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# MARGINAL COST CALCULATIONS AND PRICE DISCRIMINATION IN THE RAILWAY FREIGHT SECTOR

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## Abstract

It has been a long discussion in the field of transport economy whether the socially optimal marginal cost based prices should be a basis for price policy even in the railway freight forwarding services. The general advantages seem to confirm marginalists in their belief, while others draw the attention to the serious diseconomies of price setting equal to marginal costs. The paper summarises the main arguments from both sides, and tries to clarify some of the difficulties within the railway freight services. Since the "ordinary" marginal cost does not seem to provide full cost coverage in the case of most railway companies, an outlook to the theory and to the practice of price discrimination, its possibilities within the transport sector might be of help. One of the most important outcomes is that a multi-theory price setting is needed to fulfil all requirements set, assessing both the good cost coverage and the social optimum. The text flow strongly depends on the great literature [4].

*Keywords:* marginal costs; cost calculation; railway freight economy; price discrimination

## 1. Introduction

When considering the major economical questions of the transport sector, the forming of the pricing policy is one of the hardest and most important issues. The setting of rates is necessary in any transportation enterprise that covers its costs in whole or in part from fees paid by users of the service. The Hungarian railway freight sector belongs (at the moment) to the public owned enterprises, and is strongly regulated by the state. Directly because of this regulation the appropriate pricing tool can be a life-saving 'equipment' when considering long-run productivity of the freight shipments.

From the point of view of the society, the starting point of analysis of prices is the development of criteria for the evaluation of existing or proposed prices [9]. Considerations of efficiency in the allocation of resources lead to the criterion that prices should be based on costs. If the prices for the railway freight transport are based on costs, shippers who try to minimise their own costs will choose from competing modes of transportation the one that can perform transportation for them at the lowest cost for the society. This policy requires that all transport modes' prices

are based on social marginal costs. Shippers of the railway service will also make the socially correct choice between transport-intensive and transport-minimising methods of production [1]. Furthermore, the competition among shippers at different geographic locations will be on the correct basis since each shipper will pay the cost of the input of transportation that he uses when carrying out his activities.

If we need to fulfil the criterion of setting the prices effectively compared to scarce resources, then the price should be set equal to the marginal cost. Economists usually urge that price should be equal to the long-run marginal cost, but sometimes they propose that the price should be equal to the short-run marginal cost.

The above drafted ideal situation is not easy to reach even theoretically. It has to be considered whether short- or long-run marginal costs should be used as basis for price setting. Furthermore, the cost coverage ratio should not be worse than 100%, otherwise cost will not allow the long-run productivity of the railway company (as they do not do it now).

By short-run marginal cost is meant the marginal cost when plant and equipment are taken as fixed. This is the ordinary case in the field of railway transportation. Short-run marginal cost per unit rises with the transport performance, when the railway is straining at the limits of its capacity. Since the Hungarian railways are definitely not in this shape, short-run marginal costs are important in another interval.

By long-run marginal cost is meant the marginal cost when infrastructure and equipment can be freely expanded or decreased. Long-run marginal costs will depend on economies of scale. If there are no economies or diseconomies of scale, long-run marginal costs will be constant.

## 2. Price Basis: Long-Run Marginal Cost

To set the price equal to the long-run marginal cost of a given transport performance unit of service means to set the price equal to the value of the resources that must be used to produce the transport performance in the future. Long-run marginal cost as a rule will be equal to the full average cost, including the infrastructure elements, vehicles, etc. that have to be repaired or replaced. The two cost categories differ only under special circumstances. Furthermore, in the case of railways, the long-run marginal cost leads to a relatively good cost coverage.

Let us assume a transport demand that can be satisfied both by road and railway transport. A further assumption is that both ‘enterprises’ want to remain in the future. The question in this case is which mode will haul the commodity over a particular route for the foreseeable future? Under these circumstances, the efficient solution from a social point of view is again that the mentioned commodity should move by the mode that requires the least extra expenditure of scarce resources.

