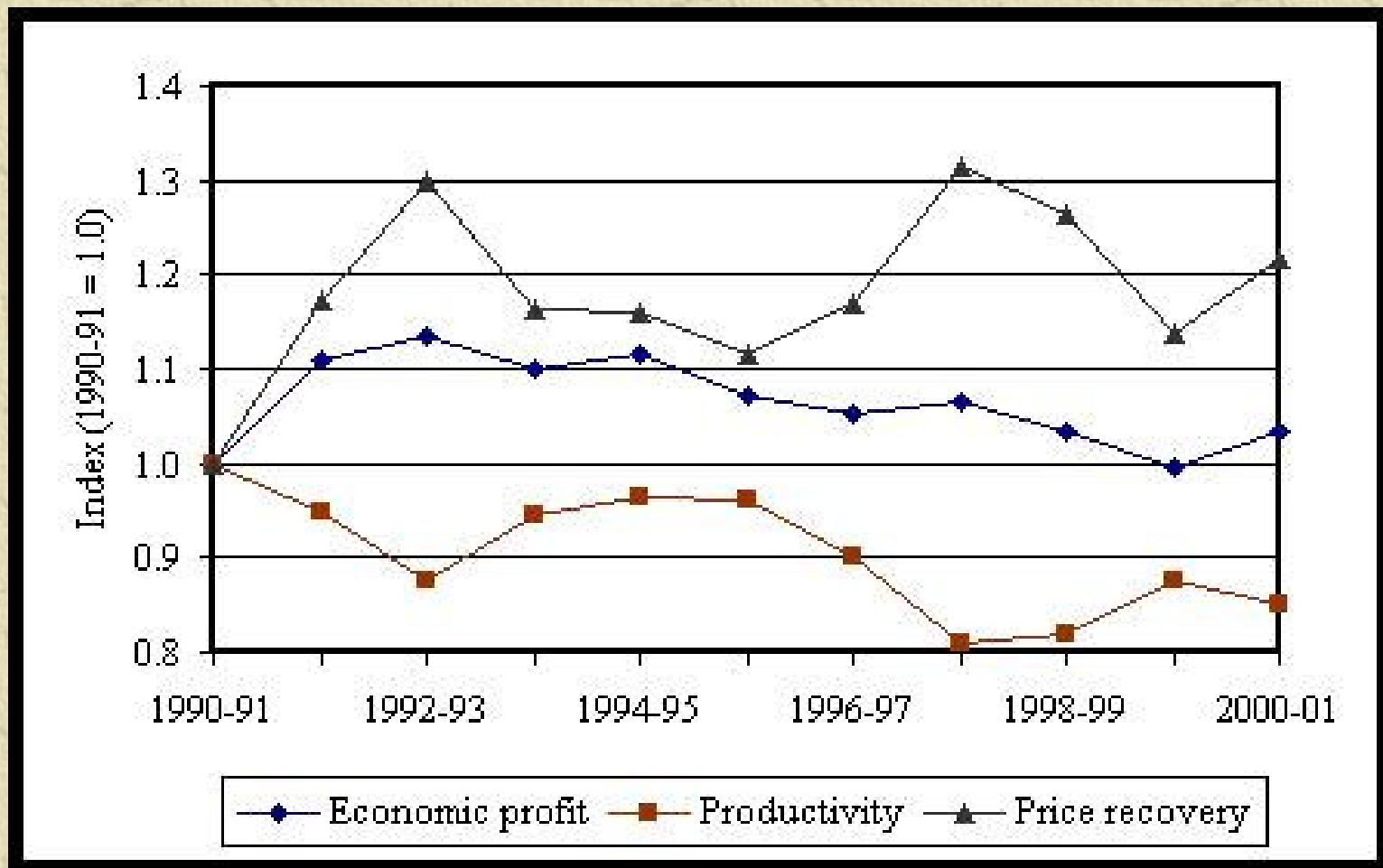
Average annual growth rate (in %age)



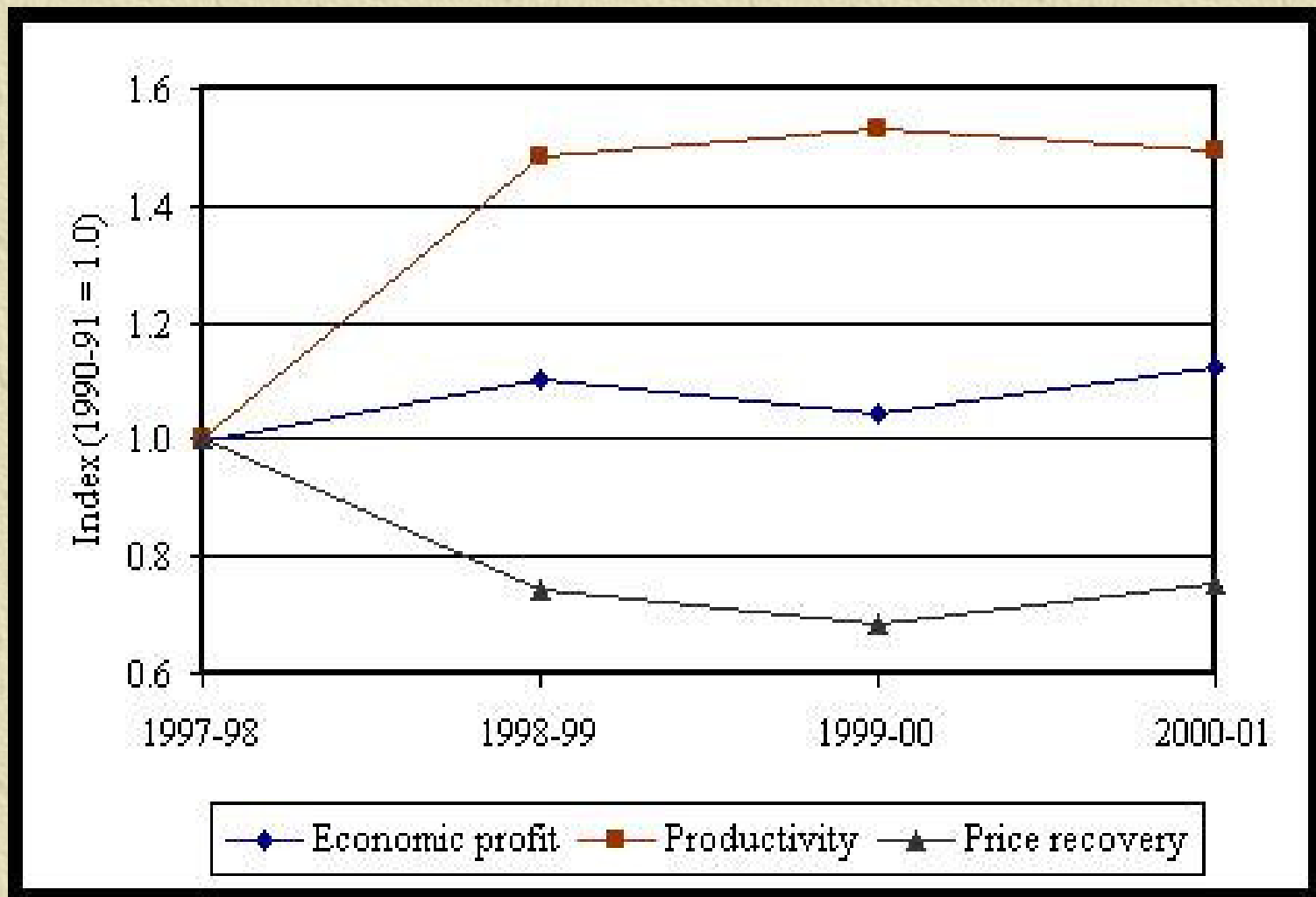
	BEST	BMTC	AMTS	PMT	TMTU	PCMT	KMTU
Output price	13.54	9.02	9.69	9.84	7.75	13.01	14.78
Input price	11.35	19.83	12.36	8.07	7.81	10.17	7.52
Price recovery	1.97	-9.03	-2.37	1.64	-0.05	2.58	6.75

