OPEN ACCESS ON THE DUTCH RAILWAYS
The possible adverse effects of competition on network size and quality

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Because of a strong complementarity of services in dense and intensively used transport networks, open access probably cannot contribute to increasing the modal share of passenger rail transport in the Netherlands. On the contrary, multiple service providers in such networks could have a disastrous effect on the size and quality of the network decreasing the attractiveness of the network for (potential) users. Complementarity causes externalities between services which can not be internalised under competition. In a network with multiple operators part of the demand restricting effect caused by higher prices and lower quality can be passed to other operators giving firms an incentive to increase price and decrease quality beyond the socially desirable level. Due to the fact that one of the main aspects of quality is frequency – a measure for quantity – this also affects the size of the network.

INTRODUCTION

Two reasons were decisive for the Dutch government to reconsider its policy towards rail transport. Firstly, a concern for the increasing congestion on the road infrastructure and a declining trend in public transport patronage combined with a considerable growth in mobility in the future. A substantial effort to curb this trend and increase the market share of rail transport in mobility was called for. Secondly, the EC rail transport policy in general and Directive 91/440 in particular forced to reorganise the railway sector.

In the last two decades the emphasis in national policy has been on the social function of the Dutch Railways (NS). The resulting public service obligations and formal government interference into the basic entrepreneurial freedoms such as investment, financing, fixing fares and setting timetables made the NS increasingly government oriented. This state of affairs was considered as a major problem which was thought to result in a mismatch between supply and demand which could be illustrated by the relatively small modal share of rail passenger transport in total mobility. A regulatory change was then called for to stimulate a development of mobility in which public transport takes a more important role.

EC-directive 91/440 gave the direction for the restructuring of the financial and administrative relationships between the government and NS. The central idea is that an ambitious increase in the market share of rail transport can only be realised by an independently and commercially operating passengers division of NS. Hence, the new relationships between the government and NS are characterised by a clear definition of competencies concerning infrastructure and operation of train services. The government is in this new situation responsible for policy on rail infrastructure facilities and for regulating their use while NS is an operator of train services.

For regulating the use of infrastructure three specialised organisations have been created and have been given exclusive responsibility for the planning, construction, maintenance, safety, allocation of capacity and admission to the rail infrastructure. Although these specialised organisations are still part of NS, central government has effective control on them in so far as their targets are concerned. For example, *Railned* is the specialised organisation that allocates the infrastructure capacity on the basis of objective criteria to be approved by the Minister of Transport and subject to independent supervision.

In order to achieve a growth in the number of passengers by an increase in efficiency and an improvement in the quality of rail transport services one of the aims of the reform process for the short term is to transform the passenger division of NS into a profitable unit before the year 2000. During this transitional period (1995 to 2000) the operational subsidy is being gradually phased out while the entrepreneurial freedoms of the passenger division increase over the same period. According to the clauses of the transitional contract between the government and NS, the railways will be free to determine the level of service of their choice within however some broadly defined limits. Services that NS does not want to provide anymore may be contracted by central government.

By this vertical separation of operations from infrastructure the Dutch government has effectively implemented Directive 91/440. The Dutch government is considering to take a crucial step further as from the year 2000. For realising the ambitious aim of doubling the modal share of passenger rail transport it is thought to be necessary to introduce open access on the Dutch railways giving way to multiple providers. This intention is not new in Europe as Britain and Sweden have also played with this thought. The European Commission, however, does not go that far. In its White Paper *A strategy for revitalising the community's railways* the Commission makes clear that open access may not be an attractive solution for passenger rail services operated on dense and highly used networks. In such networks the allocation of infrastructure capacity, the sharing of common costs and the necessary co-ordination (for optimisation of timetables, information provision and common ticketing systems) between different operators cause problems that are not easily solved. In view of the fact that the Netherlands have the most densely utilised network in Europe (Preston, 1996) these complexities are plausible arguments against the introduction of open access.

