The competitive effects of entry in the railway sector with differentiated services and partial regulation[◊]

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Abstract The aim of this research is to provide some insights on the process of passenger rail transport liberalization when services are differentiated. In particular, the paper will focus on the impact of new entry in the high-speed services (HS) segment when the traditional service is characterised by service obligations for the incumbent. On the one hand we show that the entry of new operators in the more profitable segments of the HS services (known in the literature as cream-skimming) in the presence of imperfectly substitutable services (traditional and high-speed) and of regulatory constraints binding only for traditional services, leads, in general, to beneficial effects for consumers. The entry of new operators limits the incumbent that, in absence of competition, would be induced to keep prices in the non regulated market above the monopoly level in order not to damage the traditional market. On the other hand, however, the introduction of competition can create problems for the funding of service obligations. In the view of the recent developments in the literature we discuss different modes for financing the non-remunerative services (general taxation, perequative fund, reserved rights) and we evaluate their effects. We comment different cases depending on whether the minimum service is directly allocated to the incumbent; it is assigned by auction or, eventually, it is imposed to all operators.

1.0 Introduction

In recent decades, in Italy, as in many developed countries, passenger (and freight) rail transportation showed a slow decline due to a constant loss of traffic volumes and market shares compared to other modes of transport such as road or air. The gradual expansion in these countries of new infrastructures dedicated to high speed (and high capacity) can represent, however, an opportunity to revive railway mobility. Indeed the high-speed railway transport (HS) becomes potentially competitive compared to other types of transport[1].

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[1] The high speed railway transport, on medium-to-long distance routes (400-800 km), comes into direct competition with air transport. Though the high speed railway transport still shows substantial differences in the

Also the competition that the introduction of HS services generates inside the compartment, the so-called intra-modal competition between traditional and high speed line, seems to have significant effects in terms of market structure. As long as the supply of two services is tightly integrated into a single company, the overall effect created by the shift of demand towards the new service is internalized by the company, that is usually an ex public monopolist. However, in recent years, in consideration of the widening of the HS supply, a great interest has been shown at European level for the introduction of some elements of competition in the supply of railway transport services.

The introduction of competition in the railway sector was motivated mainly, by the need to encourage modal shift in favour of the railway services in order to limit the environmental externalities generated by the increasing demand for road and air transport. Moreover, it was assumed that an increase in competition could lead to more efficient and qualitatively improved services.

The HS railway transport has the potential to attract private operators if the markets are sufficiently large, that is, if the demand in sufficiently "thick". In Italy, for example, the Salerno-Milan and, in particular, the Rome-Milan routes, are of particular interest for the large number of passengers that, given the appropriate incentives, could be shifted from the air to the railway mode and the Bologna-Milan and Naples-Rome for the traffic volumes that can be subtracted from the road traffic. The market, however, is extremely variegated. Together with these routes, that might be of particular interest for private operators, there are others, however, which would be difficult to serve in the absence of public intervention. These routes, where demand is "weak" are usually served in force of a specific service contract or through the "implicit" possibility to activate cross-subsidies among different segments of the market[2].

The governance system and the procedures for determining the funding of the minimum services can have a significant effect on the development of the sector in terms of quality of service, traffic flows, safety, value distribution and welfare. Currently, in most European countries, the railway network is managed by a publicly owned company that is, in general, vertically integrated with the operator of the transport service. All the accredited operators (with a license) can access the network, although the level of market penetration by the

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travelling time if compared to the air transport, it has the double advantage of directly connecting city centres and requiring very short boarding times. In many cases these advantages can overcome the gap in terms of total travel time. On the sections of the short-to-medium distance (200-400 km), including the congestion phenomena that characterize the major cities and main lines during peak hours, it competes directly with road transport**.**

[2] In this context we cannot speak of a truly universal service obligation, which is incompatible with the nature of the fixed network service, at national and Community levels, it was decided to identify the set of the minimum guaranteed services established in the service contracts that allow to protect the vulnerable population groups through the supplying of services with a non-market cost, fixed by the regulator.
For a discussion on the definition of universal service, see, for example, Laffont and Tirole (2000), p. 218.

newcomers are generally quite limited[3]. The market is divided among local public transport by railway, long-distance transport by traditional lines, AV transport[4].

The local transport, strongly influenced by social causes, has features that make it difficult to achieve the economic balance and so, it is subject to specific service contracts between the operator and the local administration. The traditional medium-to-long distance transport is, potentially, more economically sustainable even if the competition of alternative services or the need to supply non-peak services compromises the achievement of economic balance on many routes.

With the exception of some specific links that fall among the public service obligations and are, consequently, regulated by service contracts, the economic regulation of the medium-to-long distance transport is a grey area, very differentiated from country to country (Seabright et al, 2003).

In general, especially for countries of central and southern Europe, the public ownership of the incumbent assigns a relevant weight to forms of soft regulation, summing up in "moral suasion". In these countries, the incumbents are, in fact, often governed by a set on unwritten regulatory constraints on both quantity and prices. It is almost impossible for them, in practice, to abandon an unprofitable connection, although it does not fall within the regulated service obligations and, thus, it does not generate a specific public contribution nor it is possible to change prices. In some cases this is explicitly forbidden by existing law constraints[5] but in others there are only implicit forms of price regulation.

Therefore, although the medium-to-long distance traditional transport service is not subject, at least as a whole, to explicit regulatory constraints on rates and on service quantity, in general, these constraints *de facto* exist and they have a very concrete role in the definition of traditional service market variables. Moreover, to date, in many national markets, the actual entry of *competitors* is still quite limited, despite the package of measures established at European level.

The AV transport service, unlike the traditional one, is born in an already largely liberalized background and, in view of its higher profitability and lower implications in terms of social effects, it has a higher interest for the private operators. This segment is not, generally, subject to formal economic regulation restraints. The AV service is considered of higher quality (shorter travel time, increased comfort, fewer intermediate stops) and can be considered replaceable compared to traditional transport.

This work will focus exclusively on the national medium-to-long distance service that uses

[3] There are no problems of network congestion, except for specific stretches and hours, although near the points of overlap between traditional lines and AV ones (that is near the railway stations) it is expected an increase in these phenomena.