Economic profitability, productivity and price recovery pattern

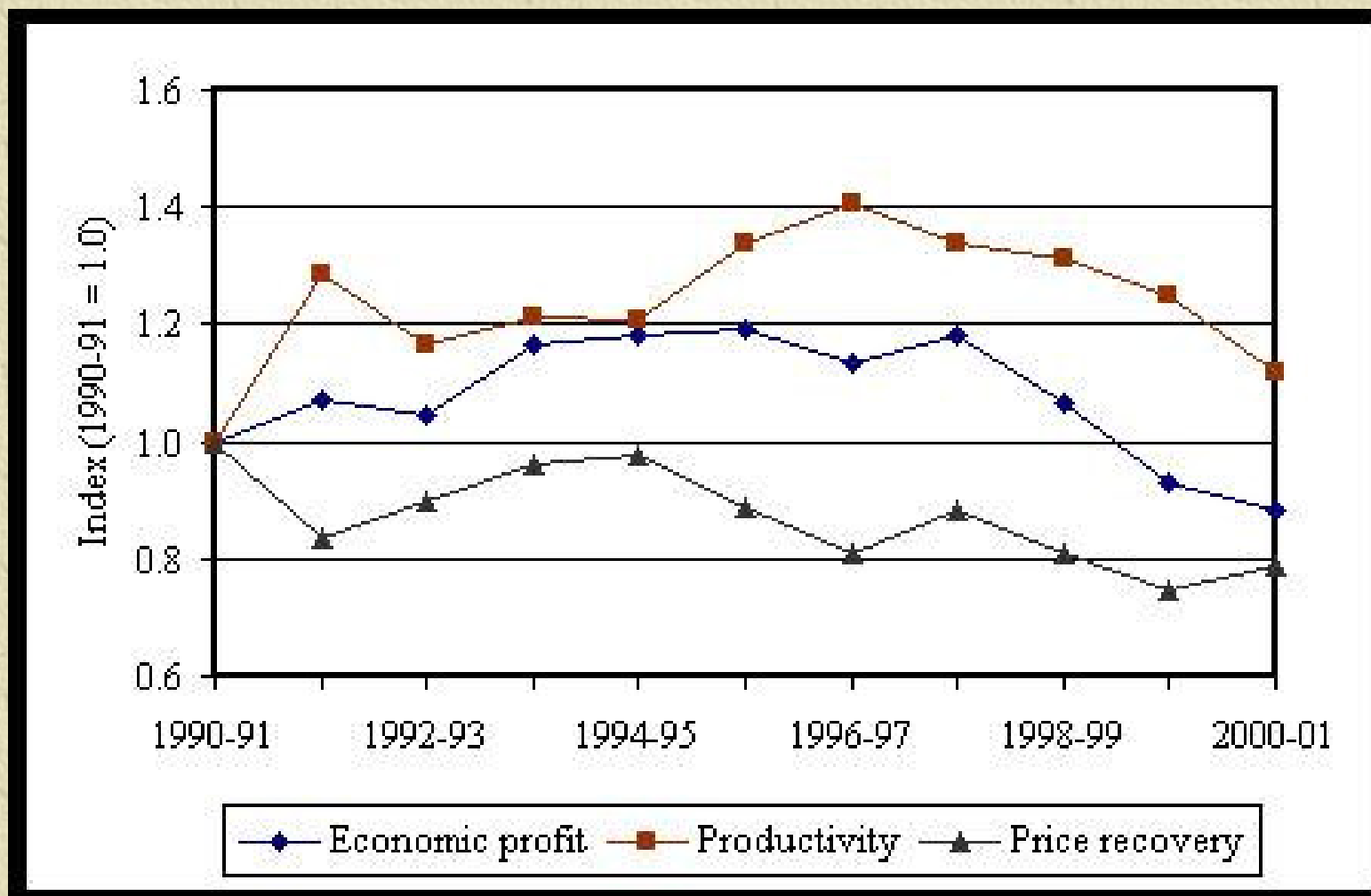
Pattern in BEST



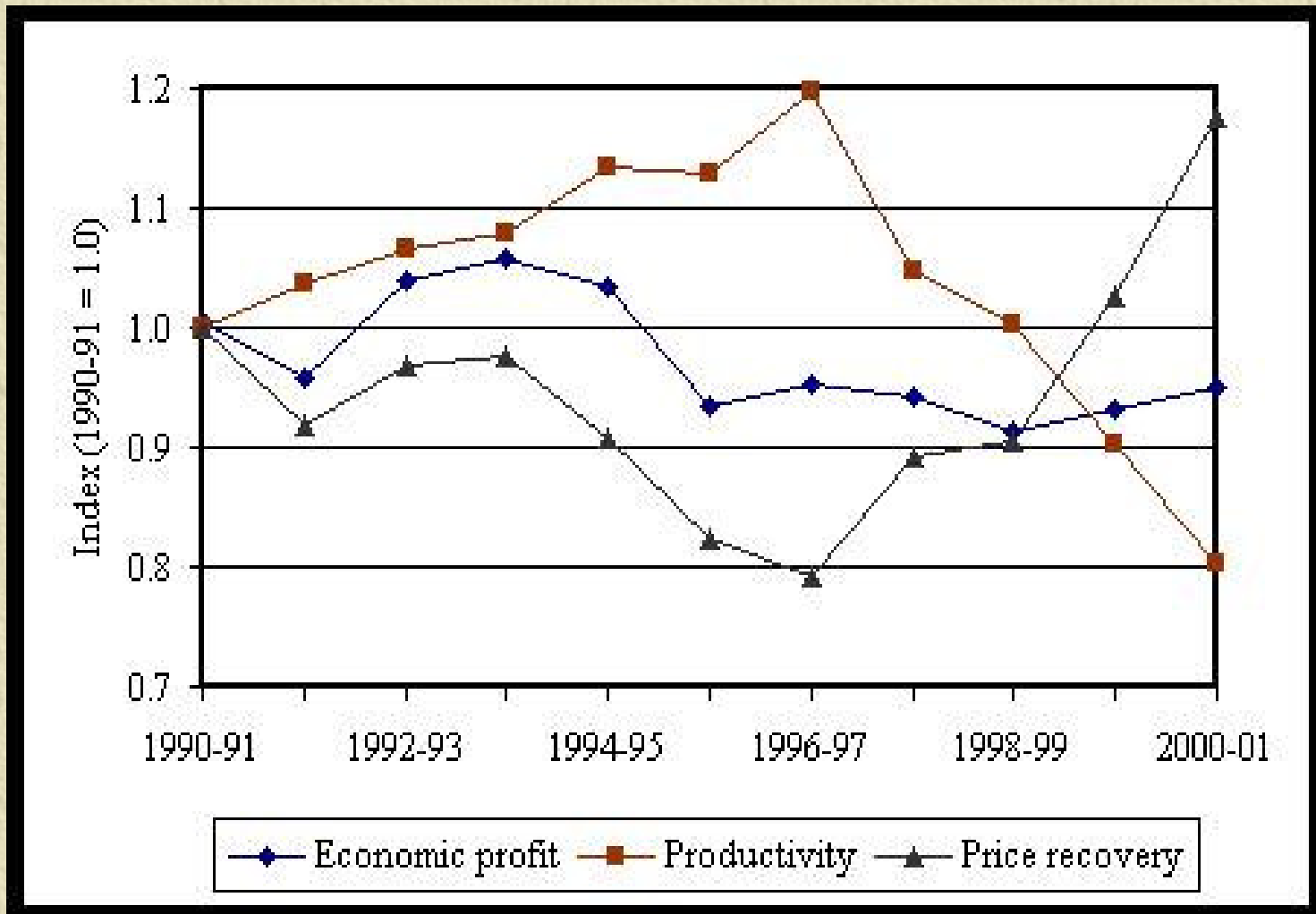
Pattern in BMTC



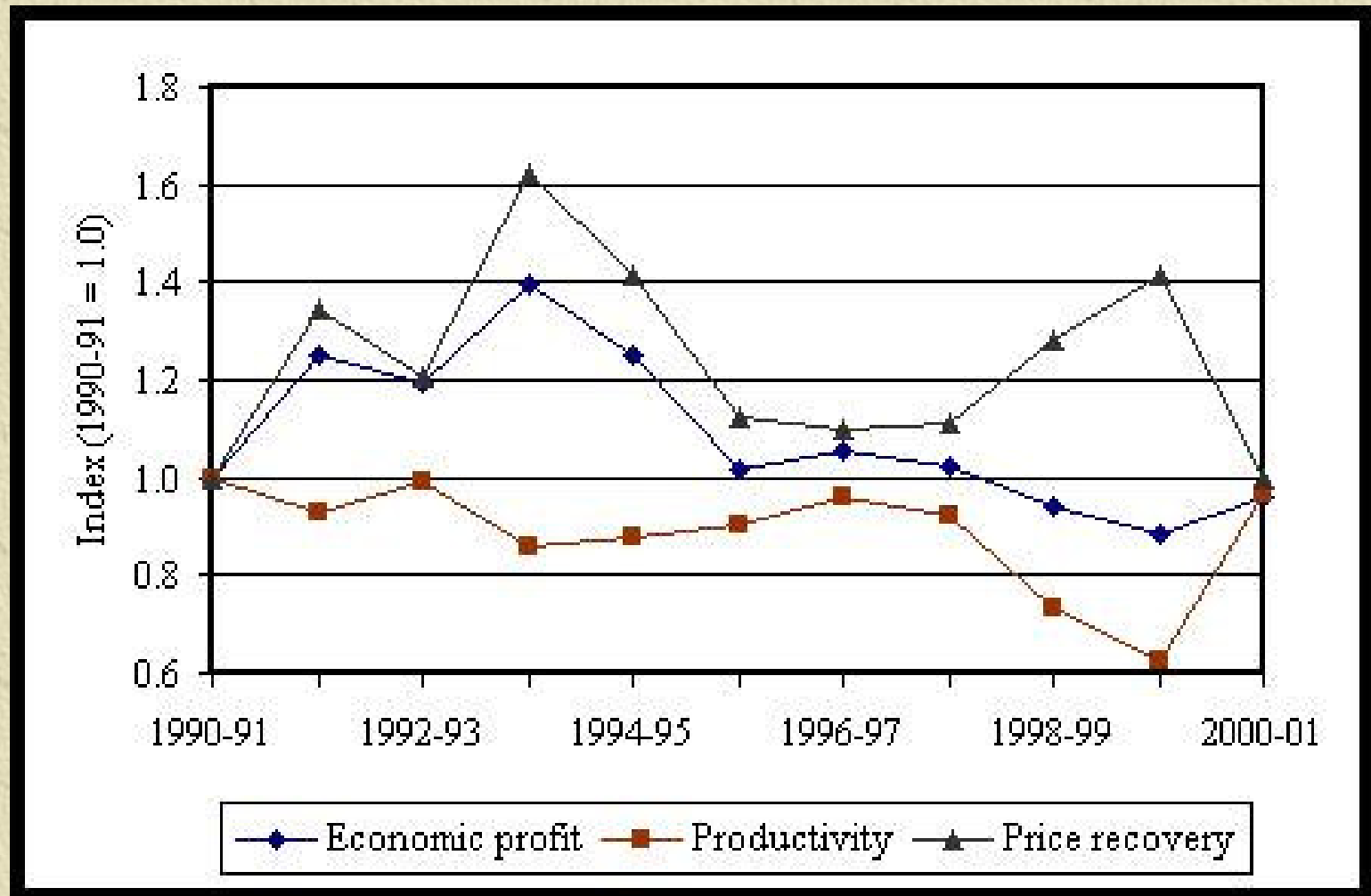
Pattern in AMTS



