International Journal of Economic Research

ISSN : 0972-9380

available at http: www.serialsjournals.com

Volume 14 • Number 15 (Part 4) • 2017

Ramsey Pricing: An Application to Publicly Supplied Urban Bus Transport Services in India

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ABSTRACT

Traditionally, in most countries, public sector firms are involved in supplying essential goods and services and operate in an industry that experiences natural monopoly characteristics where it is cost effective to have a single firm to supply the whole market. This is mainly because public sector firms are supposed to maximize social welfare instead of profit. Since natural monopolies operate on increasing returns to scale, when they charge marginal cost of production to maximize social welfare, they are unable to cover their full cost. Therefore, in the absence of subsidy, marginal cost pricing becomes infeasible. When marginal cost pricing is infeasible, natural monopolies may opt for the Ramsey pricing. This paper discusses the application of Ramsey pricing to publicly supplied urban bus transport services in India using a case study of publicly owned urban bus companies (UBCs). We found that the prices charged by UBCs in India deviate from the ones which maximize social welfare. By comparing deadweight losses, it is found that there would have been a welfare gain had optimal prices been charged rather than actual ones. However, adoption of marginal cost pricing would have left all UBCs with financial deficits as all of them are operating with increasing returns to scale. For some UBCs, welfare maximizing as well as break-even prices are found to be quite high. Moving from the prevalent fares to either of these fare rates may not be desirable from the equity viewpoint.

JEL Classification: D24, D69, H42, L32, L92, R48.

Keywords: Ramsey Pricing; marginal cost pricing; Bus Transport; Urban Transport; India.

1. INTRODUCTION

Pricing is a method of resource allocation; there is no such thing as the 'right' price but rather there are optimal pricing strategies, which facilitate attainment of specific goals. The optimum price to achieve profit maximization may differ from the one needed to maximize welfare or to ensure the highest revenue. Profit maximization is the traditional motivation of the private firms. The actual price level in this case depends upon degree of competition in the market. When competition is considerable then no single supplier has any control on price and must charge price that is determined by interaction of supply and demand in the market as a whole. Within this competitive environment, it is impossible for any supplier to make super normal profits in the long term because of the incentives such profits would have on new suppliers entering the market and increasing the aggregate supply. In contrast, a true monopoly supplier has no fear of new entrants increasing the aggregate supply and has the freedom either to set the price or to stipulate the level of service he is prepared to offer. The effective constraint on the monopolist is countervailing power of demand, which prevents the joint determination of both output and price. However, given the absence of competition and the degree of freedom enjoyed by the monopolist, it is almost certain that the profit maximizing price will result in charges above marginal and average cost. This is the one reason why governments have tended to regulate and/or control firms with monopoly characteristics.

More often than not, firms having monopoly characteristics are owned by the governments. Government owned firms are usually called publicly owned firms or public sector firms. Traditionally, in most countries, public sector firms are involved in supplying essential goods and services and operate in an industry that experiences natural monopoly characteristics. This is because public sector firms are supposed to maximize social welfare rather than their profit. But, since natural monopolies operate on increasing returns to scale, when they charge marginal cost of production to maximize social welfare, they are unable to cover their full cost. Therefore, although marginal cost pricing, also called the first best pricing, is economically efficient, it results in a deficit for the natural monopolies. In the absence of a subsidy, first best pricing becomes impractical.

The tension between economic efficiency and revenue adequacy is perhaps the fundamental problem associated with pricing in natural monopolies (Braeutigam, 1989). When first best pricing is infeasible, natural monopolies may opt for the second best pricing, also known as Ramsey pricing. Ramsey pricing is a policy rule concerning what price a monopolist should set, in order to maximize social welfare, subject to a constraint on profit. It is named after the contributions of Frank p. Ramsey to the theory of optimal taxation. Ramsey (1927) was the first to demonstrate that an efficient set of excise, or commodity, taxes would raise prices inversely to the elasticity of demand (Church and Ware, 2000). This paper mainly deals with the application of Ramsey pricing in publicly supplied urban bus transport services in India.

2. THE PRICING RULES

2.1. Marginal-Cost Pricing

Marginal-cost pricing in a first-best environment requires the following assumptions (Jha, 2002):

- only prices of publicly produced goods are controlled and all other prices in the public sector are equal to marginal cost;
- the private sector is perfectly competitive;
- the distribution of lump-sum incomes is optimally chosen; hence we deal with compensated demand; and
- there is no revenue-cost constraint on the public sector.

Marginal-cost pricing rule is normatively valid for any kind of public enterprise: for competitive public enterprise as well as for monopolistic ones. In the case of decreasing-cost industries, the marginal-cost pricing rule leads to welfare-optimal deficits which normatively have to be financed by the lump-sum taxes. These deficits are not indicative of mismanagement (provided, of course, that the cost we are talking of is the minimum cost curve).

Under the usual assumptions, the marginal-cost pricing rule results in a first-best allocation of resources. It arrives at a Pareto-optimal allocation of goods among consumers and leads to the first-best utilization of the capacity of public enterprise. If both public and private enterprises follow marginal-cost pricing, the allocation between publicly and privately produced goods is also a first-best allocation. In the decreasing-cost case, marginal-cost pricing leads to an extension of the public sector since prices will be lower than the average-cost and demand will therefore be relatively greater. It is difficult to draw a general conclusion regarding effects of marginal-cost pricing on income redistribution. Although, marginal-cost pricing does not have income redistribution as its main objective, it may have some distributional consequences. For example, if in the decreasing-cost case, the comparatively lower priced goods are mainly consumed by lower-income groups, the distributional effect may be positive. On the other hand, the positive effect may be offset by the fact that the deficits have to be financed by (possibly regressive) taxes.

2.2. Ramsey Pricing

When we restrict the public enterprise to meet a revenue-cost constraint, we are required to find the second-best set of prices. In the context of optimal taxation, Ramsey (1927) derived a formal mathematical solution to the optimal pricing in the industries in which marginal-cost prices do not cover total costs. Ramsey pricing allows the firm to use monopoly power to meet its revenue requirement. Ramsey pricing is sometimes called Ramsey-Boiteux pricing to recognize its further development by Marcel Boiteux (1956). It is widely used by regulatory agencies through out the world; for example, in 1983 the United States Interstate Commerce Commission adopted Ramsey pricing as the basic principle for setting railroad rates. Baumol (1987) provides a brief exposition that includes a short history of the subject (one may also see Boiteux (1971) and Dierker (1991)). To explain the optimal Ramsey pricing, we make the following assumptions (Jha, 2002):

- only prices of publicly produced goods are controlled and all other prices in the public sector are equal to respective marginal cost;
- the private sector is perfectly competitive;
- the distribution of lump-sum incomes is optimally chosen; hence, we deal with compensated demand;
- the public enterprise is restricted by an exogenously fixed deficit or profit Π^0.

If we totally neglect all cross-price elasticities of demand, the Ramsey price structure reduces to the well-known "inverse elasticity rule" (Singh, 2006),

$$\frac{p_k - c_k}{p_k} = -\frac{\gamma_0}{\eta_{kk}} \tag{1}$$

where, η_{kk} is the own compensated price elasticity of demand; $(p_k - c_k)/p_k$ is the Lerner index L_k; and γ_0 is Ramsey number. $0 < \gamma_0 < 1$ when, as in the most relevant cases, Π^0 exceeds the unconstrained welfare-optimal profit. If on the other hand, Π^0 falls below the unconstrained welfare optimizing profit, $\gamma_0 < 0$.

Ramsey pricing is characterized by a trade-off between the level of prices and the structure of prices. The level of prices is mainly influenced by Π^0. A low Π^0 implies a low price and, if demand reacts normally, a larger public-sector. Low Π^0 may imply lower prices of publicly provided goods in order to help the low-income group. The structure of prices is determined by the price elasticities of demand. For example, prices of goods that are price-inelastic can be increased by a higher percentage to meet Π^0 than prices of goods that are price-elastic. The trade-off exists because a low Π^0 favors low-income group, but a high γ_0 which meets the revenue-cost constraint by increasing prices of price-inelastic goods, will have the opposite effect on income distribution if these goods are bought primarily by low-income groups. If $\gamma_0 = 1$, Ramsey pricing converges to monopoly pricing for compensated demand. An agency that chooses Ramsey pricing behaves as if it were an unconstrained monopolist inflating all compensated price by a factor of $1/\gamma_0$. The level of prices when $0 < \gamma_0 < 1$, would be lower than the case of a profit-maximizing monopolist.

Equation (1) clearly reveals that, for price above marginal cost $\gamma_0 > 0$, and for price below marginal cost $\gamma_0 < 0$ (but, of course, this does not hold generally if all cross-price elasticities are taken into account.). In other words, for positive Lerner index $\gamma_0 > 0$ and for negative Lerner index $\gamma_0 < 0$. Inverse elasticity rule asserts that the Lerner index, that is, the optimal percentage deviation of the price of any goods from its marginal cost of production should be inversely proportional to its own price elasticity of demand. It also implies that the optimal percentage deviation of price from marginal cost will be larger, the smaller the absolute value of the goods' price elasticity. If we assume that goods mainly bought by lower-income consumers are comparatively price inelastic, then lower-income consumers are burdened in the case of positive price-cost margins, favored in the case of negative ones. When $\Pi^0 = 0$, in a decreasing-cost case, at least one Ramsey price will exceed marginal cost; if cross-elasticities of demand are zero, all Ramsey prices will be above their respective marginal-cost prices. The effect on allocation in this case will be that the size of public sector will be smaller than under marginal-cost pricing without a revenue-cost constraint.