Even if these technical problems could be overcome, one may still come to the conclusion that open access may not be desirable at all. The reason for introducing open access in passenger rail transport is based on the very simplistic argument that the introduction of (this form of) competition yields better and more efficient services. This paper will try to show that this does not necessarily ensue. On the contrary, the complementarity of public transport services in such dense networks can make multiple operators socially undesirable; and open access may therefore decrease rather than increase the modal share of passenger rail transport. This can be demonstrated with a simple model. According to this model that will be presented in this paper multiple producers cause higher prices and come at the expense of the size and the quality of the network making (potential) passengers less inclined to take the train.

COMPLEMENTARITY OF PUBLIC TRANSPORT SERVICES

Many products have little or no value in isolation but generate value when combined with others (Katz and Shapiro, 1994). A single public transport service is such a product. The presence of connecting services determines to a large extent the value of a single transport service. The relevant product for a potential passenger is transportation from origin to destination, making it necessary or desirable to consume different public transport services in sequence. For example, two or more connecting services are perceived by the consumer as one product, as are an outward and a return journey. Interconnection guarantees effective penetration by a larger number of (composite) products. This points to passenger transport services being complementary. Due to this complementarity, that is the basic characteristic of systems or networks, interconnection of services becomes valuable in public transport networks as it increases the value of the network and all services in it.

In public transport the level of service to the user, and hence his time and generalised cost outlay, is determined by the characteristics (frequency, reliability, etc.) of the product as a whole. However, the product is not always the unit of production so that if this service is made up of different components the characteristics of the final product are determined by the price and quality of the various components (and the quality of the interface or interconnection). Hence, a characteristic of public transport is that when changing the price or quality of one service or link of the network, this affects the usage of other parts of the network. Because the quality of a link in the network depends on the quantity of services provided (i.e. frequency), the quantity of services also affects the usage of the network. Thus, complementarity causes revenue generating externalities among transport services.

The implications of these externalities when competition is introduced in networks that are characterised by strong complementary transport services (i.e. dense networks) can be illustrated with a simple model. The simplest model one can think of has two connecting tracks extending from origin point A to an intermediate point B and from the intermediate point B to destination point C. These two tracks are denoted by 1 and 2 respectively. There are also two firms. One provides services on track 1, the other provides services on track 2. Both firms are monopolists and will be named here after the track on which they operate. For simplicity, there is only one final product being travel from A all the way to C, so that the transport services on both tracks are perfect complements. The quality of the services on the track 1 is denoted by q_1; in a similar way the quality of the services on the track 2 is denoted by q_2. The quality of service is a function of frequency and other aspects of quality. Hence,

$$\begin{aligned} q_1 &= q_1(f_1,...) \\ q_2 &= q_2(f_2,...) \end{aligned} \tag{1}$$

It should be noted that these functions embody a specific characteristic of scheduled transport services according to which the quality of services, and more generally of a transport network, depends on the quantity of services provided (i.e. frequency). The firms sell these qualities at prices p_1 and p_2 respectively. The composite product price for travelling from origin point A to destination point C is the sum of both complement prices, $p = p_1 + p_2$. The demand for the final product from A all the way to C is a function of the quality of services rendered on track 1 and 2 and composite product price p, so that

$$D = D(q_1, q_2, p) \tag{2}$$

where, naturally, demand is positively related to the level of quality of the two components and negatively related to the price of the composite product. Marginal costs for producing service qualities q_1 and q_2 are constant[1] and are denoted by c_1 and c_2 respectively.