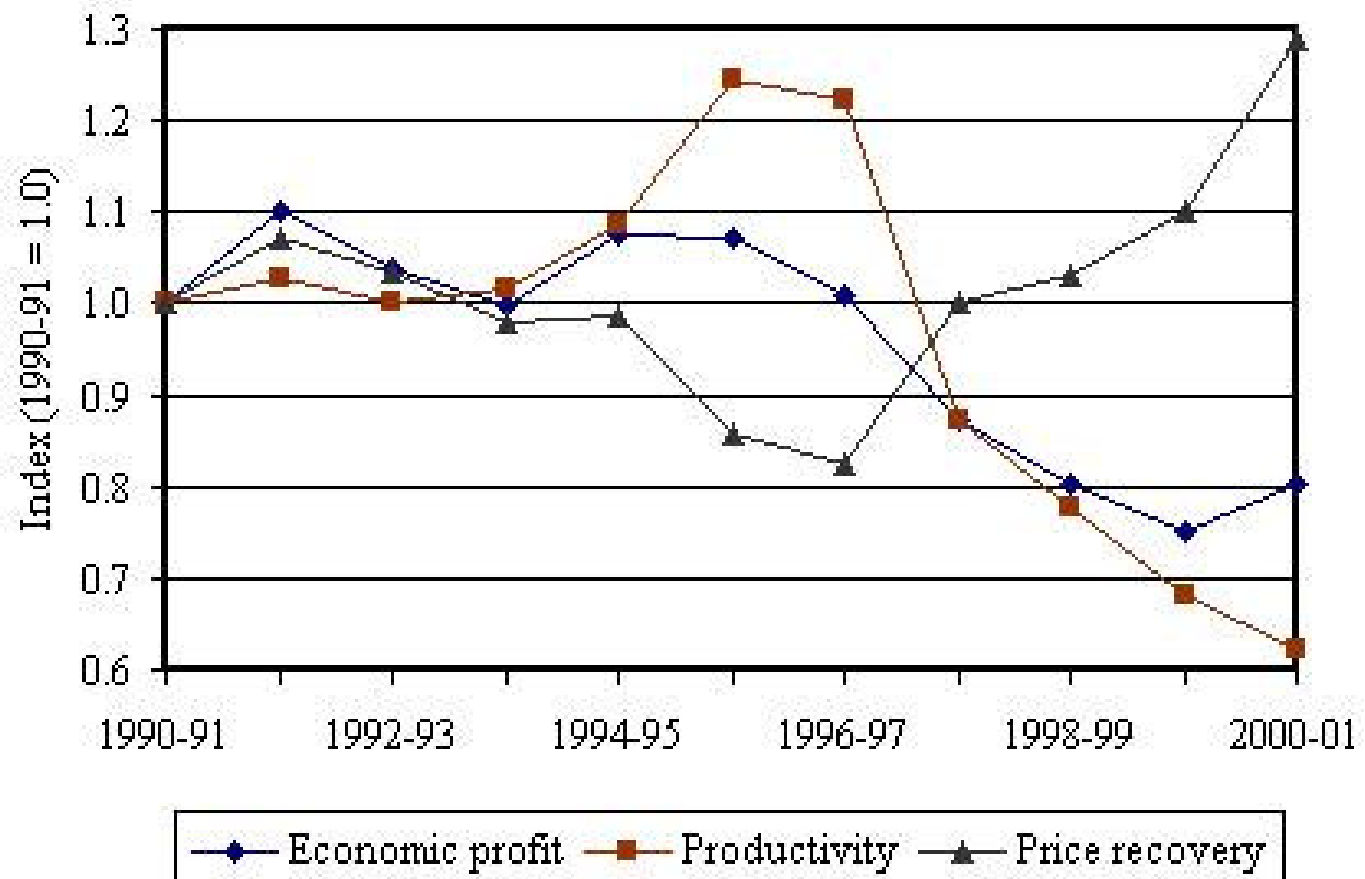
Pattern in PMT



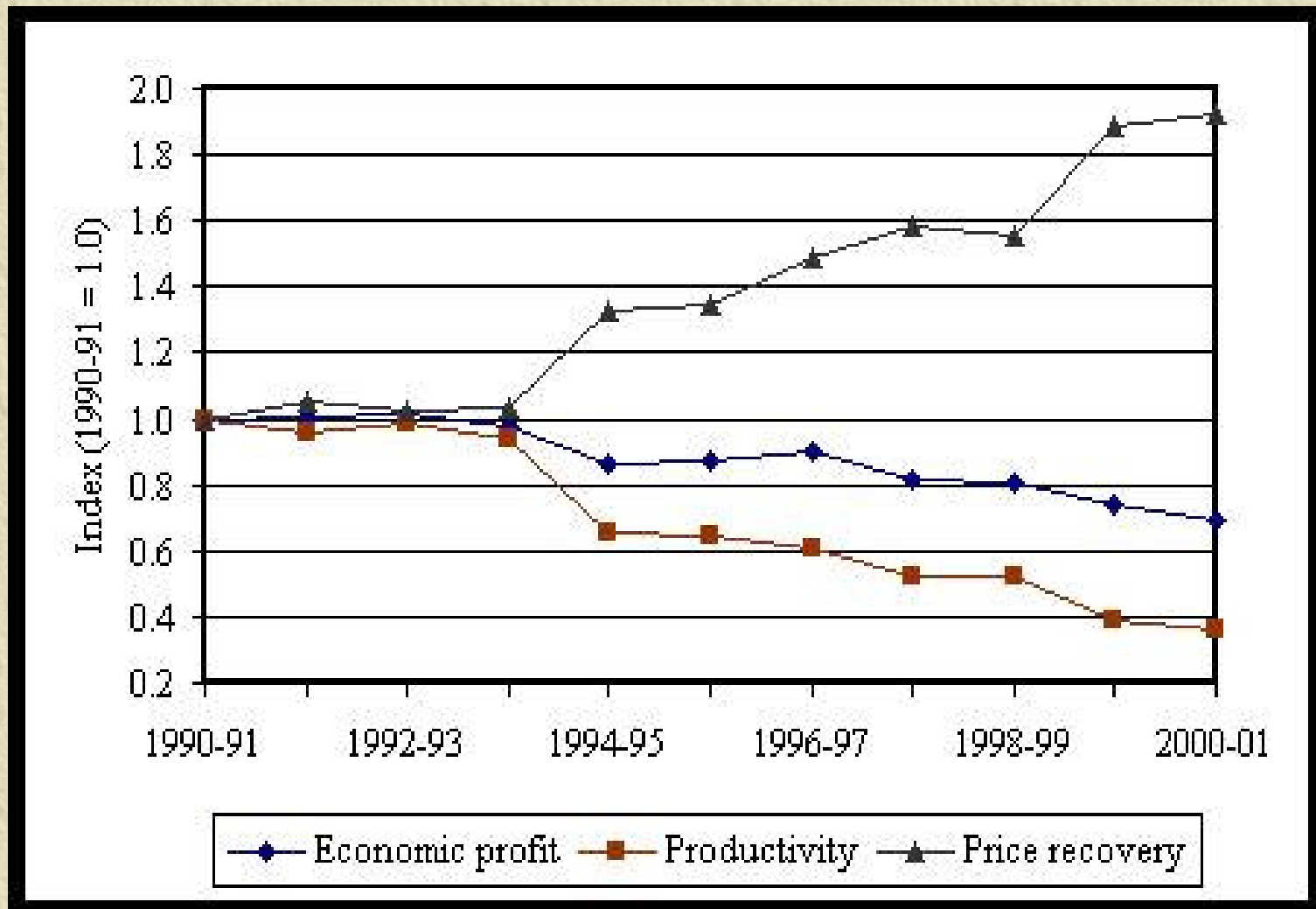
Pattern in TMTU



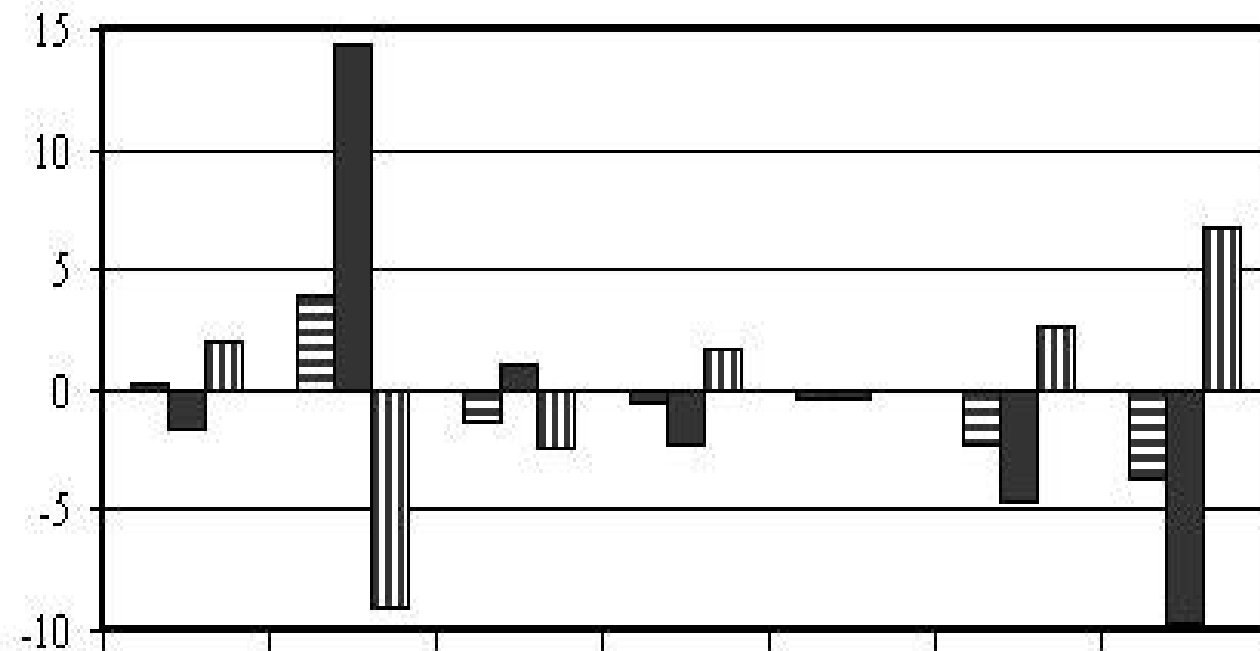
Pattern in PCMT



Pattern in KMTU



Average annual growth (in %age)



	BEST	BMTC	AMTS	FMT	TMTU	FCMT	KMTU