[4] For brevity, the international transport will not be treated since they are not covered by this analysis.

[5] In Italy, the CIPE resolution of 1999 is still in force and it provides for the regulation through price-cap of the dynamic pricing of the medium to long distance passengers transport.

traditional rail network and AV network. Therefore, we analyze a market where two qualitatively different services are offered (traditional and AV) and where a partial liberalization has took place. The result has produced, on the one hand, the maintenance of a set of written and unwritten constraints on the public incumbent and, on the other hand, the potential opening (but effective only in few cases) to the entry of new operators, especially on more profitable sections. This behaviour may due to the strategy of *cream skimming* or *cherry picking*, widely discussed in the literature with reference to different sectors but it has not yet received an overall setting in the railway framework in which, given the peculiarities of this industry, may have different consequences.

In light of recent events that have characterized this sector both in Europe and, more specifically, in Italy, we decided to explicitly analyse, on the one hand the problem of the impact of the AV on the market system, on the strategic behaviour of players and on collective welfare, taking into account the beneficial effects of a reduction of the environmental impact due to a pro-rail modal distribution; and, on the other hand, the possible effects for the management of public service and its financing with specific attention to the possibility that *cream-skimming* phenomena can occur. The two aspects, even in the light of relevant literature, are closely interconnected, and lead to particularly interesting policy considerations.

The paper is divided as follows. In section 2 we briefly describe the cream-skimming strategies in the railway sector, in the light of the recent literature that has analysed this phenomenon in other public utility sectors open to competition. In paragraph 3 we show how the introduction of elements of competition in passenger transport, in presence of cream-skimming policies (i.e. the entry of new operators in the most profitable segments of AV), unlike in other sectors (such as telephony), has a positive impact in terms of consumer surplus. A reduction of consumer surplus for the weaker segments may emerge if the incumbent, in order to maintain the balanced budget, reduces the supply and/or increases the prices of the long distance service on the traditional network for the unprofitable sections. The analysis is performed considering the presence of both benefits and positive externalities arising from a modal shift in favour of railway. In paragraph 4 we discuss the main reasons for and against the maintenance of minimum services in the long-distance transport. Finally, in section 5 we analyse the different forms of funding of non-remunerative services and we examine the redistributive effects, the impact on welfare and on the market contestability. We discuss different cases depending on whether the minimum service is assigned i) directly to the incumbent, ii) through the mechanism of the auction winner or iii) finally, as a duty for all the operators. For each of the cases cited above we comment on the different forms of funding: general taxation, establishment of a perequative fund financed by companies active in this field; through the creation of reserved rights.

2. The railway service and the cream skimming strategies

In general, where liberalization has not a significant impact on the structure of industry, public monopolies tend to endure over time or, at least, whereas the partial deregulation allows the

entry of new operators it will creates oligopolistic situations in which there are an incumbent and few competitors. This situation, already mentioned by Biglaiser and Ma (1995) for telephony and, more generally, for public utilities that in those years were opening to competition, seems to reflect the picture that is emerging in many European countries with reference to the railway sector. The segment in which we notice the potential entry of new comers in competition with the incumbent is, generally, the one of AV, which is considered more profitable and free from influences of a redistributive nature. However, it is just the behavior to "select" the most profitable segments of the market, in presence of an opaque regulation of service obligations on traditional services that creates problems of coexistence between the incumbent and new comers, especially about the management of non-remunerative services funds and about cream-skimming strategies put into practice by the new comers.

In presence of competition, the traditional form of service financing for vulnerable people through the cross-subsidization loses its effectiveness because part of the substantial revenue obtained in the most profitable segments when operated in a monopoly can be used no more to fund unprofitable services, once the field is open to competition and extra-profits are eroded by *new comers* (Armstrong and Sappington, 2006)

The implications of the cream-skimming strategies that have marked the opening of the market in many network industries (mainly with reference to the field of telephony and gas) have been discussed in specialist literature. This analysis is based, in general, on the assumption that the service provided by the incumbent is characterized by obligations of universality distinguishing between profitable markets (cities) and non-profitable markets (suburbs). The universality of the service is simplified if the service is provided to all those who ask for it and if the same price is imposed on all buyers, regardless of where they are located.

The results of the different models often depend on the assumptions regarding the allocation of service obligations and their financing. According to Anton et al. (2002), when the supply of services in non-profitable markets is assured through an auction mechanism, the company that operates in both markets, generally, acts as a “soft” competitor in a non-regulated market. The existence of a universal service obligation causes, therefore, higher prices and higher profits (after taking into account the subsidies) in comparison with the case in which firms only compete in the profitable market.

Other authors (Bourguignon and Ferrando, 2007) show that in presence of partial substitute goods and in presence of a universal service obligation, the entry of a competitor, contrary to expectations, can produce an increase in the incumbent profits.

Law (1995) and Iozzi (2001) highlight the fact that removing the service requirements it is possible to increase consumers welfare, not only in the most profitable segments but also in less profitable ones.

Valletti et al. (2002) show that when the incumbent is subject to service requirements, the entrant chooses a lower level of market coverage to reduce competition and increase profits.

It was also shown that, by allowing firms to change the quality of their service, the level of covering offered by the entrant increases (Calzada, 2009).

Although the railway transport sector presents many analogies with other network industries, the extensive debate that has accompanied the liberalization of these industries is not easily transposable *tout court* in this area. In particular, the implementation of measures to establish service requirements and the relative financing cannot take place uncritically in analogy to previously liberalized sectors (telephone, postal service, energy, etc. ..) but must take into account the peculiarities of this industry[6]. The coexistence of regulated services and completely liberalized market areas, where new operators begin to appear, makes it particularly urgent a detailed analysis of the situation.

Specifically, in fact, unlike what happens in many other liberalized network industries, phenomena of cream skimming may be beneficial to all consumers while a reduction of the consumer surplus for the weaker segments may emerge when the incumbent, that puts in place cross-subsidies policies for the financing of service obligations, reduces the supply and/or increases the prices of long-distance services for unprofitable sections in order to maintain the balanced budget.