Railway freight transport has significant advantages in this field, compared to road haulage or air transport. For the calculations, costs should be estimated on the basis not of past expenditures, but of prospective future expenditures. Unfortu-

nately, when mentioning costs, one talks about past costs, because this information is much easier to reach, and is exactly available. But only future costs are relevant to establishing future policy. Sunk costs must always be disregarded, and the relevant question is, how can the society provide the transportation services in the future, with the minimised additional (=marginal) outlay of scarce resources? If the charged prices reflect correctly these costs to the society, shippers may be expected to make the right choices in their own interest. This result will be achieved if prices are based on long-run marginal costs.

In a certain case, when the long-run average cost curve is falling (i.e. there are economies of scale), the long-run marginal cost will be less than average cost, and a price equal to long-run marginal cost will imply chronic losses (while a rising curve would imply excess returns). If such situations do appear, a tax or state subsidy may be required. Since one of the greatest advantage of railway freight transport is the considerable economies of scale (falling average cost with the increased transport performance), a long-run marginal cost based price must be handled very carefully.

## 3. Price Basis: Short-Run Marginal Cost

In the case of railways (because of the high amount of involved capital in the infrastructure and rolling stock) the question arises whether price should be equal to short-run marginal cost, since there is a big difference compared to the long-run costs. Considering different lines of the railway track, there are two options: short-run marginal cost may be very low when a track is operating with excess capacity, and it may be very high, when a track is being heavily used. This underlines the importance of the detailed railway information system and gathering them according to the principles of the general controlling methods.

As an example of a situation in which short-run marginal cost is very low, consider the new line between Zalalövő and the Hungarian-Slovenian state border. This track seems now to have excess capacity, and the marginal cost of permitting an additional train to pass over this section must be very close to zero. Theoretically, the price should be set to zero, according to the rule mentioned above.

Some other methods of paying for the section must be found, of course. The problem is whether the best alternative method has disadvantages as serious as the loss from charging a price in excess of short-run marginal costs.

## 4. Costs of a Congested Railway Line

Not all railway lines have excess capacity in Hungary as well in Europe. A different problem arises when an existing line becomes overcrowded. A section is only free, when trains travel freely without disturbing each other. But there will come a point as the number of trains is increasing, when each train slows down other trains to some degree (for example because of bidirectional traffic on a single line).The delay

means cost to other trains and time-loss of the carried commodity. There will be monetary costs of congestion for the goods that are delayed in the form of additional time-losses in factories or penalty for shippers.

In such a case, the rule that price should be set equal to the marginal cost implies the marginal social cost, including the congestion cost. Thus, price should be used as a rationing device to limit the use of a scarce resource (now the occupation time of the overcrowded track). As the price rises, some potential users of the line will be discouraged [11]. Total revenue of the railway operators of the line will also rise, and profits may well result. The argument is exactly analogous to the argument for price equal to marginal cost in money when no congestion costs are involved. If the price does not cover the full marginal social cost, shippers will 'consume' too much of the freight forwarding service.

If the principle suggested here is followed, it would be possible to use price to control peak loads on freight service systems. Tolled tracks might raise their prices during the weekend, when passenger traffic has a higher density. Higher tolls would prevent some freight movement entirely, but the more important effect probably would be to shift some of the forwarding need to off-peak periods. There are unfortunately very few lines of the Hungarian Railways, where the peak load cannot be conducted without any disturbance. This means that the lines usually work with excess capacity nowadays.

Researchers of this field are sometimes impressed with the social gains to be realised by using the price system to ration railway infrastructure in short supply in this manner. Some other economists argue that the main emphasis in situations where needs for railway freight transport are expanding (in case of establishing a new mine) should be on the expansion of the rail transport system and that the short-run gains from adjustments in price are only of secondary importance. After their suggestion, the price should be set on the basis of long-run rather than short-run marginal cost.

The ideal choice will depend on more elements involved in the situation:

- probable performance of the increased need;
- price elasticity of the demand;
- cost of collection of goods for forwarding;
- strength of the objection to fluctuating prices by shippers of the railway service.