■ Economic profit	0.33	3.99	-1.26	-0.53	-0.39	-2.18	-3.67
■ Productivity	-1.59	14.38	1.14	-2.17	-0.34	-4.65	-9.74
▨ Price recovery	1.97	-9.03	-2.37	1.64	-0.05	2.58	6.75

Remarks

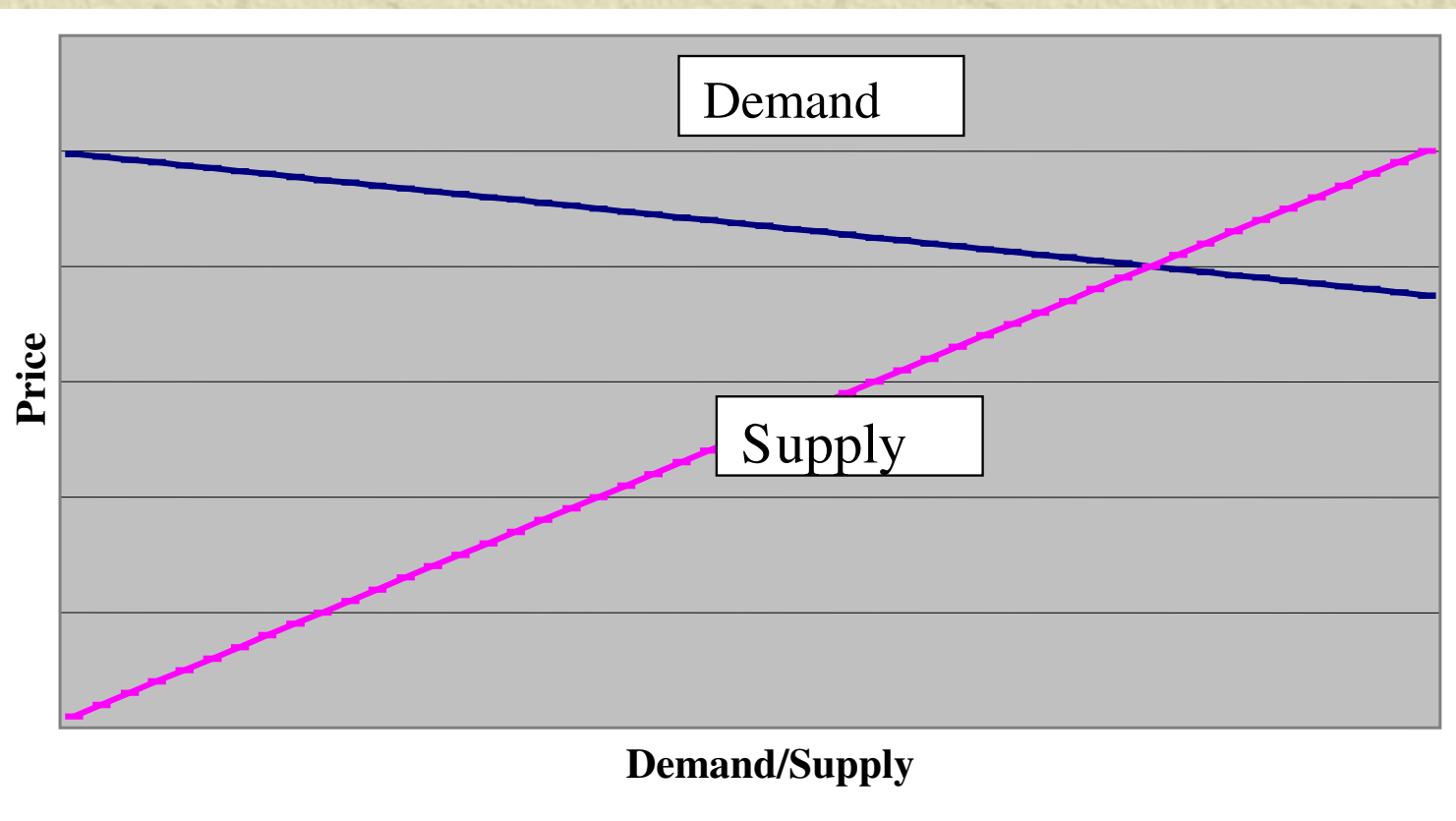
Contrary to usual perception, majority of the MTUs increased their output prices at greater rate than that of input factor prices. However, most of them also faced decline in their productivity. As a result, economic profitability of most of the MTUs has deteriorated during 1990s.