Here are some considerations, supported by a simple model on the impact, in terms of welfare, of the opening of the market in AV services taking into account the different modes of financing of minimum services.

3.0 The model

It is assumed that the railway passenger transport has two main types of services: transport on historical line (t, that is traditional transport) and high-speed transport (v, AV transport). Not the whole network can be served by the AV. It is also assumed that the network is structured as follows:

$C - I - H - P$

Figure 1. Example of a railway network in which traditional and AV transports coexist.

[6] On the other hand, the economic literature on the liberalization of the aviation sector is not very helpful because the theme of service obligations has not been closely examined for its marginal importance. On this issue, see Alderighi and Baccelli (2007). The authors show how the drawing of a service contract in some Italian regions has reduced the growth of traffic. This criticism towards the service obligations is also recurring in other sectors. Indeed, many authors have argued that the need to protect the weakest segments through service obligations has been repeatedly invoked by the incumbent in order to protect its dominant position in the market and hinder or prevent the entry of new competitors (Napolitano, 2001).

Figure 1 shows, for illustrative purposes, a rail network. Each node corresponds to a station located in an urban center. In detail, C and H are two big centers linked by a AV network, I is a center of medium size that lays on the CH route but it is not accessible through high speed, and it is subject to the "tunnel effect", while P is a peripheral center that is inaccessible by high speed.

There are strong interdependencies between traditional and AV services. By offering AV services on the CH stretch, a part of the traffic is distracting from the traditional transport that uses $CI + IH$, but in this way it is possible to help those who ask PC because they may benefit from better connections on the CH route. It is assumed that the traditional service is characterized by the connections that originate in C and end in H, with a length equal to l_t, with intermediate stops at each station, while the AV service connect C and H, with a length equal to $l_v < l_t$, without intermediate stops.

The demand function for the service (expressed in passenger/km) $s = t, v$ is given by: $D_s(p_t, p_v, f_t, f_v)$, where p_s and f_s are respectively the price and the total frequency of the service s. These services are imperfect substitutes for one another. The presence of network effects and the degree of substitutability between the two services under consideration may make that the extension of AV services has positive effects on traditional services, offsetting, at least in part, the effect of substitution. In all the cases it is assumed that the effects of complementarity have a lower extent in comparison with the effects of substitution and, as a consequence, that the increase of AV transport produces a demand reduction for traditional transport (and vice versa).

We make the following assumptions. The quantity demanded decreases as its price increases, but it increases in the case of a price increase of the substitute service. The increase in frequency increases the quantity requested, but with decreasing marginal contributions. A reduction in prices and/or an increase of the frequency in the traditional and AV transports produces an increase in total demand for railway transport with a consequent increase in consumer surplus ($S = S_t + S_v$) and with an increase in positive externalities (E)[7].

Furthermore, it is assumed that each train has a constant number of seats equal to n, and that c_t and c_v are the marginal cost of a seat/km, respectively, in traditional and in AV transport. Since the most important item of the operational costs in the transport service is the personnel cost, then the Av transport, considering the same route, due to the shorter travel times, is less expensive than traditional service. Thus: $c_t \geq c_v$.

[7] Note that this specification implicitly assumes that the rail transport is in competition with other modes of transport such as road and air. However, the interaction among different modes are not explicitly considered in this model.

In the market there is a public operator (incumbent, I) and possibly one or more private operators (entrants, E).

The transport on historical line is subject to regulation in order to maintain a certain level of minimum services (with administered prices) to protect vulnerable populations[8]. It is assumed, as referred to in paragraph 1, that in consequence of the regulatory system in most European countries, both the frequencies and the prices of the service are set exogenously and they are therefore treated as given by the incumbent and by new comers. So, we have $p_t = \overline{p}_t$ and $f_t = \overline{f}_t$.

The regulator, acting simultaneously on prices and minimal frequencies, may create imbalances between demand and supply. The supply of traditional services, in fact, in many cases exceeds the demand and therefore a part of the capacity remains unused. This can exacerbate the problems of profitability of some sections because even choosing a price for the trip equal (or higher) to the total cost per seat, the company may record negative profits.

If the companies are free to set prices and choose autonomously the number of frequencies, the load factors tend to be higher. Moreover, if the operators make use of revenue management systems, they could achieved load factors even higher (Dana, 1999). It is assumed, for simplicity, that in the traditional transport the demand is lower than supply, while in the high-speed transport it is assumed that the market price makes equal demand and capacity.

The AV market is potentially open to competition even if the regulator can impose some burdens on enterprises in order to support and/or finance, in part or completely, the minimum service. The AV prices (p_v)and frequencies (f_v)are connected through the inverse demand function: $p_v = P_v\left(\overline{p}_t,\ \overline{f}_t, f_v\right) = P\left(f_v\right)$. Finally, we define: $\overline{D}_t\left(\ f_v\right) = D_t\left(\overline{p}_t, P\left(f_v\right), \overline{f}_t, f_v\right)$.

We assume, at the end, that the regulator has a general goal of maximizing the welfare and protecting the weaker segments. So, in its specific context, it has an interest in encouraging mobility by rail (in general) and supporting the mobility of the most vulnerable people by providing them, as a form of protection, a minimum level of service[9].

3.1 The monopoly

We firstly analyse the behavior of the incumbent when operating in a monopolistic set up.

[8] The same considerations made in the introduction are valid here: although the traditional transport is not completely subject to a service contract and, as a consequence, to regulation, the political process for the price changing makes the traditional transport regulated in terms price of frequencies.

[9] For those who have more economic availability, there is no protection because the mobility is ensured by the use of alternative means (car, plane). However, the regulator may wish to give priority to rail transport compared to other means even for this segment because of environmental problems.

Because the frequencies and the prices of the traditional service are fixed, the monopolist can choose only the frequency (f_v) and therefore the capacity supplied in the HS service.