3. APPLICATION TO PUBLICLY SUPPLIED URBAN BUS TRANSPORT SERVICES IN INDIA USING A CASE STUDY OF URBAN BUS COMPANIES

Urban bus transport in India is dominated by the publicly owned Urban Bus Companies (UBCs). There are number of UBCs in India; they operate with around 18,600 buses and employ close to 128,000 people. In this section, we'll examine whether UBCs charge optimal prices for their services; if not, how much deadweight loss they create? If UBCs face financial losses in the first best pricing case, then what are the second best prices? Basically, this section focuses on application of Ramsey pricing in UBCs. Application of Ramsey pricing requires estimation of social welfare through Ramsey number (γ_0) and profitability at different level of prices. Moreover, estimation of these parameters requires information about marginal and average cost curves as well as demand curve. Using annual data for a sample of seven UBCs that operated from 1990-91 to 2001-02, Singh (2005) estimated a translog cost function jointly with factor share equations subject to required coefficient restrictions by using the method of 'Zellner's iterative' technique. We used this estimated cost function to estimate the marginal and average cost curves for the sample UBCs to illustrate the application of Ramsey pricing in publicly supplied urban bus transport services in India.

Singh (2005) used information on a total of seven UBCs for his study. All sample companies are publicly owned and provide only intra-urban travel facility to the passengers. None of them are involved in mofussil operation. Sample UBCs are as follows (with number of buses held during 2001-02):

1. Brihan Mumbai Electric Supply & Transport Undertaking (BEST) – 3,410 buses
2. Bangalore Metropolitan Transport Corporation (BMTC) – 2,304 buses
3. Ahmedabad Municipal Transport Service (AMTS) – 869 buses
4. Pune Municipal Transport (PMT) – 808 buses
5. Thane Municipal Transport Undertaking (TMTU) – 264 buses
6. Pimpri Chinchwad Municipal Transport (PCMT) – 232 buses
7. Kolhapur Municipal Transport Undertaking (KMTU) – 100 buses

The primary source of required data is *Performance Statistics of STUs, 1990-91 to 2001-02* published for the Association of State Road Transport Undertakings (ASRTU), New Delhi by the Central Institute of Road Transport (CIRT), Pune, India. Table 1 reports some indicators concerning the size of the sample UBCs during 2001-02. The size of the companies, as measured by passenger-kilometers (PKm) in 2001-02, ranges from 213 million PKm for KMTU to 9587 million PKm for BEST. Fleet strength of UBCs also varies drastically, from 100 buses for KMTU to 3410 buses for BEST. In almost all respect, BEST is the largest UBC whereas KMTU is the smallest one.

Table 2 reports average fare (in paise per pass.-km at current prices) charged by the sample UBCs over the sample period. This Table shows that there is a wide variation in fare rates across urban bus companies in India. During 2001-02, fare rates across UBCs varied from 39 paise per pass.-km for BMTC to 69 paise per pass.-km for BEST. Figure 1 presents average fare in sample UBCs during 1997-98 and 2001-02 at constant 2001-02 prices. This figure reveals that average fare, in terms of real monetary unit, of all the UBCs has increased from 1997-98 to 2001-02. Moreover, PMT, AMTS and PCMT experienced very high increase in their (real) fare, 22%, 23% and 32% respectively from 1997-98 to 2001-02 (refer Table 3). In fact, such huge increase in their fare rates turned out to be counterproductive due to greater fall in demand. Passenger-kilometer demanded has reduced at higher rates in these UBCs than the increase in their fare rates, resulting in decline in their traffic revenue from 1997-98 to 2001-02. Traffic revenue of PMT, AMTS and PCMT declined by 6%, 9% and 23% respectively from 1997-98 to 2001-02 mainly due to steep hike in their fare rates.

Table 1
Some indicators concerning the size of the sample UBCs during 2001-02

	Pass.-Km (million)	*Bus-Km (million)*	*No. of buses held*	*No. of employees*	*Pass. carried (million)*
BEST	9587	236.2	3410	37031	1482.5
BMTC	6876	182.9	2304	13878	958.1
AMTS	1655	45.4	869	6952	209.6
PMT	1697	56.5	808	6722	156.9
TMTU	829	19.5	264	2500	90.1
PCMT	273	11.4	232	1983	18.1
KMTU	213	8.3	100	986	33.2

Table 2
Average fare in UBCs (in paise/pass.-km) at current prices

	BEST	*BMTC*	*AMTS*	*PMT*	*TMTU*	*PCMT*	*KMTU*
1990-91	18		17	21	24	16	16
1991-92	23		17	22	27	17	18
1992-93	29		21	25	24	18	19
1993-94	29		24	27	36	20	22
1994-95	33		26	27	36	23	30
1995-96	34		25	27	32	23	33
1996-97	42		25	28	36	24	38
1997-98	50	29	31	36	41	33	48
1998-99	54	29	33	38	52	36	52
1999-00	53	31	36	44	67	43	55
2000-01	64	38	42	54	51	54	63
2001-02	69	39	46	53	51	53	60

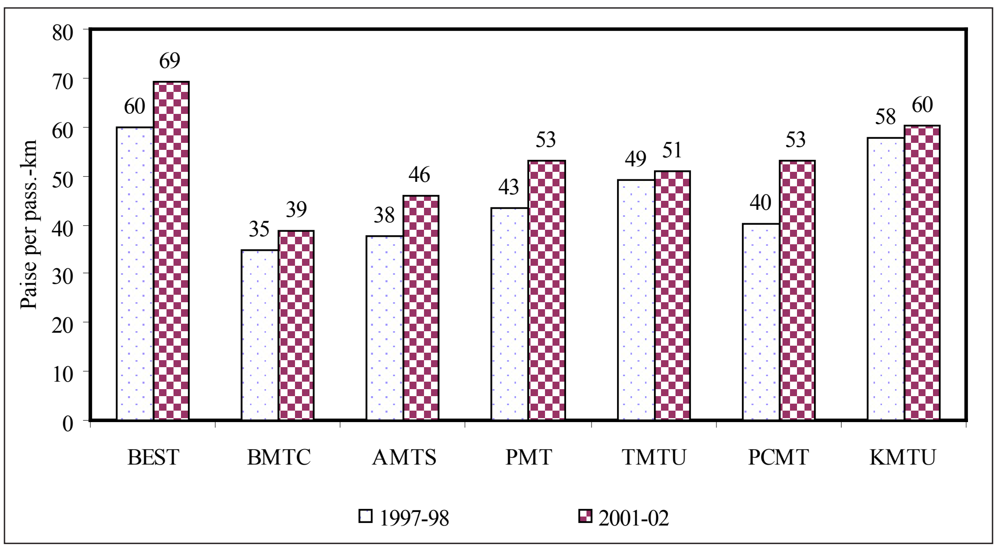

Figure 1: Average fare in UBCs during 1997-98 & 2001-02 at constant 2001-02 prices

Table 3
Percentage change in average fare at constant 2001-02 prices, pass.-km and traffic revenue from 1997-98 to 2001-02

	Percentage change in average fare	*Percentage change in pass.-km*	*Percentage change in traffic revenue*
PMT	+22	-23	-6
AMTS	+23	-25	-9
PCMT	+32	-42	-23

3.1. Proposed Fare Rates in UBCs

To know the optimal fare rates for sample UBCs, we did a simulation study based on equation **(1)** to measure the level of social welfare and profitability at different level of prices. As indicated in equation **(1)**, optimal pricing policy, in its simplest form, requires knowledge about marginal cost at different level of output as well as own compensated price elasticity of demand. Marginal cost of production of sample UBCs is calculated from the translog cost function estimated by Singh (2005). Estimation of own compensated price elasticity of demand is a tricky issue. The compensated or Hicksian demand is derived by minimizing the consumer's expenditure for achieving a given level of utility whereas the ordinary or Marshallian demand is derived by maximizing a representative consumer's utility function subject to a budget constraint. Since the utility level is held constant in case of compensated demand, the compensated price elasticity measures only the substitution effect of a price change. In contrast, the ordinary price elasticity measures both the substitution and income effects of a price change. In practice, however, the compensated demand function is not estimable because it is a function of utility, which is not directly observable. Hence, virtually all passenger travel demand studies estimate an ordinary demand function and report the associated elasticities. Moreover, if expenditure share of public bus transport services is relatively small and public bus transport demand is not highly income elastic then both the compensated and uncompensated price elasticities of demand will almost be identical. We can safely assume that expenditure share of bus transport services in urban India is relatively small and bus transport demand is not highly income elastic. Therefore, once we estimate the ordinary demand function for UBCs' transport services, we can easily compute the own uncompensated price elasticity of demand which is assumed to be close to own compensated price elasticity of demand. We will use the term own uncompensated price elasticity of demand and price elasticity of demand interchangeably during further discussions.

Price elasticity of demand is defined as percentage change in quantity demanded resulting from a 1% change in real price. Price elasticity of demand for UBCs' transport services can be computed as follows:

$$\eta = \frac{\partial D/D}{\partial P/P} = \frac{\partial \ln D}{\partial \ln P}$$

where, η is price elasticity of demand, D is demand for transport services (pass.-km), and P is price of transport services (paise/PKm).

Estimation of price elasticity of demand requires estimation of demand function. We assume that demand for passenger transport at time t, D_t, consists of a systematic component – which depends on the price charged by UBCs, P_t, as well as on other, non-price factors, X, affecting D_t and a stochastic component, ε_t, representing a surrogate for all variables that cannot be separately included in the model but which collectively affect D_t. A simple linear demand function can be written as:

$$D_t = \beta_1 + \beta_2 P_t + \sum \beta_j X_{jt} + \varepsilon_t \quad (2)$$

where, the variables are defined as above, and X_{jt} represents factors other than average fare rate that affect the quantity demanded.

Besides average fare rate, there could be many factors such as income of the people, age distribution and household composition, population, employment, automobile prices, prices and availability of other substitutes (rail, taxi, and auto-rickshaw), etc. which affect the demand for bus transport services. However, time series data for many of these variables are not available for urban India. In this situation, a variable *Time* can be included to capture the effects of omitted variables. This will also be useful to verify whether demand for UBCs' transport services shows a trend – an average increase or decrease over time – not explained by the average fare. Therefore, in the context of the empirical demand estimation, the model may be expressed as follows:

$$\ln(\text{MPKm}) = \beta_1 + \beta_2 \ln(\text{AvgFare}) + \beta_3(\text{Time}) + \varepsilon \quad (3)$$

where, the demand for transport services is measured as pass.-km in million and price of the same is expressed as average fare rate in paise per pass.-km at constant 2001-02 prices.