In normal business, in enterprises outside of the transportation sector (for example manufacturing), where prices can be set by the enterprises concerned, prices are often set at average cost, at a specific level of output. Capacity is adjusted as required without resort to short-run adjustments in price. This solution (under some circumstances) may approximate setting price equal to long-run marginal cost.

## 5. Cost Assignment Problems

Let us assume that the prices of the railway freight sector are tried to be set equal to its long-run marginal cost. Then following questions arise:

- Is it known, exactly what prices are to be set?
- How could it be checked whether the set price is correct and remains correct during a longer time interval?

The problem would remain, how to allocate the costs of the rail freight service to the particular category (RoLa, container-transport, oil forwarding, etc.) of freight traffic. The same problem arises for each separate line which has different marginal costs as well.

The difficulty can probably be handled by considering the three components of the railway system, the vehicles (cars), the infrastructure and the third-party energy supplier. Costs incur to construct and maintain the infrastructure, to pay for the energy and fuel (including the associated labour) and to provide and maintain the vehicles. No shipment could be made without the existence of all components, but facilities that serve a single shipment are also likely to be used to serve many other shipments. The only question which remains is: how should the costs be shared?

For the infrastructure the problem of allocation arises, should it be a single track, a double track or even a high-speed electrified line. When a single movement of a train and its associated power plant (the engine) is entirely devoted to one single shipment (for example like the shipments from the mine in Visonta), the problem is somewhat simplified, since there is no problem of allocation of the costs of that movement because there is still the common cost of the track. The cost of a single movement has to be determined. But it is true as well that a movement such as a train journey is not always undertaken to handle a single large shipment. Freight, in general, moves by rail in carload lots, and the cost of the journey must somehow be allocated among the cars if the costs of the individual shipments are to be estimated. For less than carload shipments there will be a problem of allocating the cost of the train movement. As some economists have put the matter, the unit of supply is not the same as the unit of the merchandising activity. Economists have meant that it is useful to distinguish at least two types of costs: common costs and joint costs. Common costs arise whenever an expenditure is made that is useful for two or more shipments. Joint costs arise if a railway company in producing certain services also necessarily produces certain other services. For example, if a railroad produces transport performance by moving goods or people in one direction on its line, it must also produce services by the reverse movement of its equipment. There must be a back haul.

The allocation of costs between the haulage in one direction and in the other is necessarily arbitrary. This arbitrary element enters the price structure. Low prices may be charged for travel in the direction of the lesser movement, or the same prices may be charged as in the direction of the greater movement. From the viewpoint of

the costs, there is no criterion for preferring one of these policies to the other, the actual solution will depend on demand.

Common costs are more frequently found than joint costs. The common-cost allocation problem may be reduced by segregating costs that are directly associated with a shipment. It may be possible to allocate other costs, if not individual shipments, at least to classes of shipments. This results in a hierarchy of costs, ranked by degree of specificity. Some are allocable to individual shipments (fuel consumption), others to classes of shipments somehow defined (engine wear) while still others are not easily allocatable to any services provided (for example, gardening activities at railway stations).

Still the question arises: what is the marginal cost of the service? What would the company save if it did not provide this service or this type of service? For example, the extra wear on a freight car from making a certain trip is allocable as cost of that shipment. The cost of maintaining a marshalling yard is allocable to freight service generally in contrast to passenger service. Neither the cost of the top-management of the company, nor the cost of the railway is easily allocable to any class of railway service.

The criterion of efficiency leads to the yardstick that each category of service should pay at least all costs that would not be incurred if that class of service were abandoned. This does not lead to a clear rule about what should be done with those costs that cannot be allocated properly. There is no simple, unique solution to the question of how to allocate these remaining costs once the other costs have been, as it were, 'peeled away'. Reasonable allocations are possible and in some cases even achieved. In practice, considerations of the demand-elasticity are commonly taken into account, and prices are based on calculations on demand as well as of cost [6].