Under these assumptions, the profit function of the public operator is given by the following expression:

$$(1) \qquad \Pi^I(f_v) = \Pi_t^I(f_v) + \Pi_v^I(f_v) = \left[\overline{p}_t \overline{D}_t(f_v) - c_t nl_t \overline{f}_t\right] + \left[\left(P_v(f_v) - c_v\right) nl_v f_v\right],$$

where the terms contained in the first and second square brackets correspond to the profits arising from traditional services (Π_t^I) and those derived from HS services (Π_v^I).

3.1.1 HS frequencies regulation

In the case of full regulation (subject to a minimal level of service), the regulator solves the following problem:

$$(2) \qquad \max_{f_v} W = \left[\overline{p}_t \overline{D}_t(f_v) - c_t nl_t \overline{f}_t + \left(P_v(f_v) - c_v\right) nl_v f_v\right] + \overline{S}(f_v) + \overline{E}(f_v),$$

where the first term in square brackets is the profit of the incumbent, the second term is the total consumer surplus and the last term captures the external effects (of the transport by railway). Assuming that W is concave in f_v, the optimality condition is given by:

$$(3) \qquad \overline{p}_t \frac{d\overline{D}_t\left(f_v^R\right)}{df_v} + nl_v\left(P\left(f_v^R\right) - c_v\right) + \frac{dP\left(f_v^R\right)}{df_v} nl_v f_v^R + \frac{d\overline{S}\left(f_v^R\right)}{df_v} + \frac{d\overline{E}\left(f_v^R\right)}{df_v} = 0,$$

where f_v^R is the optimal frequency in AV service.

3.1.2 Partial regulation

In the case of partial regulation, the choice of the number of frequencies in high-speed is up to the monopolist (M) that maximizes profit by choosing f_v. When the profit function is pseudo-concave in f_v, the monopolist optimality condition (under constraint of maintaining a certain number of frequencies and regulated prices) in the traditional transport is then given by:

$$(4) \qquad \overline{p}_t \frac{d\overline{D}_t\left(f_v^M\right)}{df_v} + nl_v\left(P\left(f_v^M\right) - c_v\right) + \frac{dP\left(f_v^M\right)}{df_v} nl_v f_v^M = 0.$$

It should be noted that (4) implies that the incumbent, working under a monopoly, set a number

of frequencies lower than the ones of the bounded optimum of the regulator (3) entailing not only higher prices in AV but also a lower level of development of the service. It should be also noted that since the first term in the equation (4) is negative (remember that the AV is an imperfect substitute for the traditional transport on CH section), the incumbent, concerned about damaging the demand and therefore the profits in the regulated market, set prices even higher to those that would be set by a single-product monopolist (MP) in the AV market.

Figure 2 clarifies this topic. The first order condition sufficient in the case of convexity clearly implies that the choice of the incumbent is at the quantity f_v^M when $d\Pi^I\left(f_v^M\right)/df_v = 0$, while the one of the monopolist MP is given by: $d\Pi_v^I\left(f_v^{MP}\right)/df_v = 0$. The previous expression can be represented as a function of total profit of the incumbent: $d\Pi^I\left(f_v^{MP}\right)/df_v = d\Pi_t^I\left(f_v^{MP}\right)/df_v < 0$. Therefore, since the slope of the profit function must be negative in equilibrium in the case of single-product company, the quantity chosen by the single-product monopolist (f_v^{MP}) is necessarily greater than the one offered by the monopoly that operates in both markets (f_v^M). Accordingly (given the law of demand) the price of AV will be lower in the latter case than the former. The previous argument can be summarized in the following proposition:

Proposition 1: the incumbent active in the HS market and in the traditional market, if partially regulated, a) supplies a lower quantity if it is completely regulated; b) offers, in the HS service, a lower quantity at a higher price in comparison with the case in which it only operates in the HS market.

Proof. Part a) in the Appendix, Part b) above, in the text.