The demand function for each urban bus company is estimated using the required annual data from 1990-91 to 2001-02. Since we are using data from 1990-91 to 2001-02, the variable *Time* takes the following values: 1 for 1990-91, 2 for 1991-92, 3 for 1992-93, …, and so on. An attractive feature of the log model is that the estimated slope coefficient β_2 will directly measure the price elasticity of demand. The parameter β_2 is expected to have a negative sign, meaning that if an UBC increases its price, the demand for its services will decrease.

3.1.1. Proposed Fare Rates for PMT

Table 4 presents results of estimated demand function for PMT. As expected, the estimated price elasticity of demand is negative and statistically significant. The inverse relationship between demand and price as implied by the *law of demand* is also presented in Figure 2. The result of Table 4 shows that PMT is facing an elastic demand for its transport services. The estimated price elasticity of demand is 1.294, which indicates that an increase in average fare rate will decrease the traffic revenue of PMT while reducing its sales by a relatively greater magnitude.

As discussed earlier, simulation study requires estimation of both price elasticity of demand as well as marginal and average cost of production. Singh (2005) presents the result of estimated translog cost function for UBCs in India. Based on the same estimated cost function, marginal as well as average cost of PMT's bus transport services at different level of pass.-km is estimated. Figure 2 presents the same. Table 5 presents an indicator of social welfare and profitability of PMT during 2001-02 at different level of prices. Result shows that during 2001-02, PMT would have been unable to recover its operating cost had it charged prices equal to marginal cost which is estimated to be 47.8 paise per pass.-km. PMT would have achieved break-even with respect to operating cost had it charged a price equal to 57.6 paise per pass.-km which is higher than the current fare rate of 53 paise per pass.-km. During the year 2001-02, taxes paid by PMT worked out to be 3.39% of its operating cost (refer Table 6). Therefore, to recover its total cost (including taxes), PMT would have had to charge around 60 paise per pass.-km which is around 13% higher than the current price. It would have had to charge 65 paise per pass.-km to achieve profit of around 10% over operating cost.

Economically efficient pricing rule tells us that prices should be equal to marginal cost of production. In this case, marginal cost is 47.8 paise per pass.-km which is less than the corresponding average operating cost. Hence, marginal cost pricing of PMT's bus transport services, though economically efficient, is not financially viable. In fact, adoption of marginal cost pricing in PMT requires a subsidy of ₹155.58 million to cover all costs including taxes.

Figure 3 measures the deadweight loss (DWL) due to sub optimal pricing in PMT during the year 2001-02. During this year, PMT charged, on an average, 53 paise per pass.-km for its transport services whereas optimal price, which equals marginal cost, was 47.8 paise per pass.-km. Marginal cost pricing would have resulted in an output of around 1980 million pass.-km which exceeds the actual output produced by around 240 million pass.-km. The social welfare losses (or deadweight loss) resulting henceforth is shown in Figure 3 by area of triangle ABC.[1] The magnitude of this loss is around ₹6.24 million during the year 2001-02.[2] Similarly, charging a price equal to average operating cost, 57.6 paise per pass.-km, would have resulted in social welfare loss of ₹20.58 million while an attempt to set a price which would recover total costs (including taxes) would have resulted in social welfare loss of ₹30.5 million.

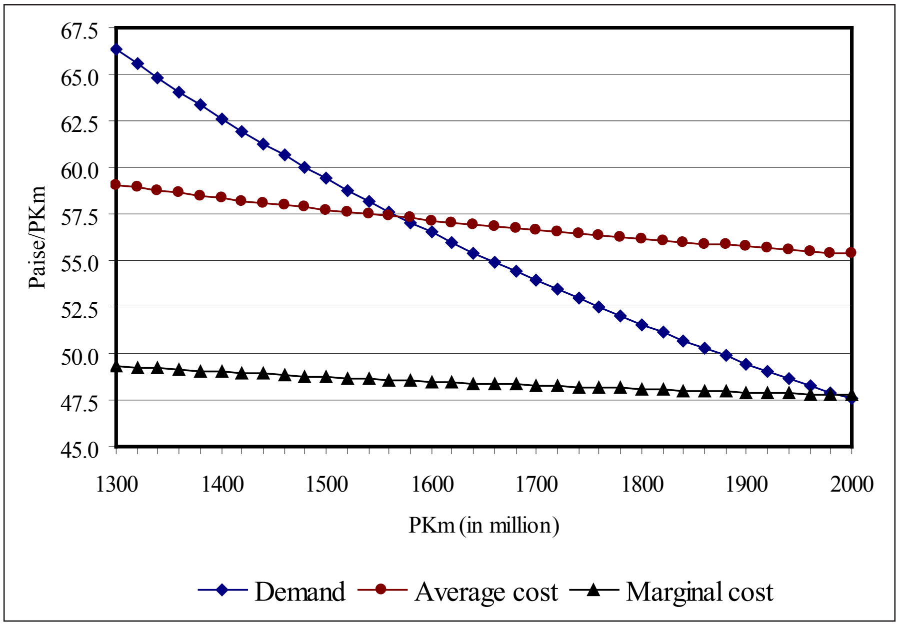

Figure 2: Estimated demand, average cost and marginal cost of PMT's bus transport services during 2001-02

Table 4
Estimated demand function for PMT (dep. var.: natural log of MPKm)[3]

Parameter	
Constant	12.334
	(17.42)
ln(AvgFare)	–1.294
	(6.78)
Time	0.022
	(3.29)
Number of observations	12
R-square	0.838
Log-Likelihood	15.97

1 Although BC and AC are not exactly straight lines, they can be considered as straight lines for simplification to compute the area of ABC.

2 DWL = 0.5 × (1980 – 1740) × (53 – 47.8) = 624 million paise = ₹6.24 million.

3 T-values are reported in parentheses.

Table 5
Measuring the social welfare and profitability of PMT at different level of prices during 2001-02

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 53)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
1300	66.3	94.5	12.3	59.1	49.3	0.33
1320	65.6	87.7	11.3	58.9	49.3	0.32
1340	64.8	80.8	10.3	58.8	49.2	0.31
1360	64.1	73.9	9.3	58.6	49.1	0.30
1380	63.3	67.0	8.3	58.5	49.1	0.29
1400	62.6	60.0	7.3	58.4	49.0	0.28
1420	62.0	53.0	6.4	58.2	49.0	0.27
1440	61.3	46.1	5.5	58.1	48.9	0.26
1460	60.6	39.1	4.6	58.0	48.8	0.25
1480	60.0	32.0	3.7	57.8	48.8	0.24
1500	59.4	25.0	2.9	57.7	48.7	0.23
1520	58.8	17.9	2.0	57.6	48.7	0.22
1540	58.2	10.9	1.2	57.5	48.6	0.21
1560	57.6	3.8	0.4	57.4	48.6	0.20
1580	57.0	-3.3	-0.4	57.3	48.5	0.19
1600	56.5	-10.5	-1.1	57.2	48.5	0.18
1620	56.0	-17.6	-1.9	57.0	48.5	0.17
1640	55.4	-24.8	-2.7	56.9	48.4	0.16
1660	54.9	-31.9	-3.4	56.8	48.4	0.15
1680	54.4	-39.1	-4.1	56.7	48.3	0.14
1700	53.9	-46.3	-4.8	56.6	48.3	0.14
1720	53.4	-53.5	-5.5	56.5	48.2	0.13
1740	53.0	-60.8	-6.2	56.4	48.2	0.12
1760	52.5	-68.0	-6.9	56.3	48.2	0.11
1780	52.0	-75.3	-7.5	56.3	48.1	0.10
1800	51.6	-82.5	-8.2	56.2	48.1	0.09
1820	51.1	-89.8	-8.8	56.1	48.1	0.08
1840	50.7	-97.1	-9.4	56.0	48.0	0.07
1860	50.3	-104.4	-10.0	55.9	48.0	0.06
1880	49.9	-111.7	-10.6	55.8	48.0	0.05
1900	49.5	-119.1	-11.2	55.7	47.9	0.04
1920	49.1	-126.4	-11.8	55.7	47.9	0.03
1940	48.7	-133.8	-12.4	55.6	47.9	0.02
1960	48.3	-141.1	-13.0	55.5	47.8	0.01
1980	47.9	-148.5	-13.5	55.4	47.8	0.00
2000	47.5	-155.9	-14.1	55.3	47.8	-0.01

Table 6
Tax payment as a percentage of total operating cost during 2001-02

Urban Bus Companies	*Tax payment as a percentage of total operating cost*
PMT	3.39
PCMT	1.70
AMTS	1.08
KMTU	6.49
TMTU	8.91
BEST	4.54
BMTC	3.19

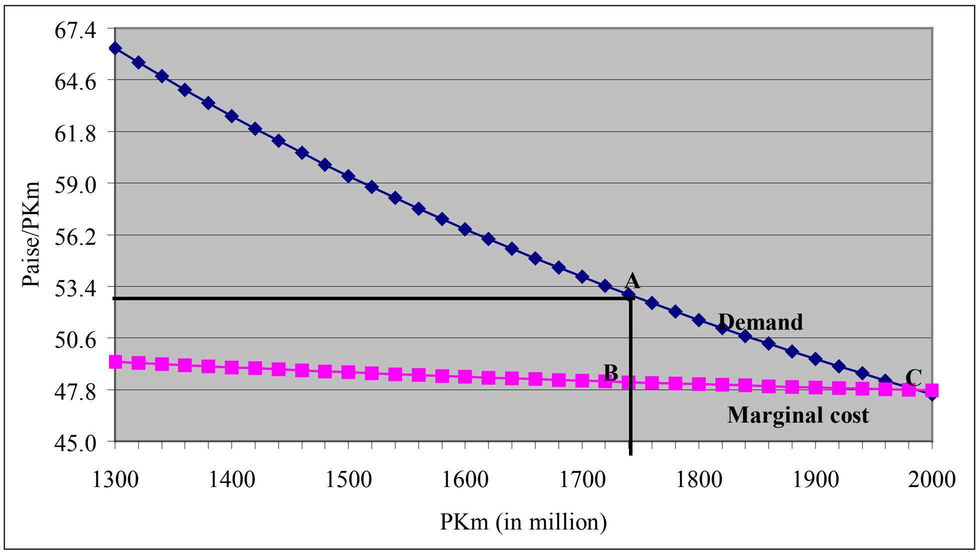

Figure 3: Deadweight loss due to sub optimal pricing in PMT during 2001-02

3.1.2. Proposed Fare Rates for PCMT

We estimated ordinary demand function for passenger transport services provided by PCMT using the required annual data from 1990-91 to 2001-02. Although the estimated model is similar to the model reported in the previous section, coefficient of *Time* is statistically insignificant according to both t-statistic as well as F-test. Therefore, demand of PCMT's services is assumed to be dependent on price alone. Table 7 presents the results of estimated demand function. The estimated price elasticity of demand is –1.419, which indicates that an increase in average fare rate will decrease the traffic revenue of PCMT while reducing its sales by a relatively higher percentage.