BMTC presents a vastly different picture of economic profitability and productivity as compared to its counterparts. It is the only MTU in India, which made accounting as well as economic profit during latest year of the sample. However, the level of BMTC's economic profitability is not as superior as its accounting profitability. Traffic revenue of BMTC exceeded its operating cost only during 2000-01.

Choice of fare structure – a numerical

illustration

Prices → an instrument for coordinating supply and demand of goods



Inverse Elasticity Rule

$$\frac{P - MC}{P} = -\frac{\gamma}{\eta}$$

where $(P-MC)/P$ is the Lerner index , γ is Ramsey number, and η is the own price elasticity of demand.

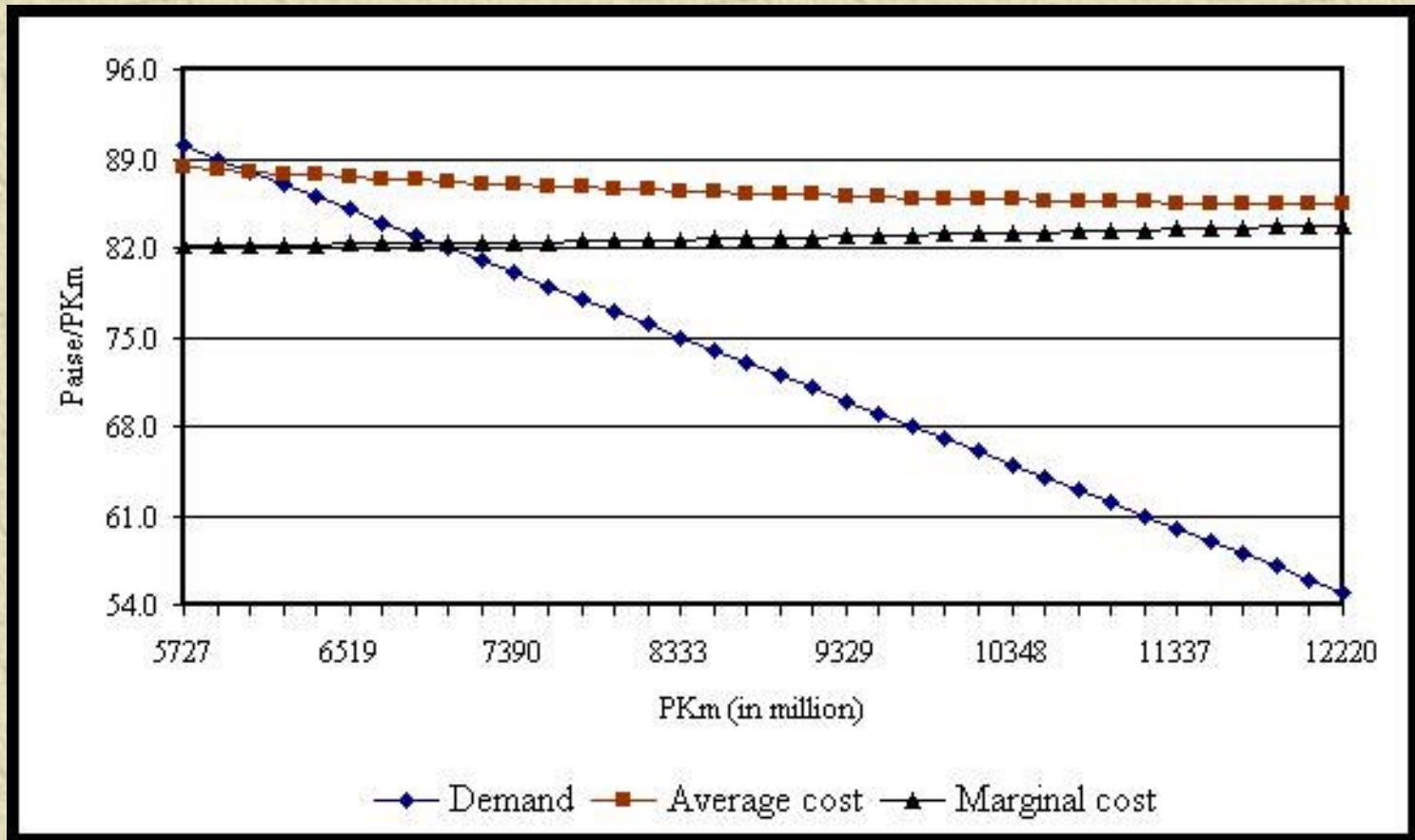
$\gamma=0$ when actual profit equals welfare optimal profit

$\gamma=1$ when actual profit equals monopoly profit

$0 < \gamma < 1$ when actual profit exceeds welfare optimal profit but less than monopoly profit