It is now possible to give the profit functions for firms 1 and 2. Firm 1 has the following profit function

$$\pi_1 = p_1 D(q_1, q_2, p_1 + p_2) - c_1 q_1 \quad (3)$$

Maximising this profit function yields the first-order conditions with respect to decision variables p_1 and q_1

$$\frac{\partial \pi_1}{\partial p_1} = D + p_1 \frac{\partial D}{\partial p_1} = 0 \text{, and} \quad (4)$$

$$\frac{\partial \pi_1}{\partial q_1} = p_1 \frac{\partial D}{\partial q_1} - c_1 = 0 \text{, s.t.} \quad (5)$$

$$\pi_1 \geq 0 \quad (6)$$

In the same way we have the profit function for firm 2

$$\pi_2 = p_2 D(q_1, q_2, p_1 + p_2) - c_2 q_2 \quad (7)$$

and the first-order conditions of this profit function with respect to p_2 and q_2

$$\frac{\partial \pi_2}{\partial p_2} = D + p_2 \frac{\partial D}{\partial p_2} = 0 \text{, and} \quad (8)$$

$$\frac{\partial \pi_2}{\partial q_2} = p_2 \frac{\partial D}{\partial q_2} - c_2 = 0 \text{, s.t.} \quad (9)$$

$$\pi_2 \geq 0 \quad (10)$$

These first-order conditions of two independent monopolistic firms offering complementary services show on the one hand which prices both firms set and on the other hand which qualities, and hence quantities, of services they will provide. By summing equations (4) and (8) we also obtain a relationship between demand and price for the composite product, i.e. travel from A to C. This yields

$$2D + p \frac{\partial D}{\partial p} = 0 \quad (11)$$

[1] Assuming that the marginal costs are not constant does not change the results in a qualitative way except in the case of an extreme and pathological behaviour of the marginal costs.

since $p = p_1 + p_2$ and, consequently, $\frac{\partial D}{\partial p} = \frac{\partial D}{\partial p_1} = \frac{\partial D}{\partial p_2}$. Comparison of these first-order conditions with the first-order profit maximising conditions of one monopolistic firm providing both complementary services demonstrates the qualitative effects of multiple providers on the supply and demand of public transport services.

The profit function of such an integrated firm can be given by

$$\pi = pD(q_1, q_2, p) - c_1 q_1 - c_2 q_2 \tag{12}$$

Differentiating this profit function with respect to p, q_1 and q_2 gives the following three first-order conditions

$$\frac{\partial \pi}{\partial p} = D + p\frac{\partial D}{\partial p} = 0, \tag{13}$$

$$\frac{\partial \pi}{\partial q_1} = p\frac{\partial D}{\partial q_1} - c_1 = 0, \text{ and} \tag{14}$$

$$\frac{\partial \pi}{\partial q_2} = p\frac{\partial D}{\partial q_2} - c_2 = 0, \text{ s.t.} \tag{15}$$

$$\pi \geq 0 \tag{16}$$

Three effects can be derived from these first-order conditions and profit restrictions. They have in common that all three demonstrate that multiple service providers in a dense transport network come at the expense of demand for public transport.

Firstly, comparison of equations (11) and (13) shows that demand for travel by train will be lower due to a higher price of the composite product under two independent firms offering complementary products and independently setting prices than under a single monopoly in which profits are maximised for the railroads in total. The explanation can be found in the fact that the initiator of a price rise is less affected by the loss of demand for the final product than the group of producers as a whole. This gives individual firms an incentive to increase their component price beyond the collectively desirable level. In other words, the two independent firms ignore the effect of their individual mark-ups on each other, while the integrated monopolist internalises this externality. This result is analogous to Cournot's model of complementary duopoly[2]. Thus, we have here the result that merger or integration of firms that offer complementary products raises welfare (see for this pricing effect Allen, 1938; see also Baumol, 1983 and Economides and Salop, 1992)[3].

[2] Cournot considered the merger of two monopolists that produce complementary goods (zinc and copper) into one single (fused) monopolist that produces the combination of the two complementary goods (brass). He showed that joint ownership by a single integrated monopolist reduces the sum of two prices, relative to the equilibrium prices of the independent monopolists.