As described in the previous sub-section, marginal cost curve and demand curve for PCMT is estimated and presented in Figure 4. Table 8 presents an indicator of social welfare and profitability of PCMT during 2001-02 at different level of prices. Result shows that during 2001-02, PCMT would have been unable to recover its operating cost had it charge price equal to marginal cost which is estimated to be 47.4 paise per pass.-km. Given the nature of its average cost curve and demand elasticity, it would really be difficult for PCMT to achieve break-even. PCMT has to charge extremely high fare, around 76 paise per pass.-km to recover its operating cost. To recover the total cost including taxes, PCMT has to charge around 78 paise per pass.-km. Figure 4 could be used to measure the deadweight loss due to sub optimal pricing in PCMT during the year 2001-02. During this year, PCMT charged, on an average, 53 paise per pass.-km for its transport services whereas optimal price, which equals marginal cost, was 47.4 paise per pass.-km. Marginal cost pricing would have resulted in an output of around 350 million pass.-km which is significantly higher than the actual output produced. The social welfare losses (or deadweight loss) resulting due to this is around ₹1.44 million.[4] One should note that marginal cost pricing in PCMT requires a subsidy of ₹56.60 million to cover all costs including taxes.

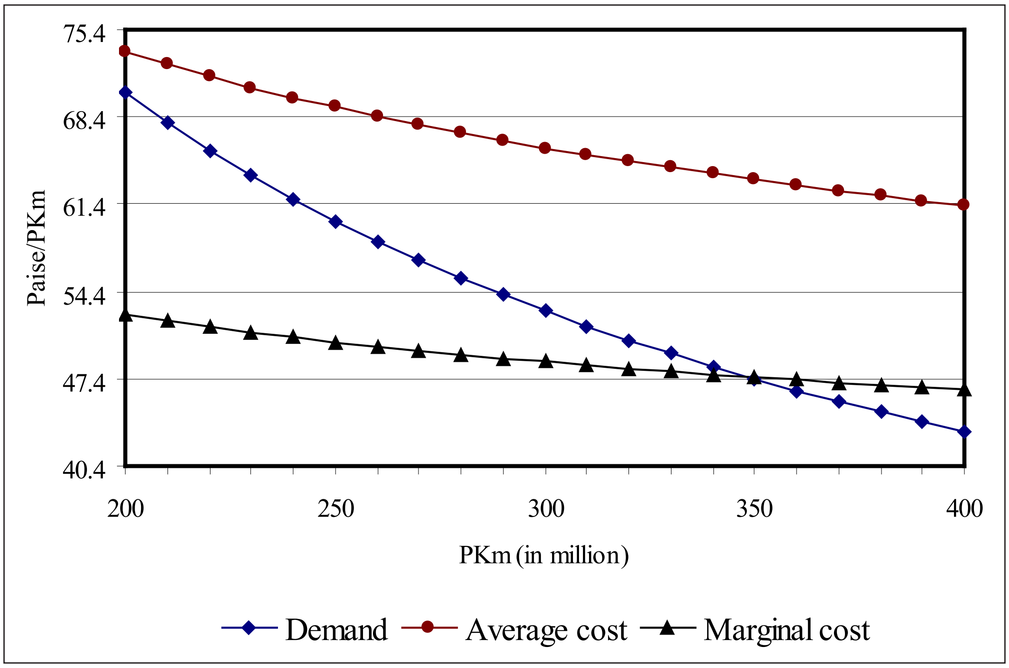

Figure 4: Estimated demand, average cost and marginal cost of PCMT's bus transport services during 2001-02

Table 7
Estimated demand function for PCMT
(dep. var.: natural log of MPKm)[5]

Parameter	
Constant	11.333
	(19.86)
ln(AvgFare)	-1.419
	(9.06)
Number of observations	12
R-square	0.891
Log-Likelihood	11.20

4 DWL = 0.5 × (350 – 298.62) × (53 – 47.4) = 144 million paise = ₹1.44 million.

5 T-values are reported in parentheses.

Table 8
Measuring the social welfare and profitability of PCMT at different level of prices during 2001-02

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 53)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
150	86.1	8.9	7.4	80.2	55.7	0.50
160	82.3	5.9	4.7	78.6	54.9	0.47
170	78.8	2.8	2.1	77.2	54.3	0.44
180	75.7	-0.3	-0.2	75.9	53.6	0.41
190	72.9	-3.5	-2.5	74.7	53.1	0.39
200	70.3	-6.6	-4.5	73.6	52.5	0.36
210	67.9	-9.8	-6.4	72.6	52.0	0.33
220	65.7	-13.0	-8.3	71.7	51.6	0.31
230	63.7	-16.3	-10.0	70.8	51.1	0.28
240	61.8	-19.5	-11.6	69.9	50.7	0.25
250	60.1	-22.8	-13.2	69.2	50.4	0.23
260	58.4	-26.0	-14.6	68.4	50.0	0.20
270	56.9	-29.3	-16.0	67.8	49.7	0.18
280	55.5	-32.6	-17.3	67.1	49.3	0.16
290	54.1	-35.9	-18.6	66.5	49.0	0.13
300	52.8	-39.2	-19.8	65.9	48.8	0.11
310	51.6	-42.5	-21.0	65.3	48.5	0.09
320	50.5	-45.9	-22.1	64.8	48.2	0.06
330	49.4	-49.2	-23.2	64.3	48.0	0.04
340	48.4	-52.5	-24.2	63.8	47.7	0.02
350	47.4	-55.9	-25.2	63.4	47.5	0.00
360	46.5	-59.2	-26.2	62.9	47.3	-0.03
370	45.6	-62.6	-27.1	62.5	47.1	-0.05
380	44.7	-66.0	-28.0	62.1	46.9	-0.07
390	43.9	-69.3	-28.8	61.7	46.7	-0.09
400	43.1	-72.7	-29.6	61.3	46.5	-0.11

3.1.3. Proposed fare rates for AMTS

An ordinary demand function for passenger transport services provided by AMTS is estimated and the result is presented in Table 9. The result of Table 9 shows that the price of bus transport services of AMTS do influence the quantity demanded in significant manner. The estimated price elasticity of demand is – 1.255, which indicates that an increase in average fare rate will decrease the traffic revenue of AMTS while reducing its sales by a relatively higher percentage.

We also estimated marginal and average cost of AMTS at different level of pass.-km; they are presented in Figure 5 along with demand curve. Table 10 presents implication of different fare rates on social welfare and profitability of AMTS during 2001-02. Simulation result shows that, during 2001-02, marginal cost equals price at the fare rate of 56.3 paise per pass.-km. This will not be sufficient to recover its operating cost since corresponding average cost is 67 paise per pass.-km. In fact, AMTS will be able to recover its operating cost at a very high fare rate of around 70 paise per pass.-km. During 2001-02, AMTS priced its service at the rate of 46 paise per pass.-km which is even less than its marginal cost of production. This leads to a deadweight loss of around Rs. 20.6 million during 2001-02.[6] Due to low fare rate, AMTS also incurred huge financial losses (refer Table 11). Had AMTS adopted marginal cost pricing it would have required financial assistance only to the tune of ₹153.58 million to recover all costs including taxes. This is less than half of the present requirement of financial assistance.

Table 9
Estimated demand function for AMTS (dep. var.: natural log of MPKm)[7]

Parameter	
Constant	11.872
	(15.00)
Ln(AvgFare)	–1.255
	(5.61)
Time	0.037
	(5.99)
Number of observations	12
R-square	0.828
Log-Likelihood	18.37

Table 10
Measuring the social welfare and profitability of AMTS at different level of prices during 2001-02

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 46)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
1000	74.4	32.9	4.6	71.1	58.2	0.27
1020	73.2	24.3	3.4	70.8	58.0	0.26
1040	72.1	15.7	2.1	70.6	57.9	0.25
1060	71.0	7.0	0.9	70.4	57.8	0.23
1100	69.0	-10.4	-1.4	69.9	57.6	0.21
1140	67.0	-27.9	-3.5	69.5	57.4	0.18
1180	65.2	-45.4	-5.6	69.1	57.2	0.15
1220	63.5	-63.1	-7.5	68.7	57.1	0.13
1260	61.9	-80.8	-9.4	68.3	56.9	0.10
1300	60.4	-98.5	-11.2	67.9	56.7	0.08
1340	58.9	-116.3	-12.8	67.6	56.6	0.05
1380	57.6	-134.2	-14.5	67.3	56.4	0.02
1420	56.3	-152.1	-16.0	67.0	56.3	0.00
1460	55.0	-170.1	-17.5	66.7	56.2	-0.03

(Contd...)