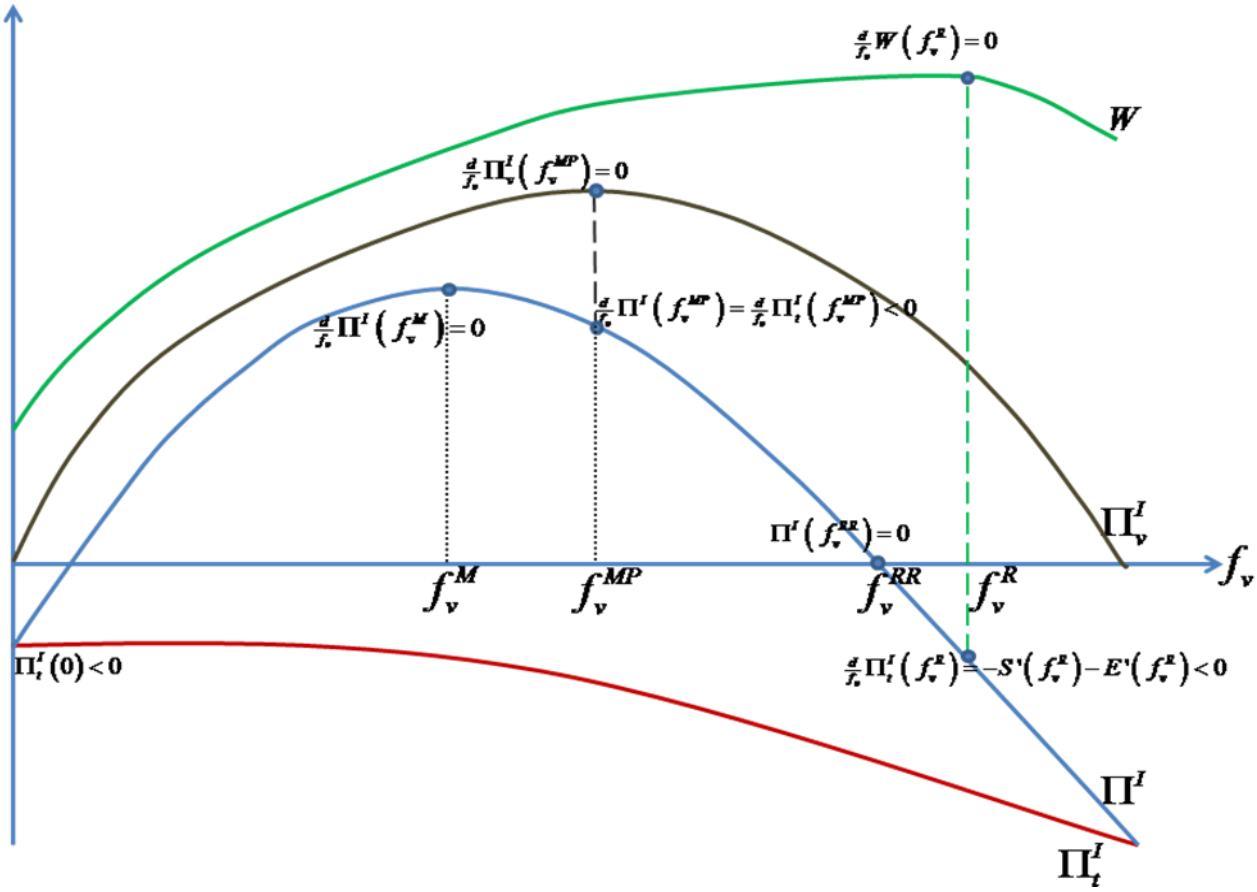

Figure 2: Frequencies offered in the case of the monopoly (M) and single-product monopoly (MP).

Hence, it appears that a regulatory structure based on a single operator deters the development of HS transport not only on account of the characteristics of the monopoly (or the lack of the assessment of the positive externalities by railway transport), but also because the incumbent, fearing the cannibalization of the traditional market, would not develop the HS market. This second effect is not present when the two services are complementary or independent (i.e. in the telephone market, calls from fixed network and broadband internet).

The inefficiency of such a regulatory system is even more relevant if the regulator has the objective of reducing the externalities caused by other modes of transport or if the incumbent had not sufficient financial resources to undertake the necessary investments in rolling stock material in order to offer a level of frequency equal to f_v^M.

3.2 The competition

We present the case of opening HS market to competition. It is assumed that there are two companies that offer AV services (the incumbent and the entrant), and only one of them, the incumbent, offers traditional railway service. The previous constraints on the traditional market are maintained.

3.2.1 The simultaneous entry

Operators compete on frequencies, and ultimately on the number of seats offered in HS service. It is assumed that the choice of frequencies by the two operators is simultaneous and so that we are in presence of Cournot competition. The equilibrium conditions for the incumbent (I) and for the entrant (E) are:

$$\overline{p}_t \frac{d\overline{D}_t\left(f_v^C\right)}{df_v} + nl_v\left(P\left(f_v^C\right) - c_v\right) + \frac{dP\left(f_v^C\right)}{df_v} nl_v f_v^I = 0, \tag{6}$$

$$nl_v\left(P\left(f_v^C\right) - c_v\right) + \frac{dP\left(f_v^C\right)}{df_v} nl_v f_v^E = 0 \text{, dove } f_v^C = f_v^I + f_v^E . \tag{7}$$

Proposition 2: in equilibrium, the incumbent offers a lower HS service quantity than the entrant. The equilibrium price and incumbent profit are lower in duopoly than they are in monopoly, while the consumer surplus is higher.

Demonstration. See Appendix.

Now, the introduction of competition leads to a reduction of prices in high-speed market, an improvement of the service (a larger number of frequencies), but it also leads to a reduction in the profits of the incumbent. Consequently, this may cause or increase problems of financial sustainability.

Note that the subsidy that the incumbent should get to avoid losses is given by:

$$s^m = \max\left\{0; -\left[\overline{p}_t \overline{D}_t\left(f_v^m\right) - c_t nl_t \overline{f}_t + \left(P\left(f_v^m\right) - c_v\right) nl_t f_v^i\right]\right\}, \tag{8}$$

where $(m,i) = (M,M)$ in the case of monopoly, and $(m,i) = (C,I)$ in the case of duopoly. This shows that:

Proposition 3: in duopoly the subsidy is not lower than the one in monopoly.

Demonstration. See Appendix.

With the liberalization of railway service, the entry of a new operator in the HS transport clearly favors the development of the service but, at the same time, it causes the erosion of incumbent's revenues both in traditional (on CI and IH sections) and in HS (on the CH section) service. To prevent losses it may be necessary to reduce the supply of traditional services, to increase their prices and/or to provide more subsidies to the incumbent.

It is useful to note that as a consequence of the reduction of prices in the HS market, the benefits would fall also upon the weak segments of demand that might now find it interesting, if available (i.e., consumers who demand a transport service on *CH* and *CP* sections), to use the HS service rather than the traditional ones. In general, therefore, the utility of weak segments could increase, notwithstanding the reduction in supply of long-distance services, should the reduction in prices in high-speed segment be sufficiently relevant (as a result of competition).

Let's consider now the following network: $C-I-H-J-K-P$, where C,H and K are the largest towns served by high-speed and *I* and *J* are stations located on the route but not served by the AV service, while P represents suburban stations. In this case, people located in I and J can benefit from both a reduction in prices and an increase in quality granted by HS services, for reaching, for instance, K and C respectively.

3.2.2 The delayed entry

In a partial regulation framework, it may be best to delay entry. That is, allowing the incumbent to install its capacity before the entry of additional operators. Assuming that in this case the final equilibrium would be à la Stackelberg, the equilibrium conditions for the incumbent (L) and for the entrant (F) are:

(9) $$\overline{p}_t \frac{d\overline{D}_t\left(f_v^S\right)}{df_v}(1-R)+nl_v\left(P\left(f_v^S\right)-c_v\right)+\frac{dP\left(f_v^S\right)}{df_v}(1-R)nl_v f_v^L=0,$$

(10) $$nl_v\left(P\left(f_v^S\right)-c_v\right)+\frac{dP\left(f_v^S\right)}{df_v}nl_v f_v^F=0\text{, dove } f_v^S=f_v^L+f_v^F,$$

with $R=-df_v^F/f_v^L\in(0,1)$, because the two products are strategic substitutes.