$\gamma < 0$ when actual profit falls below welfare optimal profit

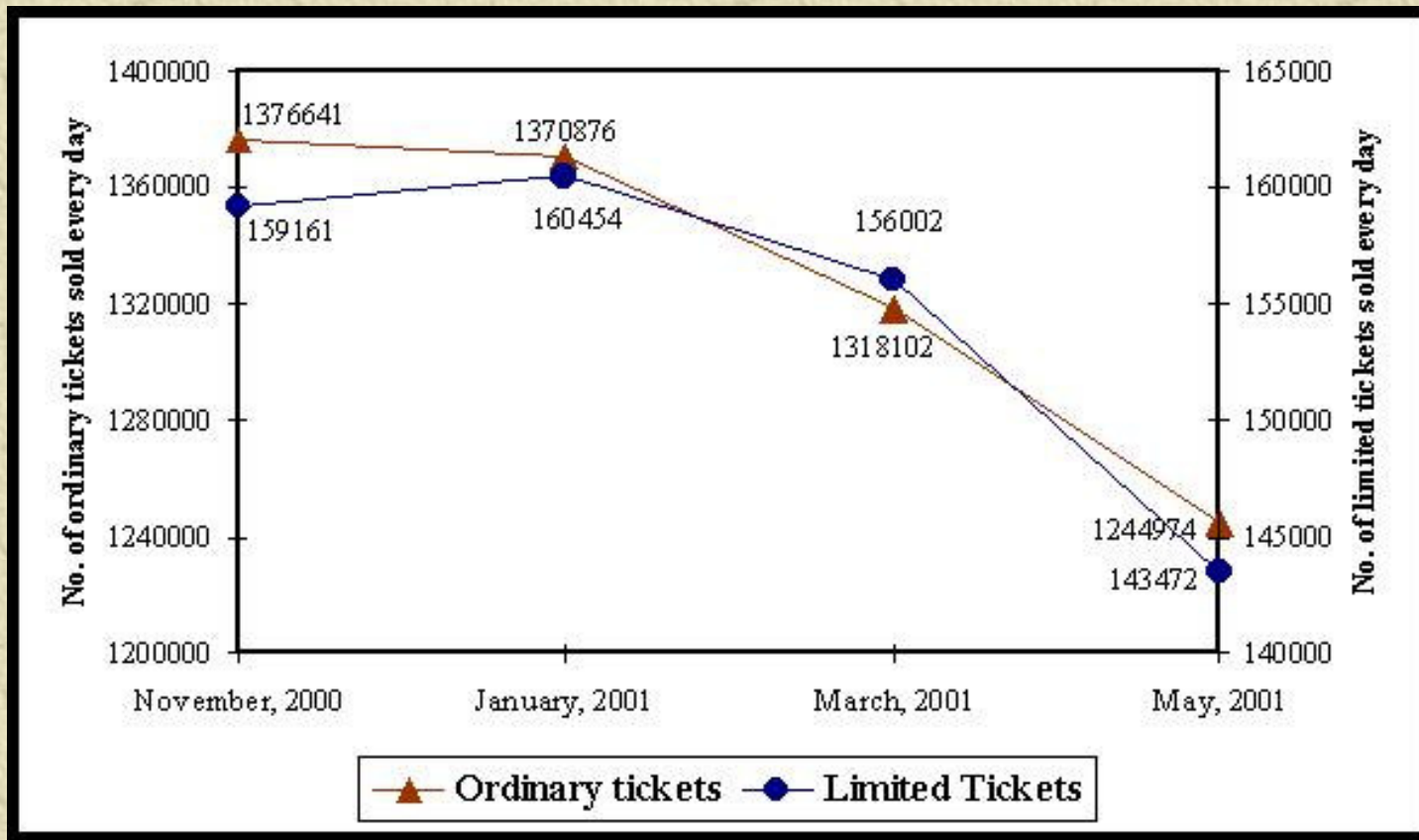
Estimated demand, average cost and marginal cost of BEST's bus transport services during 2001-02.



Measuring the social welfare and profitability of BEST at different level of prices during 2001-02.

Avg. fare rate (paise/PKm) 2001-02 (= 69)	Demand (= Supply) (PKm in million)	Profit over operating cost (Rs. in million)	Profit as a percentage of operating cost	Average operating cost (paise/PKm)	Marginal cost (paise/PKm)	γ
94.0	5152	259.1	5.7	89.0	82.3	0.31
93.0	5291	222.6	4.7	88.8	82.3	0.29
92.0	5433	183.5	3.8	88.6	82.2	0.26
91.0	5578	141.9	2.9	88.5	82.2	0.23
90.0	5727	97.6	1.9	88.3	82.2	0.20
89.0	5879	50.6	1.0	88.1	82.3	0.18
88.0	6034	0.8	0.0	88.0	82.3	0.15
87.0	6192	-52.1	-1.0	87.8	82.3	0.12
86.0	6354	-108.0	-1.9	87.7	82.3	0.10
85.0	6519	-167.1	-2.9	87.6	82.3	0.07
84.0	6687	-229.4	-3.9	87.4	82.3	0.04
83.0	6858	-295.1	-4.9	87.3	82.3	0.02
82.0	7033	-364.3	-5.9	87.2	82.4	-0.01
81.0	7210	-437.1	-7.0	87.1	82.4	-0.03
80.0	7390	-513.6	-8.0	86.9	82.4	-0.06
79.0	7573	-593.8	-9.0	86.8	82.5	-0.08
78.0	7759	-677.9	-10.1	86.7	82.5	-0.11
77.0	7948	-765.9	-11.1	86.6	82.5	-0.13
76.0	8139	-857.9	-12.2	86.5	82.6	-0.16
75.0	8333	-954.1	-13.2	86.4	82.6	-0.18
74.0	8529	-1054.4	-14.3	86.4	82.7	-0.20
73.0	8726	-1158.8	-15.4	86.3	82.7	-0.22
72.0	8926	-1267.6	-16.5	86.2	82.8	-0.24
71.0	9127	-1380.6	-17.6	86.1	82.8	-0.26
70.0	9329	-1497.9	-18.7	86.1	82.9	-0.28
69.0	9533	-1619.4	-19.8	86.0	82.9	-0.30
68.0	9736	-1745.3	-20.9	85.9	83.0	-0.31
67.0	9941	-1875.4	-22.0	85.9	83.1	-0.33
66.0	10145	-2009.6	-23.1	85.8	83.1	-0.34
65.0	10348	-2148.0	-24.2	85.8	83.2	-0.36
64.0	10550	-2290.3	-25.3	85.7	83.2	-0.37
63.0	10751	-2436.5	-26.5	85.7	83.3	-0.38
62.0	10949	-2586.3	-27.6	85.6	83.4	-0.38
61.0	11145	-2739.7	-28.7	85.6	83.4	-0.39
60.0	11337	-2896.2	-29.9	85.5	83.5	-0.39
59.0	11525	-3055.7	-31.0	85.5	83.5	-0.40