6 DWL = 0.5 × (1820 – 1420) × (56.3 – 46.0) = 2060 million paise = ₹20.60 million.

7 T-values are reported in parentheses.

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 46)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
1500	53.9	-188.1	-18.9	66.4	56.1	-0.05
1540	52.7	-206.2	-20.2	66.1	56.0	-0.08
1580	51.7	-224.3	-21.6	65.9	55.8	-0.10
1620	50.7	-242.5	-22.8	65.6	55.7	-0.13
1660	49.7	-260.7	-24.0	65.4	55.6	-0.15
1700	48.7	-278.9	-25.2	65.1	55.5	-0.18
1740	47.8	-297.2	-26.3	64.9	55.5	-0.20
1780	47.0	-315.5	-27.4	64.7	55.4	-0.22
1820	46.2	-333.8	-28.4	64.5	55.3	-0.25
1860	45.4	-352.2	-29.4	64.3	55.2	-0.27
1900	44.6	-370.6	-30.4	64.1	55.1	-0.30

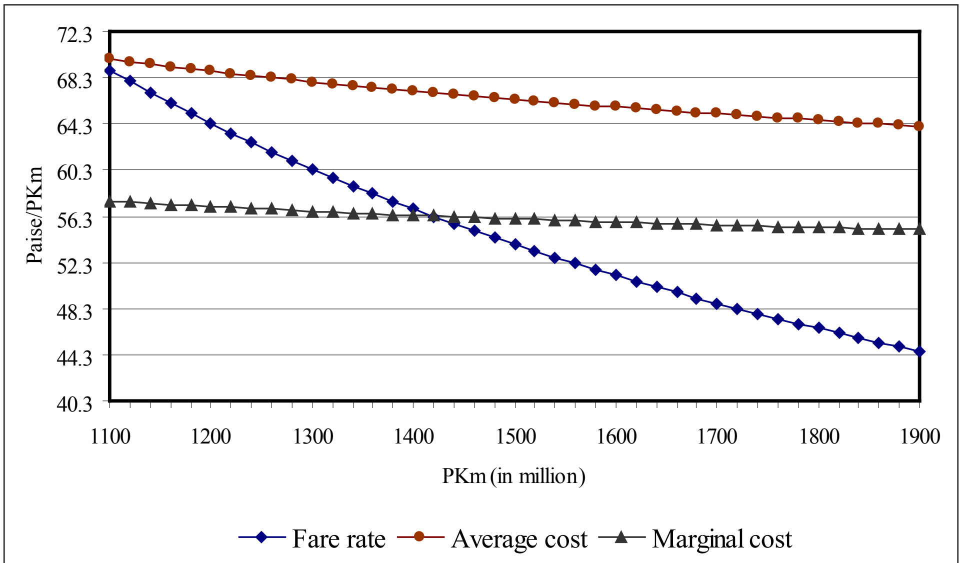

Figure 5: Estimated demand, average cost and marginal cost of AMTS's bus transport services during 2001-02

Table 11
UBCs' actual profitability during 2001-02; all monetary units in Rs. million

	Total revenue	*Traffic revenue*	*Total cost*	*Total operating cost*	*Total revenue minus total cost*	*Traffic revenue minus total operating cost*
BEST	6980.91	6630.41	8568.91	8196.80	-1588.00	-1566.39
BMTC	2879.97	2668.70	2655.37	2573.30	224.60	95.40
AMTS	805.70	760.80	1199.65	1186.79	-393.95	-425.99
PMT	926.64	898.97	1114.92	1078.37	-188.28	-179.40
TMTU	427.71	422.13	466.40	428.23	-38.69	-6.10
PCMT	156.39	144.56	224.65	220.91	-68.26	-76.35
KMTU	152.84	128.72	163.35	153.39	-10.51	-24.67

3.1.4. Proposed Fare Rates for KMTU

Demand function for passenger transport services provided by KMTU is estimated using required annual data from 1990-91 to 2001-02. Although, the estimated model is similar to the model reported in the sub-section 3.1.1, coefficient of *Time* is statistically insignificant according to both t-statistic as well as F-test. Therefore, demand of KMTU's services is assumed to be dependent on price alone. Table 12 presents results of estimated demand function. The estimated price elasticity of demand is –1.367, which indicates that an increase in fare rate will decrease the traffic revenue of KMTU while reducing the sales by a relatively higher percentage.

Figure 6 presents marginal and average cost curves along with demand curve for KMTU for the year 2001-02. Table 13 presents an indicator of social welfare and profitability of KMTU during 2001-02 at different level of prices. Result shows that during 2001-02, KMTU would have been unable to recover its operating cost had it charge price equal to marginal cost which is estimated to be 49.0 paise per pass.-km. Given the nature of its average cost curve and demand elasticity, it would really be difficult for KMTU to achieve break-even. KMTU has to charge extremely high fare to recover its cost of production; fare rate of more than 81 paise per pass.-km would result in positive profit.

Economically efficient pricing rule tells us that price should be equal to marginal cost of production. In case of KMTU, price equals marginal cost at 49 paise per pass.-km which is 17.7 paise less than the corresponding average operating cost. Hence, marginal cost pricing of KMTU's bus transport services, though economically efficient, is not financially viable. In fact, adoption of marginal cost pricing in KMTU requires a subsidy of ₹52.78 million to cover all costs including taxes. Figure 6 could be used to measure the deadweight loss due to sub optimal pricing in KMTU during the year 2001-02. During this year, KMTU charged, on an average, 60 paise per pass.-km for its transport services whereas optimal price, which equals marginal cost, was 49 paise per pass.-km. Marginal cost pricing would have resulted in an output of around 280 million pass.-km which is around 70 million pass.-km higher than the actual output produced. The social welfare losses (or deadweight loss) resulting due to this is around ₹3.85 million.[8]

Table 12
Estimated demand function for KMTU
(dep. var.: natural log of MPKm)[9]

Parameter	
Constant	10.959
	(10.02)
ln(AvgFare)	-1.367
	(4.87)
Number of observations	12
R-square	0.704
Log-Likelihood	1.80

8 DWL = 0.5 × (280 – 210) × (60 – 49) = 385 million paise = ₹3.85 million.

9 T-values are reported in parentheses.

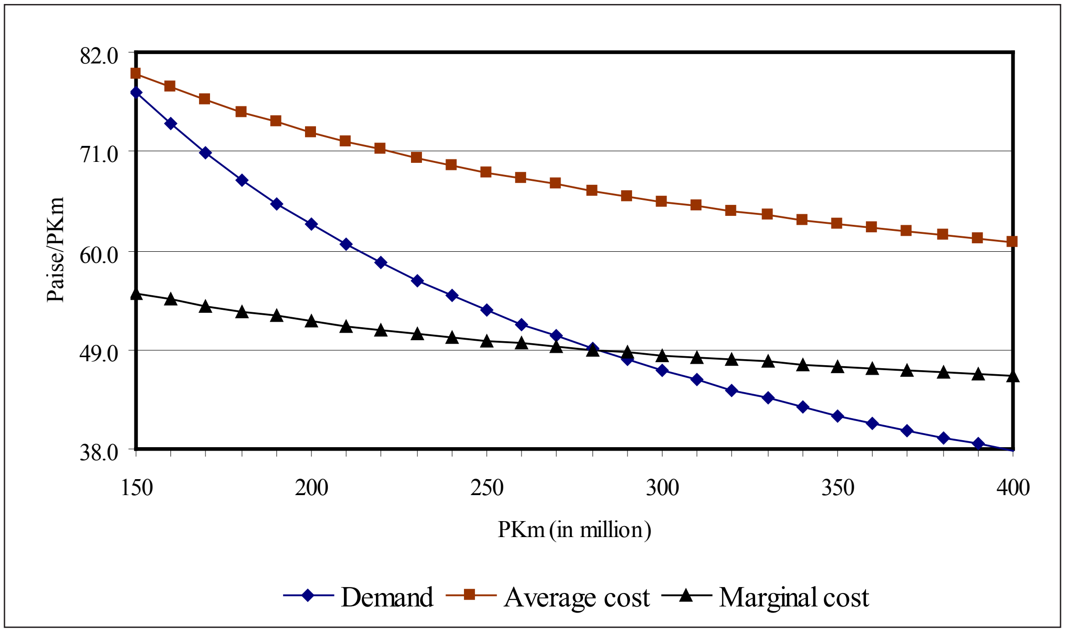

Figure 6: Estimated demand, average cost and marginal cost of KMTU's bus transport services during 2001-02

Table 13
Measuring the social welfare and profitability of KMTU at different level of prices during 2001-02

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 60)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
100	104.4	13.8	15.2	90.6	60.6	0.57
110	97.3	10.5	10.9	87.8	59.2	0.54
120	91.3	7.2	7.0	85.4	58.1	0.50
130	86.1	3.8	3.5	83.2	57.1	0.46
140	81.6	0.4	0.3	81.3	56.1	0.43
150	77.6	-3.1	-2.6	79.6	55.3	0.39
160	74.0	-6.5	-5.2	78.1	54.6	0.36
170	70.8	-10.0	-7.7	76.7	53.9	0.33
180	67.9	-13.5	-10.0	75.4	53.3	0.29
190	65.3	-17.0	-12.1	74.2	52.7	0.26
200	62.9	-20.5	-14.0	73.1	52.2	0.23
210	60.7	-24.1	-15.9	72.1	51.7	0.20
220	58.6	-27.6	-17.6	71.2	51.2	0.17
230	56.8	-31.2	-19.3	70.3	50.8	0.14
240	55.0	-34.7	-20.8	69.5	50.4	0.11
250	53.4	-38.3	-22.3	68.7	50.0	0.09
260	51.9	-41.9	-23.7	68.0	49.7	0.06
270	50.5	-45.4	-25.0	67.3	49.3	0.03
280	49.1	-49.0	-26.3	66.7	49.0	0.00

(Contd...)

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 60)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
290	47.9	-52.6	-27.5	66.0	48.7	-0.02
300	46.7	-56.2	-28.6	65.5	48.4	-0.05
310	45.6	-59.8	-29.7	64.9	48.2	-0.08
320	44.6	-63.4	-30.8	64.4	47.9	-0.10
330	43.6	-67.0	-31.8	63.9	47.7	-0.13
340	42.6	-70.6	-32.7	63.4	47.4	-0.15
350	41.7	-74.2	-33.7	62.9	47.2	-0.18
360	40.9	-77.8	-34.6	62.5	47.0	-0.20
370	40.1	-81.4	-35.4	62.1	46.8	-0.23
380	39.3	-85.0	-36.3	61.7	46.6	-0.25
390	38.6	-88.6	-37.1	61.3	46.4	-0.28
400	37.9	-92.2	-37.8	60.9	46.2	-0.30

3.1.5. Proposed Fare Rates for TMTU

Demand function for TMTU is estimated using required annual data from 1990-91 to 2001-02. Estimated demand function for TMTU is presented in Table 14. The estimated price elasticity of demand is –1.117, which indicates that an increase in fare rate will decrease the traffic revenue of TMTU while reducing its sales by a relatively higher percentage. Figure 7 presents demand curve along with marginal cost curve for TMTU for the year 2001-02. Table 15 presents an indicator of social welfare and profitability of TMTU during 2001-02 at different level of prices. Result shows that during 2001-02, TMTU would have been unable to recover its operating cost had it charge price equal to marginal cost which is estimated to be 40.6 paise per pass.-km since corresponding average operating cost is 49.4 paise per pass.-km. Marginal cost pricing in TMTU would have required a subsidy of ₹103.03 million to cover all costs including taxes.