Proposition 4: In equilibrium, if the entry of private operators is delayed, the incumbent offers an higher number of frequencies than in the case of simultaneous entry. The equilibrium price and the profit of the incumbent are, in any case, lower in duopoly than in monopoly, but higher than in the case of simultaneous entry. The consumer surplus in case of delayed entry is greater than in the cases of monopoly and simultaneous entry.

Demonstration. See the Appendix

If it were possible to delay the entry of private operators, one can achieve a favourable result in terms of both consumer welfare and financial sustainability. The benefits achieved in each case depend on the ability of the incumbent to rapidly develop the HS service and on the hypothesis made on its efficiency level (marginal costs for HS services similar between incumbents and new entrants).

3.2.3 Many operators

Assume now that there is only one firm (the incumbent), which offers traditional transport and $N+1$ companies that offer AV services: the incumbent (0) and N entrants ($j=1,..,N$). The previous constraints on the traditional market will remain. Companies compete on the frequencies, and ultimately on the number of seats offered in the AV service. The equilibrium conditions for the incumbent and for the entrants are:

$$(11) \qquad \overline{p}_t \frac{d\overline{D}_t\left(f_v^N\right)}{df_v} + nl_v\left(P\left(f_v^N\right)-c_v\right)+\frac{dP\left(f_v^N\right)}{df_v} nl_v f_v^0 = 0,$$

$$(12) \qquad n\left(P\left(f_v^N\right)-c_v\right)+\frac{dP\left(f_v^N\right)}{df_v} nf_v^j = 0 \text{ con } j=1..N \text{ e } f_v^N = f_v^0 + \sum_{j=1}^{N} f_v^j$$

The subsidy that the incumbent should receive in order not to suffer losses is now given by (8) with $(m,i)=(N,0)$. As the number of firms in the market increases, the profits of the new entrants and the one of the incumbent in the AV service tend to zero.

4.0 Minimum services and competition

Leaving the modes of supply of minimum services out of consideration, the opening to competition of the AV service market directly produce efficiency gains. One cannot also rule out that an increased competition in the AV segment would be also beneficial, indirectly, for the segment of weak demand, which - with lower prices and higher frequencies - may, in some cases, found it advantageous to opt for the AV service: the limit, a strong competition in the AV segment could reduce prices to the point of making no more attractive the use of the traditional service, except for covering the routes that are not covered in the AV supply[10].

If the traditional service was not only a substitute service but it also had features of complementary service, of adduction to AV network (improving connections, etc...), the welfare gains could be even more relevant. Incidentally, a greater supply of AV services may also have positive effects on local transport if it favoured, by means of connections, a greater number of links in place of other modes of transport[11].

[10] Although the lack of information on the costs per km of AV and traditional routes, since a great part of the costs are attributable to personnel, it can be assumed that the AV transport is less expensive than the one on traditional routes.

[11] However, It does not seem to occur a problem in terms of changes in profitability for local transport, where the entrant offers AV transport services on the same routes of local transport. The number of passengers that in this case would be absorbed by the AV transport would be minimal and it would be certainly balanced by those making more use of the AV transport would require more local transport.

It is worth noting that the cream skimming and the cherry picking phenomena, as described in the literature on universal service, are not directly replicable in this sector, or at least they do not have the same form. Indeed, it is usually assumed that the incumbent must offer a service at a uniform price throughout the market, subsidizing less profitable markets with the proceeds from the richest markets: in this case the entrant can focus on the more profitable market and the incumbent can not react by lowering prices because it would damage its profitability over the entire market. The situation is different in the railway market. The incumbent operates on two different markets, whose assets are only partial substitutes. While assuming that the incumbent relies on revenues of more profitable routes to offset losses in weak demand traditional routes, it is reasonable to assume that the ex-monopolist is still free to compete in the AV service with the entrant on equal basis.

The issue of the partial regulation of the market must be linked to the financing of minimum services in the long haul rather than to the fact that the incumbent, in a competitive environment, have greater difficulty in achieving financial balance due to a competitive disadvantage linked to service obligations. We must therefore consider the reasons for and against the maintenance of service obligations on the incumbent and the implications, in terms of social welfare, of the different methods of allocation and financing.

4.1 The methods of allocation and financing of the minimum service

The need for forms of protection of the weak through minimum services obligation has been widely discussed in literature and debate on universal service (Cremer et al., 1998). In general, as regards the rail sector, in addition to the well known reasons of redistributive nature and to the presence of increasing scale returns, it takes out the need for subsiding the modal reallocation in favour of the rail and for supporting a service that has the characteristics of merit good (Macchiati et al., 2007).

However, there are also strong arguments in favour of the opposite theory, of the abolition or reduction of minimum services. For example, Hoerning and Valletti (2001) argue that the maintenance of these obligations may require significant resources and that is not necessarily true that those receiving low cost services are the weakest segments of the population. The financing of minimum services, in favor of the weakest segments of the population, can also be very costly in terms of efficiency losses relative to other possible measures to protect the mobility right.

The spectrum of alternative options for financing national railway transport for the non-profitable routes is quite large and the choice can decisively influenced both the real possibility of introducing aspects of competition in the market and the profitability of the incumbent and new entrants.

It is assumed that the incumbent is supervised by a public shareholder - a very common

situation in continental Europe - and that, therefore, the design of financing forms for covering the minimum services must respect the constraint of a balanced budget[12]. Moreover, we suppose that the firm's management pursues the aim of maximizing the profit.

We do not consider the auction mechanism for the allocation of routes (profitable and non profitable). This solution has been adopted by more than 10 years in the United Kingdom and, after an initial critical phase, it has recorded some success[13]. However, it requires a large number of operators to function properly and therefore it is difficult to export this solution in other European countries, at least in the short to medium term[14]. An auction system limited to the minimum service, on the other hand, could produce, as described by Anton et al. (2002), higher prices and higher profits for companies. Choné et al. (2002) show that the use of a pay-or-play system (that is, the company may pay a contribution in order not to have the burden of service obligations), compared to a rule that assigns to the incumbent the supplying of the service may produce a higher level of welfare and therefore the competition for the supplying of minimum services may be harmful to consumers.