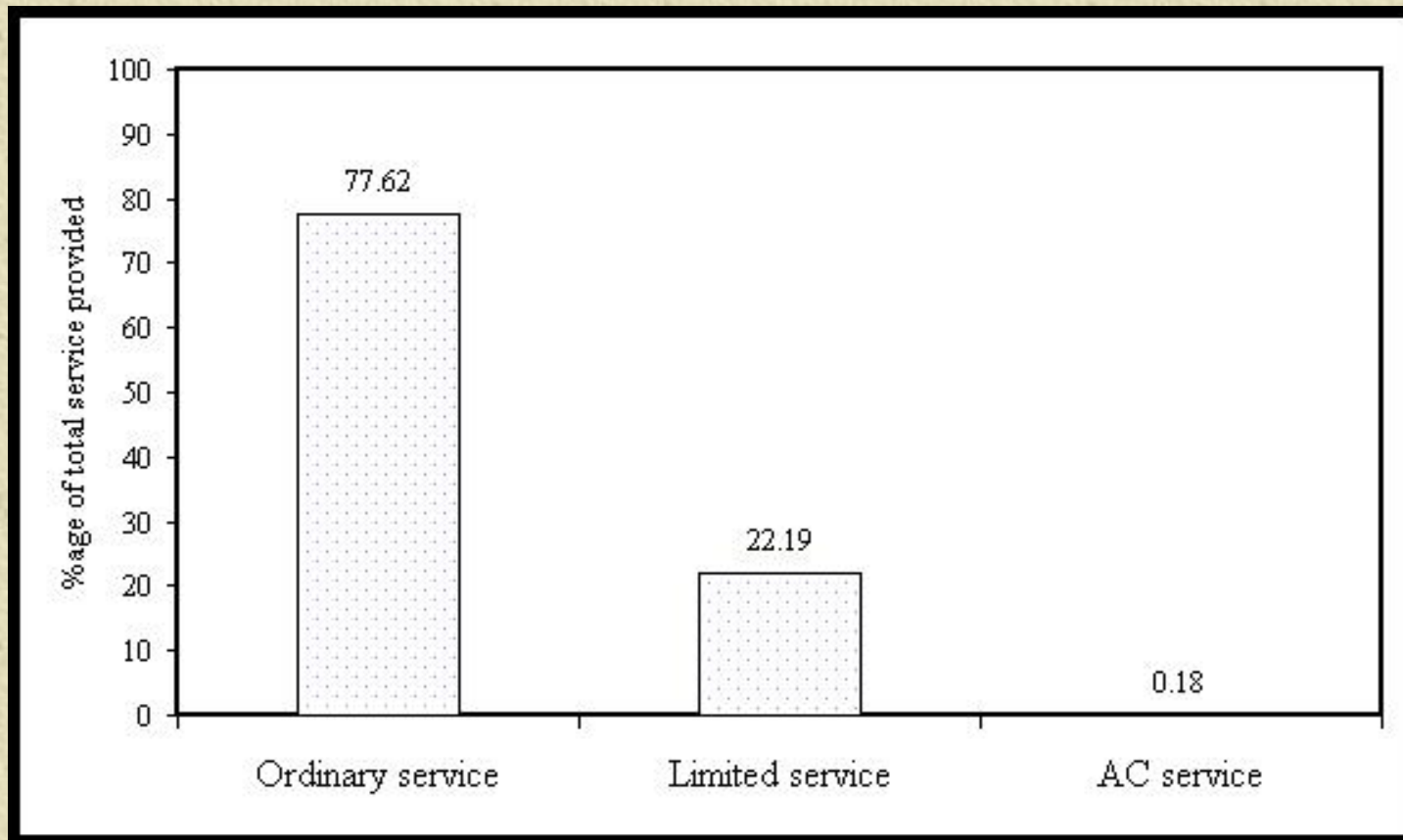
Decline in demand for shorter distance service provided by BEST.



Stage-wise price elasticity of demand for ordinary service of BEST

Distance in Km	Fare (in Rs.) May-2000	Fare (in Rs.) May-2001	No. of tickets sold May-2000	No. of tickets sold May-2001	% age change in real fare ¹	% age change in demand	Elasticity
3.0	3.00	3.00	39636605	38594203	-	-2.6	-
5.0	4.00	4.00	25233617	25894852	-	2.6	-
7.0	5.00	5.00	10815683	10836804	-	0.2	-
10.0	6.00	6.00	6336016	6414320	-	1.2	-
15.0	7.00	9.00	4328355	3310810	24.6	-23.5	-0.96
20.0	8.00	10.00	1443225	1234168	21.0	-14.5	-0.69
25.0	9.00	11.00	543120	443166	18.2	-18.4	-1.01
30.0	10.00	12.00	166551	123515	16.0	-25.8	-1.61
35.0	11.00	13.00	60897	34347	14.2	-43.6	-3.07

Percentage distribution of different services provided by BEST during May 2001.



It's not possible to have cross-subsidization from AC services to other services (0.18% can't subsidize to the rest). If we charge very high price for AC services, passengers will shift to some other more flexible modes.

Percentage distribution of stage-wise travel demand for different services provided by BEST during May 2001.

Distance in Km	Travel demand (in %age) ORDINARY SERVICE	Travel demand (in %age) LIMITED SERVICE	Travel demand (in %age) AC SERVICE
3.0	44.42	18.17	0.81
5.0	29.80	19.24	3.40
7.0	12.47	12.40	3.76
10.0	7.38	14.90	8.53
15.0	3.81	15.22	20.78
20.0	1.42	10.47	30.36
25.0	0.51	6.15	17.83
30.0	0.14	2.57	12.70
35.0	0.04	0.87	1.83
Total	100.00	100.00	100.00

Pricing scenarios for UBCs in the year 2001-02

UBCs	Actual fare in paise per pass.-km	Welfare maximizing fare in paise per pass.-km	Subsidy requirement for welfare maximization in Rs. million	Break-even fare (w.r.t. operating cost) in paise per pass.-km	Brek-even fare (w.r.t. total cost including taxes) in paise per pass.-km
PMT	53	48	155.58	58	60
PCMT	53	47	56.60	76	78
AMTS	46	56	153.58	71	72
KMTU	60	49	52.78	81	91
TMTU	51	41	103.03	52	58
BEST	69	83	358.47	88	93
BMTC	39	36	142.37	38	39

Subsidy is required to maximize social welfare mainly because MTUs operate on increasing returns to scale.

Points to be noted..

- In the present context, increase in real fare may not necessarily lead to significant improvement in profit;
- Enhancing the productivity and lowering the cost will be key to success;
- Objective of firm should be to achieve rate of return which is at least equal to opportunity cost of capital;
- Govt. subsidy should be discouraged since it could induce inefficiency. However, targeted subsidies may be provided;
- Optimal pricing policy and efficiency enhancement measures to be viewed holistically.



THANKS