[3] It should be emphasised that this result is based on the assumption that firms in the market have some pricing discretion. This appears to be a plausible assumption given the experience with competition in air passenger transport. In the current U.S. airline environment the enormous price flexibility indicates that there is a good

Secondly, comparing equations (5) and (14) on the one hand and equations (9) and (15) on the other hand show that the quality of service and, consequently, the quantity of services offered is lower under a situation of two firms offering complementary services than under a situation of one integrated firm. Given the positive but diminishing partial derivatives of demand with respect to quality that follow from the second order conditions this is caused by the fact that the factor input prices in terms of the output prices increase with the number of complements. The explanation of this result is straightforward. The loss of demand for the final product by lowering the quality of a component product comes at the expense of the group of firms as a whole rather than the initiating firm. Part of the demand restricting effect is pushed off to other firms in the form of an externality that only integration or formal co-ordination enables to be internalised. This gives individual firms an incentive to lower the quality beyond the collectively desirable level. Consequently, the size and quality of the resulting network will be lower than socially desirable restricting the demand for public transport.

It is quite clear from the first-order conditions that these two effects cannot be obviated by tacit collusion between independent complementary products firms in which each firm selects the jointly optimal low component price and high component quality that would have been selected by an integrated firm. In such an arrangement the first-order conditions of both firms with respect to their component prices (i.e. equations (4) and (8)) are positive, and the first-order conditions with respect to their component qualities (i.e. equations (5) and (9)) are negative. This implies that each firm can increase its profits (at the detriment of the group) by increasing price and lowering quality. Hence, this type of collusion is highly unstable, being an example of the familiar prisoner's dilemma problem.

Both effects follow directly from the complementarity of transport services. They show that division of the network among multiple producers comes at the expense of the attractiveness of the network and, hence, the demand for public transport. This throws another light on the desirability of franchising or tendering of concessions that should be considered as rather being part of a larger network than autonomously, but also on the introduction of open access as it bears the risk of multiple producers becoming active on the network.

On the other hand there are some further implications that mitigate these consequences of the introduction of competition in dense networks in the longer run. By the complementarity of services independent entrants will not be granted a long life, not because they can not be successful but because of a tendency to monopolise supply by merger or take-over. The model implies that profits for an integrated firm are larger than the sum of profits of independent complementary products firms. The difference between the profits from an integrated firm and the sum of profits for independent firms are additional gains from merger or take-over. Mathematically, these gains can be represented by the discounted value of $\pi - \pi_1 - \pi_2 > 0$. Hence, in the end only one firm will dominate the market.

It should be noted that for franchising, tendering or contracting the same reasoning applies. A dominant firm that operates passenger services on a large part of the network has a strategic

reason to expect a carrier operating alone in a market to charge close to monopoly prices. Unlike in the contestability model, airfares can be revised instantaneously when a competitor enters the market, so that an incumbent carrier has little to lose from temporarily exploiting monopoly power (Brueckner and Spiller, 1991). Notwithstanding the non-perfect contestability of public transport markets, firms are not completely free in their pricing behaviour as they experience competition from other modes. This will especially be the case if the share of 'captives' is low.

advantage as it comes to winning the contract. Franchised, tendered or contracted services increase demand for services in the rest of the network making it for a dominant firm possible to make relatively better bids.

Thirdly, production of a number of complementary products by as many independent firms requires that production of every component is profitable. Integration relaxes this requirement by replacing it by the restriction that only the production of the composite good must be profitable. In the model this has been expressed in the combination of conditions (6) and (10) in a situation of two complementary products firms versus condition (16) for only one firm offering both products. These conditions become interesting in the case that one or more components cannot be made profitable while the composite product is. Then, the final product, travel from origin point A to destination point C, can only be provided by an integrated firm, not by two independent firms.

This seems to imply cross-subsidisation as such a firm compensates the losses from one component with the profits from another. This is however not the case. The relevant measure for revenues imputed to services supplied on both tracks are incremental revenues (i.e. $(p_1 + p_2)D$ and the identical $(p_1 + p_2)D$) rather than the actual revenues generated on the different tracks for the composite product (i.e. p_1D and p_2D). The market appears to split revenues automatically on the arbitrary basis of the prices of the components. The relevant product is however travel from origin point A all the way to destination point C so that when no services are offered on one track there will be no demand for services on the other. Because of these values of the incremental revenues we have no cross-subsidy[4] in our model but simply an externality between productions.