If the supply of the traditional service was reserved to the operator that has historically played the service, namely the incumbent, and it was not able to achieve a balanced budget, in part because of competitive pressures in the AV service, then the question of the modes of financing would arise. They have been traditionally identified in the general taxation, in the establishment of a perequative fund financed by the firms of the industry and, ultimately, in establishing reserve rights and then in the use of cross-subsidies.

Financing through general taxation ensures the greatest welfare for the system in case of a low marginal social cost of public funds (ie if the tax system is efficient in collecting the funds)[15] and it is more appropriate when the presence of externalities grows (and thus, interest in encouraging the modal split). In any case, the use of general taxation has implications of distribution nature, as it lumbers onto the community as a whole, the burden of ensuring the right of mobility to some particular segments of the population. Indeed, opting for other forms of financing, the burden of ensuring the right of mobility may be against the users of the AV

[12] For example, in other contributions that study the introduction of service charges in presence of private enterprises, it is usually requires the neutrality of charges on the profits of the company and not only a balanced budget.

[13] However, in England, the applying of the so-called (Track Authority model) (in which not only the unprofitable routes, but all the routes are auctioned) demanded the dismemberment of the incumbent in order to create three types of business: a) the provider of the network, b) the owner of rolling materials, c) the firms which provide the services. The advantage of using an auction system is to allow the award of service to the more efficient company. It also allows cross-subsidies between profitable and the unprofitable routes.

[14] Currently, for example, there are 25 operators who offer a service (after winning an auction) to transport passengers. As regards the results of auctions in Italy, with regard to public transport, see: Alderighi and Sparacino (2008). In these contributions it is evident that the characteristics of the notice and the contract of service impact in a significant way on the outcome of the auction. It emerges that a crucial element consists of the asymmetry of information between the incumbent and new operators, the rolling material, the duration, etc..

[15] If the collection of funds through general taxation is highly burdensome or in presence of stringent budgetary constraints for the public sector, this method of financing may be not applicable and may require the complementation with other financing methods.

services, that would be unreasonably affected also in this case.

The financing through a perequative fund shifts the burden on operators that are not obliged to supply the minimum services, maintaining, in this way, the redistributive effects within the sector. The fund can be feed with a fixed sum withdrawal or as a percentage of profits or revenues. In the case fixed-sum tax, that is adopted, for example, in the German postal system, distorting effects on prices should not occur: if it discourages the entry, however, the levy could produce a distortion in terms of number of entrants.

In principle, the taxation of pure profits is not distorting, but it has the disadvantage of a tax base that narrows, until it became too small, as the number of firms in the industry grows. On a more concrete basis, the gains, which are actually affected by taxes, are far from the pure surplus, because they contain substantial elements of factors remuneration: the tax is therefore distorsive It can also lead to behaviours aimed at reducing the tax base with the various forms of elusion and evasion tools, well-tested in the practices of companies.

A proportional contribution to revenue would give, in this latter respect, a little more security, but it is equivalent to an increase in costs and would therefore reduce output.

The third method of financing, the creation of reserve rights, leaves to the incumbent a total privilege on some routes of the AV service in order to finance the minimum services through cross-subsidies. As demonstrated in Section 3, this solution leads the incumbent to set for the AV service a price above the one of monopoly and, in so doing, it further shrinks the market. This option, that seems to be little used in other sectors such as telephony or the air transport market, is opposed by the national and Communitarian market and competition authorities[16].

An alternative to leave the monopoly of services with low demand to the incumbent is to force companies that want to offer AV connections to contribute, simultaneously, offering such services. This aspect is discussed below.

Assume that a share $1-\alpha$ of the burden of service is assigned to entrant. In this way, a more equitable distribution of profitable and less profitable market segments among the firms would be created. Clearly, a request like this is very burdensome for new entrants and especially for smaller-scale enterprises[17].

Under the above mentioned assumptions, the conditions obtained in Section 3.2 are modified as follows:

[16] In a decision dated 23 April 2007, the European Commission introduced an important revision of the regulations established with the decrees n° 35 and 36 of the Ministry of Infrastructure and Transport on 29 December 2005 (which allowed the exclusive exercise on some routes from Sardinia to the main Italian cities). On this issue, see Alderighi and Baccelli (2007).

[17] The increased uncertainty due to the need to know two types of markets, the search for the rolling materials, new machinery etc. ... On this issue the European Commission has expressed in this sense, with regard to air transport (EC, decision C/2005 577).

(13) $$\alpha\,\overline{p}_t\frac{d\overline{D}_t\left(f_v^{C_\alpha}\right)}{df_v}+nl_v\left(f_v^{C_\alpha}\right)+\frac{dP\left(f_v^{C_\alpha}\right)}{df_v}nl_v f_v^{I_\alpha}=0,$$

(14) $$(1-\alpha)\,\overline{p}_t\frac{d\overline{D}_t\left(f_v^{C_\alpha}\right)}{df_v}+nl_v\left(P\left(f_v^{C_\alpha}\right)-c_v\right)+\frac{dP\left(f_v^{C_\alpha}\right)}{df_v}nl_v f_v^{E_\alpha}=0$$

Proposition 4: In equilibrium, the prices and the total number of frequencies coincides with the one obtained from equations (6) and (7) of paragraph 3.2.

Demonstration. See the Appendix.

From an efficiency point of view, it appears that the total number of frequencies and the equilibrium price of the market would not be affected by assigning a share $1-\alpha$ of the burden of service to the entrant[18]. It would instead reduce the subsidy that the incumbent should receive in order not to record losses:

(15) $$s^{C_\alpha}=\max\left\{0;-\alpha\left[\overline{p}_t\overline{D}_t\left(f_v^{C_\alpha}\right)-c_t nl_t\overline{f}_t+\left(P\left(f_v^{C_\alpha}\right)-c_v\right)nl_t f_v^{I_\alpha}\right]\right\},$$

which is increasing in α (share covered by the incumbent).