In fact, during 2001-02, TMTU charged 51 paise per pass.-km which was just below to its average operating cost. Due to this, it faced an economic loss (total operating cost minus traffic revenue) of just ₹6 million during the year 2001-02. During the same year, taxes paid by TMTU worked out to be 8.91% of its operating cost. Therefore, to recover its total cost (including taxes), TMTU would have had to charge around 58 paise per pass.-km. So, for TMTU, an increase of around 14% in (real) fare would be sufficient to recover its total cost (including tax liability). To achieve a profit of around 10% of total cost (including taxes), TMTU would have had to charge a fare of around 65 paise per pass.-km.

Figure 7 can be used to measure the deadweight loss due to sub optimal pricing in TMTU during the year 2001-02. During this year, TMTU charged, on an average, 51 paise per pass.-km for its transport services whereas optimal price, which equals marginal cost, was around 40.6 paise per pass.-km. Marginal cost pricing would have resulted in an output of around 1075 million pass.-km which exceeds the actual output produced by around 246 million pass.-km. The social welfare losses (or deadweight loss) resulting henceforth is around ₹12.79 million.[10] Similarly, an attempt to set a price which would recover total costs (including taxes) would have resulted in social welfare losses of ₹30.45 million during the year 2001-02.

[10] DWL = 0.5 × (1075 – 829) × (51 – 40.6) = 1279 million paise = ₹12.79 million.

Table 14
Estimated demand function for TMTU (dep. var.: natural log of MPKm)[11]

Parameter	
Constant	9.471
	(8.85)
ln(AvgFare)	-1.117
	(4.06)
Time	0.138
	(13.24)
Number of observations	12
R-square	0.952
Log-Likelihood	9.96

Table 15
Measuring the social welfare and profitability of TMTU at different level of prices during 2001-02

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 51)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
600	69.0	82.0	24.7	55.4	43.5	0.41
625	66.6	72.9	21.2	54.9	43.2	0.39
650	64.3	63.8	18.0	54.4	43.0	0.37
675	62.1	54.8	15.0	54.0	42.8	0.35
700	60.1	45.7	12.2	53.6	42.6	0.33
725	58.3	36.6	9.5	53.2	42.4	0.30
750	56.5	27.5	6.9	52.9	42.3	0.28
775	54.9	18.4	4.5	52.5	42.1	0.26
800	53.4	9.4	2.2	52.2	41.9	0.24
825	51.9	0.3	0.1	51.9	41.8	0.22
850	50.5	-8.8	-2.0	51.6	41.7	0.20
875	49.2	-17.9	-4.0	51.3	41.5	0.18
900	48.0	-27.0	-5.9	51.0	41.4	0.15
925	46.9	-36.1	-7.7	50.8	41.3	0.13
950	45.8	-45.2	-9.4	50.5	41.1	0.11
975	44.7	-54.3	-11.1	50.3	41.0	0.09
1000	43.7	-63.4	-12.7	50.0	40.9	0.07
1025	42.7	-72.4	-14.2	49.8	40.8	0.05
1050	41.8	-81.5	-15.7	49.6	40.7	0.03
1075	41.0	-90.6	-17.1	49.4	40.6	0.01
1100	40.1	-99.7	-18.4	49.2	40.5	-0.01
1125	39.3	-108.8	-19.7	49.0	40.5	-0.03
1150	38.6	-117.9	-21.0	48.8	40.4	-0.05
1175	37.8	-127.0	-22.2	48.6	40.3	-0.07
1200	37.1	-136.0	-23.4	48.5	40.2	-0.09
1225	36.4	-145.1	-24.5	48.3	40.1	-0.11

11 T-values are reported in parentheses.

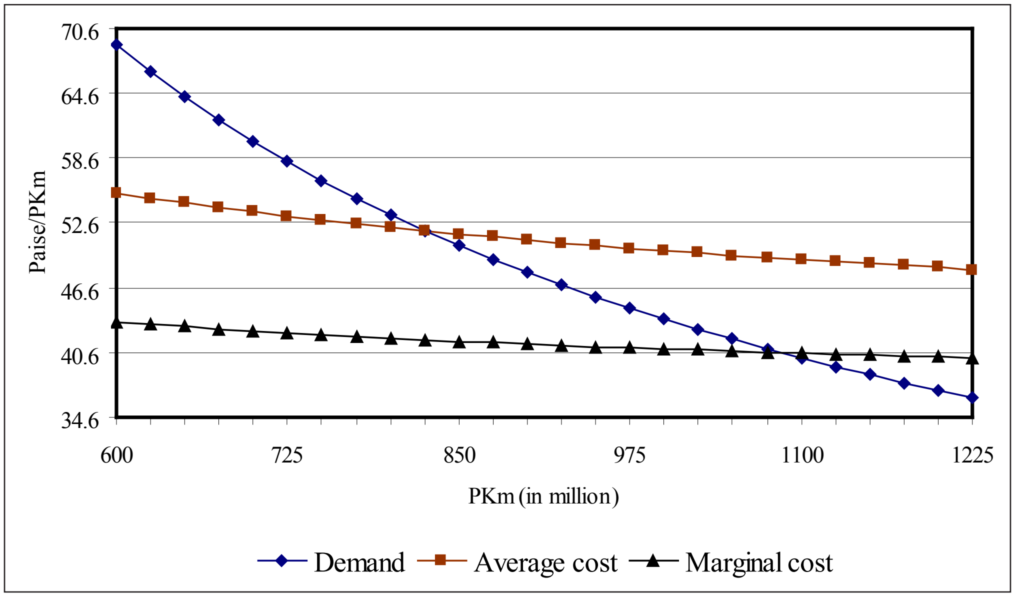

Figure 7: Estimated demand, average cost and marginal cost of TMTU's bus transport services during 2001-02

3.1.6. Proposed Fare Rates for BEST

Demand function for passenger transport services provided by BEST is estimated using required annual data from 1990-91 to 2001-02. The estimated model is similar to the model reported in previous sub-sections where demand is assumed to be dependent on price and time. However, the estimated model does not assume that price elasticity of demand is constant at different level of prices. Table 16 presents results of estimated demand function for BEST. The coefficient of *Time* is estimated to be 0.027 which means if fare rate is unchanged demand for BEST's services will increase by around 2.7% every year due to various other factors such as population growth, increase in income of the people, increase in economic activities in the city, etc. The result also shows that the price of bus transport services of BEST influences the quantity demanded in significant way. The estimated price elasticity of demand is reported in Table 17 at different fare rates. During 2001-02, average fare in BEST was 69 paise per pass.-km and corresponding price elasticity of demand was estimated to be –1.47 which indicates that an increase in fare rate will decrease the traffic revenue of BEST. At a fare rate of around 60 paise per pass.-km, the price elasticity of demand is estimated to be unity. BEST's traffic revenue will be maximum at this fare rate.

Figure 8 presents marginal and average cost curves along with demand curve for BEST for the year 2001-02. Table 18 presents an indicator of social welfare and profitability of BEST during 2001-02 at different level of prices. Result shows that during 2001-02, BEST would have been unable to recover its operating cost had it charge price equal to marginal cost which is estimated to be 83 paise per pass.-km since corresponding average operating cost is around 87 paise per pass.-km. Charging marginal cost prices would have required BEST to be subsidized to the extent of ₹358.47 million to cover all costs including taxes.

Figure 8 could also be used to measure the deadweight loss due to sub optimal pricing in BEST during the year 2001-02. During this year, BEST charged, on an average, 69 paise per pass.-km for its transport services whereas optimal price, which equals marginal cost, was 83 paise per pass.-km. Marginal cost pricing would have resulted in an output of around 6858 million pass.-km which is less than the actual output produced by around 2675 million pass.-km. The social welfare losses (or deadweight loss) resulting henceforth is around ₹187.25 million.[12]

Table 16
Estimated demand function for BEST (dep. var.: natural log of MPKm)[13]

Parameter	
Constant	-14.860
	(1.69)
ln(AvgFare)	12.668
	(2.86)
$(\ln(AvgFare))^2$	-1.670
	(2.99)
Time	0.027
	(2.59)
Number of observations	12
R-square	0.655
Log-Likelihood	21.42

Table 17
Price elasticity of demand for BEST's transport services

Fare rate	*Price elasticity of demand*	*Fare rate*	*Price elasticity of demand*	*Fare rate*	*Price elasticity of demand*
90.0	-2.36	80.0	-1.97	70.0	-1.52
89.0	-2.32	79.0	-1.93	69.0	-1.47
88.0	-2.29	78.0	-1.88	68.0	-1.43
87.0	-2.25	77.0	-1.84	67.0	-1.38
86.0	-2.21	76.0	-1.80	66.0	-1.33
85.0	-2.17	75.0	-1.75	65.0	-1.27
84.0	-2.13	74.0	-1.71	64.0	-1.22
83.0	-2.09	73.0	-1.66	63.0	-1.17
82.0	-2.05	72.0	-1.62	62.0	-1.12
81.0	-2.01	71.0	-1.57	61.0	-1.06

At a fare rate equal to 88 paise per pass.-km which is around 27% higher than the prevailing fare rate of 69 paise per pass.-km, BEST would be able to recover its operating cost. During the year 2001-02, taxes paid by BEST worked out to be 4.54% of its operating cost. Therefore, to recover its total cost (including taxes), BEST would have had to charge extremely high fare, around 93 paise per pass.-km, which would indeed be against the principle of equity. In fact, average operating cost of BEST during 2001-02 was 85.5 paise per pass.-km which is the highest among urban bus companies in India. Even after providing an allowance for good quality of service, one cannot but help conclude that the costs of operation in BEST are indeed exorbitant. The need of the hour is to introduce efficiency enhancement measures while at the same time maintaining their good quality of service.