If one relaxes the model by also allowing for demand for each of the components taken alone, i.e. travel from A to B or B to C for which demands can be denoted by D_1 and D_2 respectively, then the question whether cross-subsidy occurs is more difficult to answer. Incremental revenues are then somewhere in between p_1D_1 and $p_1D_1 + (p_1 + p_2)D$ for services supplied on track 1 and in between p_2D_2 and $p_2D_2 + (p_1 + p_2)D$ for services supplied on track 2 while actual revenues generated by services on tracks 1 and 2 will be $p_1D_1 + p_1D$ and $p_2D_2 + p_2D$ respectively. For determining the proper values of the incremental revenues it will be necessary to look at the consequences of stopping the operation of one track on the demand for the other.

Thus far only complementary products were considered. Competition however concerns services that are more and less substitutable. A substitutable service is interpreted here as a service that fulfils the same travel needs as an existing service. The aforementioned externality between complementary productions shares a common feature with cross-subsidisation; both are not sustainable in competition. 'Profits' generated by component services encourage entry. This entry of a firm that offers substitutable services causes that 'profits' that are necessary to maintain the 'loss-making' components are skimmed. Hence, substitutability (i.e. competition) comes at the expense of complementarity. In practice, competition (or the threat thereof)

[4] A cross-subsidy is present when the average-incremental revenue contributed by a product of a firm is insufficient to cover its average-incremental cost, but the firm nevertheless earns sufficient revenue from all its products to cover its cost of capital together with its other outlays. (Baumol and Sidak, 1994)

implies that operation of tracks that are not 'profitable' will be stopped while operation can be profitable in the context of the network.

This consequence is not undesirable by definition. By increasing the quality of services on the remaining track competition might offset the loss in quality by stopping operation of a complementary track. This increase in quality of services on the remaining track will however only be achieved if firms can arrive at common pricing and ticketing systems and co-ordinated supply. Since it appears that competition in scheduled transport is unstable (see for example Sjostrom, 1989 and Pirrong, 1992 on liner shipping and Button, 1996 on aviation; see also Mackie et al., 1995 on the experiences with bus deregulation in Britain) being costly for firms and customers competition in public transport is often a phenomenon for very short periods of time that are alternated by long periods of collusion by means of conferences/cartels, mergers or take-overs. This collusion not only realises socially beneficial co-ordination but makes it also possible for firms to select the less socially desirable jointly optimal (monopoly) price and frequency (quality). Despite these monopoly prices and quality this monopoly can be socially beneficial given the alternative of unstable competition deteriorating the level of service to the customer. But by this tendency to monopolise supply competition, i.e. entry from a substitutable services provider, comes at the expense of complementary services without being able to offer something in return.

POLICY IMPLICATIONS

The railways in the Netherlands are a multi-nodal, polycentric network. On this rail infrastructure 84 train series were supplied by NS during the year 1990 (Wijffels et al., 1992). Train series, which are the main identifiable units of production, consist of a set of trains offering similar services on one route. These 84 train series can be divided into 15 intercity services and 69 agglomeration and regional services. The performance of both types of services in terms of passenger-kilometres is almost fifty-fifty.

The majority of these train series is loss-making, although there is a clear distinction between intercity series and agglomeration or regional series. Only a single intercity train series is unprofitable, while 64 of the agglomeration and regional train series are unprofitable. This profitability measure, that is comparable to the one used in the model above, is based on the allocation of revenues from ticket sales in proportion to the number of passenger-kilometres on the different train series. Due to the complementarity of services these calculations give no accurate measure for the real profitability of different train series since externalities have not been taken into account.