However, note that for sufficiently large $1-\alpha$, the profit of the entrant can become negative and thus lead to a situation in which the entrant decides not to enter the market. In fact, this procedure usually tends to put barriers that make the entry of new players difficult and it creates a limit to market development. In addition, the service obligation extended to new players would act as a further limitation because they incur in start-up costs to prepare an additional service and these costs do not rest on the incumbent.

5.0 Final considerations

This article has shown that in the absence of market opening, with partial regulation, the monopolist would choose a very limited number of frequencies, lower than in the case in which HS and TR services are supplied by separate companies. This would lead to a price level not only higher than the first-best but also higher than the level which would prevail with service separation. In the case of market opening (entry in the HS segment), consumers take advantage from the entry of new operators which would grant a greater number of frequencies and lower market prices. It is shown, however, that in case of delayed entry, benefits for consumers are

[18] However, assuming complementarity between traditional and AV transport at carrier level (this happens, for example, through the organization of schedules or through combined sales of ticket) you can show that in terms of efficiency, it is preferable to assign the traditional transport to a single operator.

greater and the incumbent gets higher profits than in the case of a simultaneous entry. As expected, thus, the entry of new operators benefits consumers. However, it can worsen the problem of financing. In this paper it is shown that the problem does not arise from the well known phenomenon, known in the literature as cream skimming.

Financing through general taxation ensures the greatest welfare in case of a low/limited marginal social cost of public funds and it is appropriate when externalities are relevant and there is a great incentive to favour modal shift. However, if we exclude the use of general taxation, the alternatives may be the rights of reserve, the obligation of the service supply or the perequative fund (which, as is it shown, would be the preferred system).

The analysis of these different financing options shows that the auctions system (English model) would require the break-up of the incumbent, but this is a solution that is currently not feasible in most European countries. Financing through the formation of a perequative fund may be an alternative. In this case, however, the use of a tribute proportional to revenue may cause losses of efficiency (a reduction of supply and lower revenue), while the taxation of profits, that would have a neutral effect on efficiency, could lead to problems of strategic behavior by operators. The allocation of the service obligations imposed on all operators seems not to offer benefits in terms of efficiency, on the contrary it would be a limit of competition, for it would reduce the opportunities for new operators to enter the market because of the higher start-up costs to prepare the additional service. Finally, the establishment of the reserve rights would be the worst solution for consumers, as it would reduce the possibility of development of the sector, leaving some routes under the control of a single operator.

Possible extensions of the work would include to transform the constraint, currently expressed in terms of frequencies and prices, in terms of a minimum level of surplus. In this case the benefits of lower prices in the HS segment are extended also to the weaker segments (thus favoring the substitution effect): in case of a large reduction in the prices of the HS services, the overall utility of the weak consumers could increase, even with a reduction in the supply of TR services.

6.0 Appendix

This section contains the proofs of the Propositions 1.a, 2, 3, 4 e 5. These proofs have strong similarities to Proposition 1b presented in the text.

Proof of Proposition 1.a.
The (4) can be re-written as:

(A1) $$\frac{d\Pi^I\left(f_v^R\right)}{df_v} = \overline{p}_t \frac{d\overline{D}_t\left(f_v^R\right)}{df_v} + nl_v\left(P\left(f_v^R\right) - c_v\right) + \frac{dP\left(f_v^R\right)}{df_v} nl_v f_v^R = -\left[\frac{d\overline{S}\left(f_v^R\right)}{df_v} + \frac{d\overline{E}\left(f_v^R\right)}{df_v}\right] < 0 .$$

The concavity of Π^I implies that $f_v^M < f_v^R$.

Proof of Proposition 2.
Subtracting (7) from (6) we obtain:

(A2) $$\bar{p}_t \frac{d\overline{D}_t\left(f_v^C\right)}{df_v} + \frac{dP\left(f_v^C\right)}{df_v} nl_v\left(f_v^I - f_v^E\right) = 0$$

Since the two derivatives are both negative, it follows that in equilibrium $\left(f_v^I - f_v^E\right) < 0$.

If we calculate the derivative of the incumbent's profit in the case it was a monopolist and decided to produce f_v^C and if we take into account the equations (6) and (7), we obtain:

(A3) $$\frac{d\Pi^I\left(f_v^C\right)}{df_v} = \bar{p}_t \frac{d\overline{D}_t\left(f_v^C\right)}{df_v} + nl_v\left(P\left(f_v^C\right) - c_v\right) + \frac{dP\left(f_v^C\right)}{df_v} nl_v f_v^C = nl_v\left(P\left(f_v^C\right) - c_v\right) < 0$$

The concavity of Π^I implies that $f_v^M < f_v^C$ and therefore the price is higher in monopoly than in duopoly and so the consumer surplus is greater in duopoly. Note that since the profit that the incumbent would get in monopoly choosing f_v^C is lower than the one it would get in duopoly (where the market quantity is f_v^C but the quantity sold by the incumbent is only f_v^I) and that the optimal choice (that is, the one that maximizes the profit) in monopoly is $f_v^M < f_v^C$, it follows that profits are lower in duopoly.

Proof of Proposition 3.
It follows directly from Proposition 2.

Proof of Proposition 4.
Adding the (9) divided by $(1-R)$ to the (10) we obtain:

(A4) $$\frac{d\Pi^I\left(f_v^S\right)}{df_v} = -\frac{1}{1-R}\left[nl_v\left(P\left(f_v^S\right) - c_v\right)\right].$$

Comparing (A4) to (A3) and recalling that $(1-R) \in (0,1)$ we get $f_v^C < f_v^S$, that shows that consumer surplus is greater in the Stackelberg case and the equilibrium prices are lower: $P\left(f_v^S\right) < P\left(f_v^C\right)$. Finally, since $f_v^L = f_v^I$ is a strategy available to the leader that leads to the choice of quantity $f_v^F\left(f_v^I\right) = f_v^E$, and since it has not been chosen by the leader this implies that in duopoly $\Pi^I\left(f_v^L + f_v^F\right) < \Pi^I\left(f_v^I + f_v^E\right)$. Since market prices are lower and profits of the leader are greater in the Stackelberg case: $f_v^L > f_v^I$.

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