[12] DWL = 0.5 × (2675) × (14) = 18725 million paise = ₹187.25 million.

[13] T-values are reported in parentheses.

Besides emphasizing on efficiency enhancement measures, BEST in particular and other urban bus companies in general can think of providing different quality of services and charge different prices for the same, what is commonly known in economic parlance as yield management. This is not only possible but also desirable since there would be different demand curves for different quality of services. Assuming that shift of consumers between different qualities of services is negligible; the availability of the range of services means that total potential consumer surplus will exceed that is generated if only a single price and service package were available. It is imperative that management identifies different groups of consumers, differentiated by their price elasticities of demand, and based on the same charge different prices. Management stands to gain as a result of this pricing strategy since costs of servicing each customer group are not drastically different.

Apart from this, one could also envisage differential pricing mechanism such as peak period, off-peak period, peak direction, off-peak direction, etc. based pricing strategy. The problem of the peak is peculiar to transport and electricity sector. The problem here arises from systematic variation in demand, frequently over a relatively short time. The problem is further aggravated due to the fact that transport can not be stored to reconcile the systematic changes in demand with smooth, even production. Reconciliation can only be through price.

Justification of differential pricing for peak and off-peak passengers stems from the fact that marginal cost of production during peak exceeds that during off-peak. Charging peak and off-peak passengers prices equal to their respective marginal costs not only maximizes social welfare but also has potential to augment traffic revenue. Even after adopting such pricing strategy if traffic revenue is not sufficient to cover costs, then one may have to adopt second best pricing (Ramsey pricing) where price charged to a particular group of passengers equals marginal cost plus mark-up. The mark-up over marginal cost would be inversely proportional to the price elasticity of demand. For example, peak travelers whose demand is relatively inelastic could be charged a price substantially higher than the marginal cost as compared to off-peak passengers.

Table 18
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_0
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

(Contd...)

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_0
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

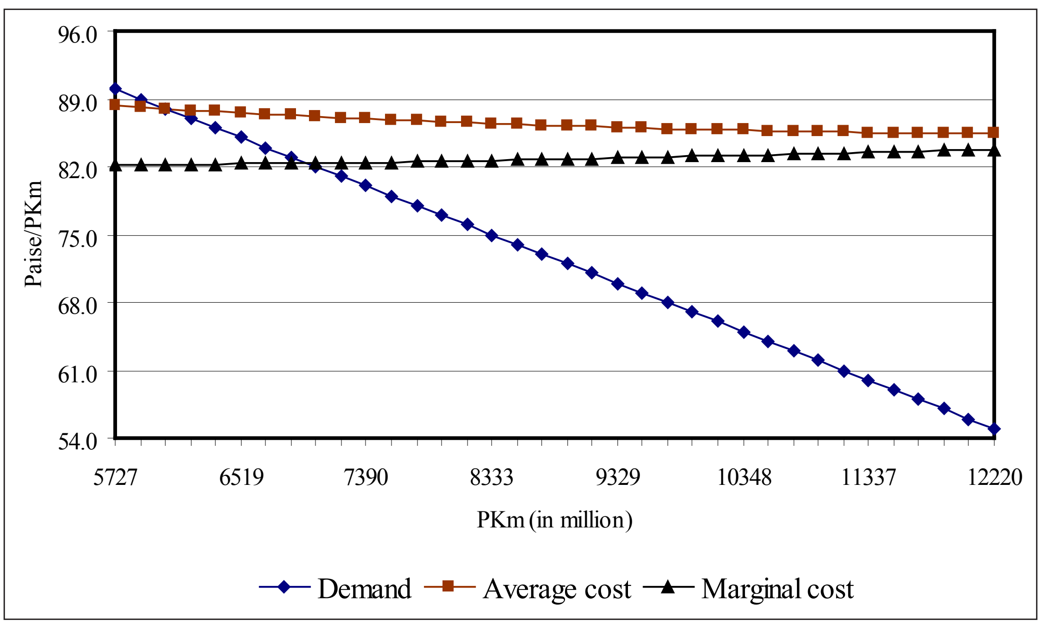

Figure 8: Estimated demand, average cost and marginal cost of BEST's bus transport services during 2001-02

3.1.7. Proposed Fare Rates for BMTC

Table 19 presents results of estimated demand function for BMTC. The price elasticity of demand is estimated to be –2.064, which indicates that *ceteris paribus* an increase in fare rate will decrease the traffic revenue of BMTC. Figure 9 presents marginal and average cost curves along with demand curve for BMTC for the year 2001-02. Table 20 presents an indicator of social welfare and profitability of BMTC during 2001-02 at different level of prices. Result shows that during 2001-02, BMTC would have been unable to recover its operating cost had it charge price equal to marginal cost which is estimated to be 35.5 paise per pass.-km since corresponding average operating cost is 37.2 paise per pass.-km. In fact, during 2001-02, BMTC charged 39 paise per pass.-km which was just 1.5 paise higher than the corresponding average operating cost. Due to this, it experienced an economic profit (traffic revenue minus total operating cost) of nearly Rs. 100 million during the year 2001-02. During the same year, taxes paid by BMTC worked out to be 3.20% of its operating cost. Therefore, to recover its total cost (including taxes) through traffic revenue, BMTC would have had to charge around 39 paise per pass.-km. So, for BMTC, a fare rate of 39 paise per pass.-km will provide traffic revenue which will be sufficient to recover total cost of production including taxes and non-traffic revenue will be equal to its financial profit. Had BMTC charged 44 paise per pass.-km, it would have been able to achieve a profit of around 12% of total cost including taxes. One should note that adoption of marginal cost pricing in BMTC requires a subsidy of ₹142.37 million to cover all costs including taxes.

Table 19
Estimated demand function for BMTC (dep. var.: natural log of MPKm)[14]

Parameter	
Constant	15.313
	(5.39)
Ln(AvgFare)	-2.064
	(2.50)
Time	0.217
	(4.62)
Number of observations	5
R-square	0.919

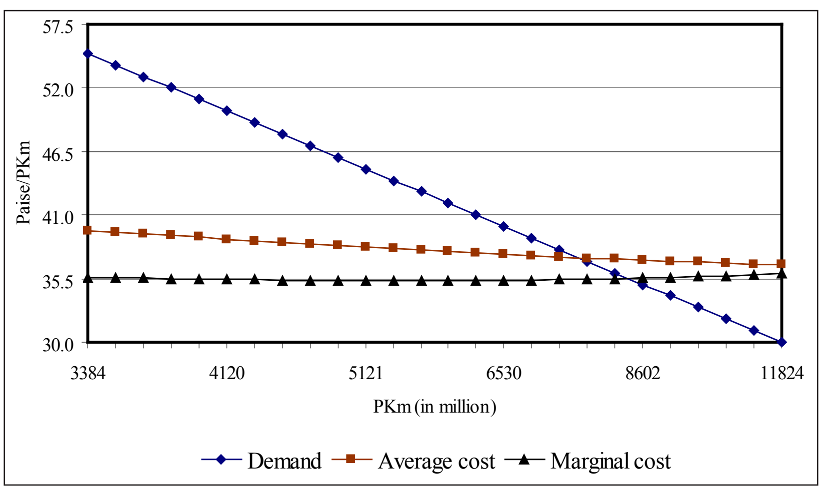

Figure 9: Estimated demand, average cost and marginal cost of BMTC's bus transport services during 2001-02

[14] T-values are reported in parentheses.

Table 20
Measuring the social welfare and profitability of BMTC at different level of prices during 2001-02

Demand (= Supply) (PKm in million)	*Avg. fare rate (paise/PKm) 2001-02 (= 39)*	*Profit over operating cost (Rs. in million)*	*Profit as a percentage of operating cost*	*Average operating cost (paise/PKm)*	*Marginal cost (paise/PKm)*	γ_0
3384	55.0	518.6	38.6	39.7	35.6	0.73
3515	54.0	508.8	36.6	39.5	35.6	0.70
3653	53.0	497.8	34.6	39.4	35.5	0.68
3800	52.0	485.5	32.6	39.2	35.5	0.66
3955	51.0	471.6	30.5	39.1	35.5	0.63
4120	50.0	456.1	28.4	38.9	35.4	0.60
4295	49.0	438.7	26.3	38.8	35.4	0.57
4482	48.0	419.3	24.2	38.6	35.4	0.54
4681	47.0	397.6	22.1	38.5	35.4	0.51
4894	46.0	373.4	19.9	38.4	35.3	0.48
5121	45.0	346.4	17.7	38.2	35.3	0.44
5364	44.0	316.3	15.5	38.1	35.3	0.41
5624	43.0	282.6	13.2	38.0	35.3	0.37
5904	42.0	245.0	11.0	37.8	35.3	0.33
6205	41.0	203.1	8.7	37.7	35.3	0.28
6530	40.0	156.1	6.4	37.6	35.4	0.24
6880	39.0	103.5	4.0	37.5	35.4	0.19
7259	38.0	44.7	1.6	37.4	35.4	0.14
7670	37.0	-21.4	-0.7	37.3	35.4	0.09
8116	36.0	-95.7	-3.2	37.2	35.5	0.03
8602	35.0	-179.3	-5.6	37.1	35.5	-0.03
9132	34.0	-273.5	-8.1	37.0	35.6	-0.10
9713	33.0	-380.1	-10.6	36.9	35.7	-0.17
10350	32.0	-500.7	-13.1	36.8	35.7	-0.24
11051	31.0	-637.7	-15.7	36.8	35.8	-0.32
11824	30.0	-793.6	-18.3	36.7	35.9	-0.41

Figure 9 can be used to measure the deadweight loss due to sub optimal pricing in BMTC during the year 2001-02. During this year, BMTC charged, on an average, 39 paise per pass.-km for its transport services whereas optimal price, which equals marginal cost, was around 35.5 paise per pass.-km. Marginal cost pricing would have resulted in an output of around 8116 million pass.-km which exceeds the actual output produced by around 1236 million pass.-km. The social welfare losses (or deadweight loss) resulting henceforth is around ₹21.63 million.[15] We should note that an attempt to set a price equal to marginal cost would result in financial losses for BMTC. BMTC presents a vastly different picture of profitability performance as compared to its counterparts operating in other cities. It is the only urban bus company in India, which made profit. During 2001-02, BMTC's total revenue exceeds its total cost by around 8%. Even in terms of economic profitability (traffic revenue in comparison to operating cost), it is the best

[15] DWL = 0.5 × (8116 – 6880) × (39 – 35.5) = 2163 million paise = ₹21.63 million.

performing urban bus company from last four years of the sample period. One should note that BMTC's average fare rate is also the lowest among urban bus companies in India.