These calculations give however a fair approximation of the profitability of different train series if they had been operated by different firms, giving a frightening prospect for the future of the Dutch railways if multiple operators would become active on the rail network. On the basis of positive profit restrictions, 65 out of a total of 85 train series will in any case cease to be offered. Unless such services are reinstated by (tendered) contract or franchise, the remaining up to 19 series will face a considerable drop in demand making it necessary to decrease further the number of services. The number of services offered will decrease even further because firms ignore the effect of their pricing and output decision on each other, decreasing service levels and increasing prices so that train series on the average become even more unprofitable.

Fortunately, entry brought about by open access only has this effect in the short run. In the long run there will be a strong tendency to monopolise supply by merger or take-over. This monopoly would be basically beneficial for society.

Integration is the situation in the Netherlands at the moment. During a transitional period from 1996 and 2000 entry will only be permitted in so far as this adds value to the network and does not come at the expense of the existing supply of services. Hence, only entry by means of complementary service is allowed. This effectively protects the passengers division of NS from competitors offering substitutable passenger rail services. During the same period the passenger division of NS gains in stages commercial independence in return for a phasing out of operational subsidies and contracting by the government of train series that NS cannot provide commercially. Interestingly enough, NS has identified only 30 train series out of a total of 95 (note that between 1990 and 1996 the total number of train series has increased by 10), indicating that NS voluntarily wants to provide 65 series of which the majority is, according to the definition above, unprofitable.

It should be noted that the threat of entry can be a sufficient incentive for NS to dispose of the 'unprofitable' 65 train series, especially if they subsequently will be tendered as they are likely to win the contract due to the aforementioned strategic advantage. This result of open access will lay a heavy financial burden on the government and, hence, the taxpayer.

The current transitional contract allowing for entry only in so far as this entry is complementary to already supplied services complies with the analysis in this paper. Apart from being complementary, this kind of entry can have a positive effect on NS as it offers some reflection on the current practices. However, the threat to introduce open access after the year 2000 and the associated uncertainties are counterproductive for the developments of strategies by the deregulated passengers division of NS during the transitional period. Hence, possible benefits resulting from the increased managerial freedoms can hardly be realised. Noteworthy is that these managerial freedoms and the entry by *Lovers Rail*, a small new – thus far complementary – train operator, already have had some beneficial results.

Hence, competition can create more harm than good in a dense rail network. Insofar a monopoly can be expected to lack discipline, regulation is probably a better alternative than the introduction of competition. Naturally, this regulation should be of a different nature than the regulation of the last decades. For designing this regulation it should be taken into account that intermodal competition (e.g. car) possibly already disciplines NS to a large extent, especially if the share of 'captives' is low. Competition is only an interesting option insofar competition for this monopoly can be organised, especially if the current Dutch railway network can be divided into a few smaller ones that generate little travel across networks (i.e. are autonomous). Then not only competition for the market can have a disciplining effect, but also the possibility to compare (benchmark) the performance of firms in different networks.

CONCLUSION

The introduction of open access, and more generally, competition in dense public transport networks can appear to be socially undesirable. Dense networks are characterised by a strong complementarity of public transport services. This complementarity causes three adverse effects. Two effects demonstrate that multiple operators come at the expense of the size and quality (i.e. density and penetration) of dense networks. The other effect demonstrates that multiple operators charge higher prices than a single integrated operator. These three effects have in common that they affect the attractiveness of the public transport network for (potential) customers and hence demand. Hence, we have here three reasons why the introduction of competition in dense networks may decrease rather than increase the modal share of public transport while this is the reason for which open access is considered to be introduced.

Fortunately, this will only be a short run consequence as multiple operators in a dense public transport network create an unstable situation. Due to these three effects merger or take-over create additional gains giving firms an incentive to monopolise supply. In principle, this monopolisation will be socially beneficial. Insofar as this monopoly needs to be disciplined, it will be necessary to rely on regulation, but a different one than in the preceding decades in the Netherlands. Competition can probably only be considered an interesting option insofar as competition for this monopoly can be organised.

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