Furthermore and more general, the costs can be allocated by type of transportation service. It has been urged in the recent years that each mode of transportation should pay for itself [10]. Cost of engines and cars and their operation, in general, are borne by those for whom the service is provided. It is frequently urged that this principle should be extended to cover the cost of the track [2]. These costs should be met by user charges [7]. Public assistance to the railways should be covered by tax rates and tolls paid by rail shippers. This is why, as already mentioned, considerations of demand affect the determination of prices charged for rail freight transport.

## 6. Price Discrimination in Freight Transport

The economic theory of price discrimination received its classic position in the middle of the $20^{th}$ century. It is extremely useful as a succinct way of describing the methods that profit-seeking companies will use to set prices to the extent they are free to do so. In this case, the word 'discrimination' means making a distinction between the users of the transportation (or, in general, all) services.

In the monopolistic theory, a monopolist without price discrimination is

thought of as producing a single commodity. He equates the marginal revenue and marginal cost for that type of output (in our case the freight forwarding service), and in this manner he maximises his net revenue. Price is determined by the intersection of his marginal revenue and marginal cost curves [3]. Price discrimination is said to exist, if there is a difference in price with no difference in cost. The term is also used in situations where there are differences in cost between markets, but no differences in price (for example, railway passenger transport on different tracks), or only small differences in price that fail to reflect the full differences in cost. That is, price discrimination occurs if the following three conditions are met:

- The railway must sell its service at least in two different markets;
- There must be differences in the price elasticity of demand between these markets and;
- The railway company must have monopolistic control of price in one or all markets.

Under these conditions it will be profitable for the railways to sell the same service at different prices in the separate markets, that is, it will be profitable to discriminate in price between the two markets.

How the logic of this situation works, may be seen most easily in the special case in which the marginal cost per one performance unit output of the railway company is constant over the entire relevant range of output. Constant marginal cost implies only that the total cost curve is a straight line in the relevant range. In this situation, the railway will equate its marginal cost with the marginal revenue in each market. Since the elasticity of demand differs in the two markets, the demand curves or average revenue curves will differ with the markets, and the marginal revenue curves will also differ. The railways, by setting price and cost equal to marginal revenue in each market separately, will charge separate prices in the different markets (lines or track sections).

It is quite sure that monopolists will earn more money in this case by discriminating between the markets than by charging the same price in all markets. Since private shippers and freight agencies are motivated by the profit, it is not surprising that many companies in the transportation agencies spend much of their time trying to devise successful schemes of price discrimination.

For the economy of transport, the discrimination among freight shipments is of great importance. It is often based on the type of goods. Discrimination may also be based on differences in the place of origin and destination of a certain shipment. The carrier will know where it picked up and where it discharged each shipment. Goods moving in one direction cannot masquerade as goods proceeding in the opposite direction.

## 7. Demand and Price Elasticity

Even if there are differences between tracks or lines, only differences in elasticity of demand will make worthwhile differences in price. Therefore the elasticity dif-

ferences have to be examined as first step. Three factors seem to be most important:

- value;
- competition and;
- potential entry.

The value per ton of a commodity or bulk good to be shipped is commonly taken as a rough approximation of the price elasticity of the demand for shipping that commodity. Goods high in value are charged high prices for this reason. Since the cost of shipment is a small fraction of the total value of the product, it is argued that the transport price will be less important to the shipper or to his customers.

Differences in the elasticity of the demand curve confronting a seller will also arise depending on the availability of substitute services like road trucks or pipelines for mineral oil. Other things being equal, the demand will be more elastic, where there are more competing services available. The demand is elastic, because if the railway company raises its prices, it will lose its customers to the competition.

As an example of the relation between price elasticity and competition we mention the relation between trucking and the demand for railroad freight. When trucks became available for the shippers (about three decades earlier), their situation changed. They will become less willing to pay high prices for rail shipment and prices in excess of truck rates will seem high. An increase of price in rail freight over the rate offered by trucks may even lead a shipper to switch his entire business to trucks. Thus, the demand for rail service becomes more elastic, more sensitive to price changes because of the increased competition in the freight forwarding market.