3.2. Profit Maximizing Prices

How to determine profit maximizing price for urban bus companies in India? Given cost and demand functions, a price which corresponds to a value of γ_0 equal to unity is the profit maximizing price for urban bus companies. For illustrative purpose, profit maximizing output and price is computed for BEST during 2001-02. Table 21 presents results of simulation exercise undertaken in this regard. It can be seen from the Table that average fare of 120 paise per pass.-km is profit maximizing fare for BEST. Charging fares either above or below this rate will cause profit to diminish (refer Figure 10). The corresponding output level is 2529 million pass.-km which is considerably less than the prevailing output of around 9587 million pass.-km during 2001-02. This shows that the objective of profit maximization would exclude a large number of passengers from using BEST's services which is not socially desirable. Furthermore, charging a profit maximizing price will lead to huge social welfare losses (deadweight losses). For example, in case of BEST, profit maximizing pricing will lead to social welfare losses amounting to ₹748 million in 2001-01 alone. This is far higher than ₹187 million, the social welfare losses corresponding to the current price charged by BEST. An analysis of other UBCs regarding profit maximizing prices yields similar results.

Table 21
Measuring 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_0
130.0	1918	595.5	31.4	98.9	85.1	1.24
128.0	2026	604.0	30.4	98.2	84.8	1.19
126.0	2142	611.1	29.3	97.5	84.6	1.15
124.0	2264	616.5	28.1	96.8	84.3	1.10
122.0	2392	619.9	27.0	96.1	84.1	1.05
120.0	2529	621.2	25.7	95.4	83.8	1.00
118.0	2673	620.0	24.5	94.8	83.6	0.95
116.0	2825	616.0	23.2	94.2	83.4	0.90
114.0	2985	608.7	21.8	93.6	83.2	0.85
112.0	3155	598.0	20.4	93.0	83.1	0.80
110.0	3334	583.2	18.9	92.5	82.9	0.75
108.0	3522	564.0	17.4	92.0	82.8	0.69
106.0	3721	539.9	15.9	91.5	82.7	0.64
104.0	3931	510.3	14.3	91.0	82.6	0.59
102.0	4152	474.7	12.6	90.6	82.5	0.53
100.0	4384	432.4	10.9	90.1	82.4	0.48
98.0	4627	382.8	9.2	89.7	82.3	0.42

(Contd...)

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_0
96.0	4883	325.3	7.5	89.3	82.3	0.37
94.0	5152	259.1	5.7	89.0	82.3	0.31
92.0	5433	183.5	3.8	88.6	82.2	0.26
90.0	5727	97.6	1.9	88.3	82.2	0.20
88.0	6034	0.8	0.0	88.0	82.3	0.15
86.0	6354	-108.0	-1.9	87.7	82.3	0.10
84.0	6687	-229.4	-3.9	87.4	82.3	0.04
82.0	7033	-364.3	-5.9	87.2	82.4	-0.01
80.0	7390	-513.6	-8.0	86.9	82.4	-0.06
78.0	7759	-677.9	-10.1	86.7	82.5	-0.11
76.0	8139	-857.9	-12.2	86.5	82.6	-0.16
74.0	8529	-1054.4	-14.3	86.4	82.7	-0.20
72.0	8926	-1267.6	-16.5	86.2	82.8	-0.24
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
66.0	10145	-2009.6	-23.1	85.8	83.1	-0.34
64.0	10550	-2290.3	-25.3	85.7	83.2	-0.37
62.0	10949	-2586.3	-27.6	85.6	83.4	-0.38
60.0	11337	-2896.2	-29.9	85.5	83.5	-0.39

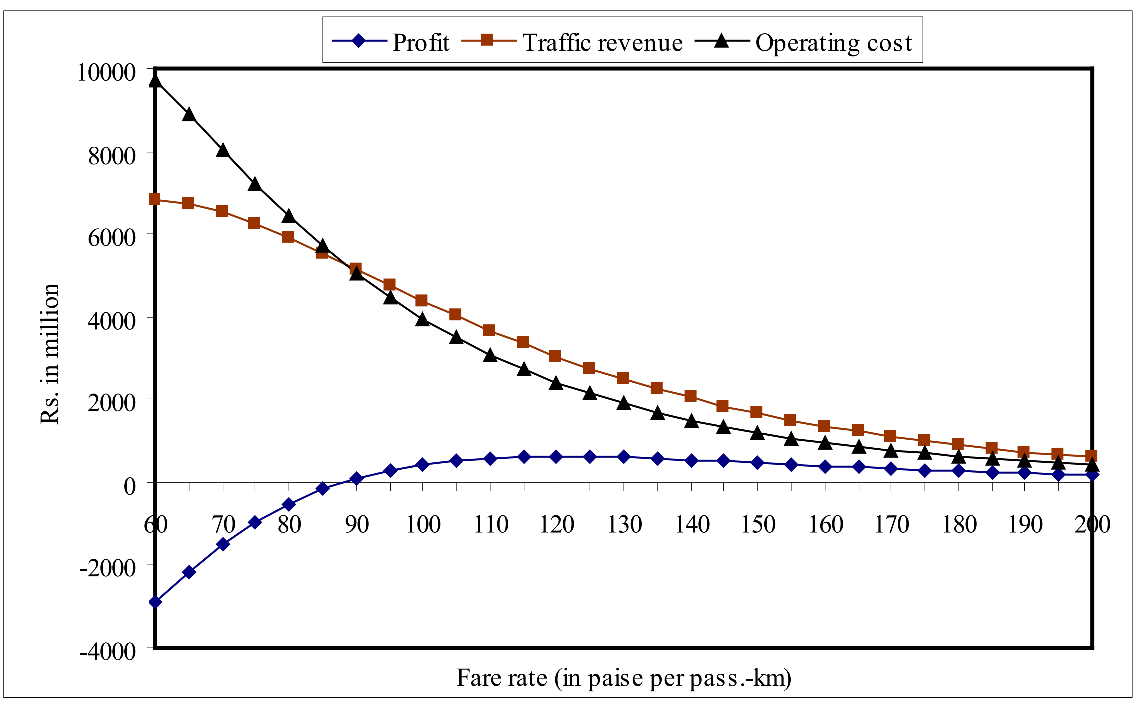

Figure 10: Relationship between fare rate and profitability in BEST during 2001-02

4. CONCLUDING REMARKS

Ramsey pricing provides optimal pricing rule for public enterprises that have a mandated budget constraint. The price and output combinations that it computes minimize the deadweight loss due to unavoidable deviation of price from marginal cost of production. Since Ramsey pricing rule takes into account price elasticity of demand, it is superior to the average-cost pricing rule that most urban bus companies tend to adopt. Average-cost pricing does not explicitly include demand-side information.

We did a simulation study to measure the level of social welfare and profitability of the sample UBCs at different level of prices charged for passenger transport services offered by them. Since the price elasticity of demand is an important ingredient of the optimal pricing rule, we first estimated, by regression analysis, the derived demand for passenger transport services offered by them. Marginal cost calculation is based on translog cost function estimated by Singh (2005). Finally, we compared prices with the marginal cost and calculated a measure of the level of social welfare and profitability of sample urban bus companies at different level of prices.

An analysis of price elasticity of demand reveals that all sample UBCs are facing relatively elastic demand for their services. Price elasticity of demand is estimated to be 1.294, 1.419, 1.255, 1.367, 1.117, 1.470, and 2.064 for PMT, PCMT, AMTS, KMTU, TMTU, BEST and BMTC, respectively. We found that the prices charged by UBCs deviate from the ones which maximize social welfare. By comparing deadweight losses, it is found that there would have been a welfare gain had optimal prices been charged rather than actual ones. For example, deviation from marginal cost pricing during 2001-02 resulted in social welfare losses of ₹6.24, 1.44, 20.60, 3.85, 12.79, 187.25 and 21.63 million for PMT, PCMT, AMTS, KMTU, TMTU, BEST and BMTC, respectively. However, adoption of marginal cost pricing would have left all UBCs with financial deficits as all of them are operating with increasing returns to scale. During the year 2001-02, adoption of marginal cost pricing in urban bus companies would have required subsidy of ₹155.58, 56.60, 153.58, 52.78, 103.03, 358.47 and 142.37 million for PMT, PCMT, AMTS, KMTU, TMTU, BEST and BMTC, respectively to cover all costs including taxes through their traffic revenue. However, subsidy required can be reduced wholly or in part by means of augmenting non-traffic revenue. During the year 2001-02, non-traffic revenue of PMT, PCMT, AMTS, KMTU, TMTU, BEST and BMTC was ₹27.66, 11.83, 44.90, 24.12, 5.58, 350.50 and 211.27 million, respectively. Therefore, for instance, during the year 2001-02, BMTC's non-traffic revenue would have enabled the same to be in financial surplus even without government subsidy after adopting economically efficient pricing.

For some UBCs such as BEST, welfare maximizing as well as break-even prices are found to be quite high. Moving from the prevalent fares to either of these fare rates may not be desirable from the equity viewpoint. In such a scenario, one could envisage differential pricing mechanism such as peak period, off-peak period, peak direction, off-peak direction, etc. based pricing strategy. This is an exercise worth pursuing since UBCs are serving different market segments with heterogeneous elasticities of demand.

Note: Another version of this paper has been published as a chapter in the book on *Productivity, Cost Structure, and Pricing in Urban Bus Transport: A Case Study of Urban Bus Companies in India*. Amani Int'l Publishers, 2006.

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