The demand curve confronting a seller will become price elastic, whenever the chance exists that new sellers enter the market, in general. It is not necessary for these sellers actually to enter. Exactly this principle drives the EU policy-makers when directing railway market liberalisation. The ‘threat’ of entry may influence the price policy of railways which are already in the market. The threat that the shippers may carry their own goods may have a similar influence on railway companies, as this result was observed in the end of the 20$^{th}$ century in Germany [5].

The theory of price discrimination has been presented using the assumption that the output of the railway ‘industry’ is a single, standard product. The horizontal axis is scaled to measure homogeneous units of the transportation provided. Of course, reality is more complex. The measure of transportation service in most common use is ton-kilometre. But on close inspection, ton-kilometres are far from being homogeneous. They differ in part because of inherent variation in the service being provided and in part because of deliberate attempts by sellers of transportation to make their service distinguishable from that of other sellers. The latter may be referred to as product differentiation. All expenditures for customer services (like the new WAP-information system of MÁV), advertising and public relations may be grouped under this heading.

For product differentiation in freight services there are more options. Services differ with respect to speed, special handling of perishable or fragile merchandise,

special attention to the exact time and place requirements of a shipper and the like. Ton-kilometres also differ in cost for reasons quite apart from any special efforts by sellers to differentiate their products. The cost per ton-kilometre for a given shipment is higher for short than for long distances by any lines or haulage types (diesel, electric). Costs depend upon the bulk as well as the weight of a shipment. The existence of variations in prices based upon differences in costs is by no means evidence of price discrimination. Such a system of prices as the actual railroad price constitutes an elaborated system of price discrimination. However, it is not easy to disentangle from variations in rates based on variations in the cost of service provided, associated with differences in what is being shipped, under what circumstances, and between what points.

The theory of price discrimination also needs to be supplemented in another way to provide a more complete account of events in actual markets. The model of price discrimination applies to markets in which a single seller or a small group of sellers enjoy some degree of monopolistic power, but the buyers are numerous and too small individually to influence the price. This easily can be said to be true for rail freight services. But not in all cases: for example the market for the transportation of assembled automobiles from points of assembly to dealers is a market with large buyers. Almost all giant corporations are large buyers of transportation. In those markets where large buyers confront large sellers, the price is determined by a bargaining process that may be dominated by either party. The price may be more advantageous for the buyer than to the railway company. The model of a discriminating monopolist is not applicable to these situations. A closer approximation to economic reality may be to think of a bargaining situation.

A further task is (when considering the optimal prices) that the ones determined by using the different elasticities of the demand side should be not very far from the ones which result from the marginal cost theory. If the set price is too close to the long-run marginal cost, the threat of having bad cost coverage occurs. On the other hand, when the prices are based too far from the marginal equation (for example, average prices), then the social loss increases enormously. The connection between the two methods is provided by the Ramsey-prices, which allow higher rates in case of weak demand elasticity, and lower price-rise in case of big elasticity. More exactly, the difference between the socially optimal marginal costs and the practically set costs should be reverse proportional with the elasticity of the mentioned market if it is a certain track, a special forwarding technology or somehow connected to the forwarding distance [8]. In this case, the net social loss is minimised and, at the same time, a relatively better cost coverage can be reached. The parameter along which the elasticity of the market should be measured is usually the price (price-elasticity) but in the case of the freight forwarding services it can be one of the other transportation specialities (shipping time length, guaranteed arrival date, freight following system, etc.).

## 8. Summary

As seen in the paper, marginal cost based pricing in the railway freight sector is a hard question both for policy-makers and for the railway company itself. Because of the specialities of this transport mode, the classic way of determining the prices according to the long-run marginal cost does not lead to full cost coverage. That is why other methods have to be used to save the railway companies from serious difficulties. One of the methods originates from the price discrimination theory, which uses the different elasticities of shippers, service and types of goods. On this basis different prices can be set to partly different services, and these prices might be not equal to the optimal marginal costs. However, the net welfare loss of the society can be minimised, and for this 'rate', nearly full cost coverage can be achieved in the discussed railway freight forwarding service.

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