Università degli Studi di Bari
Dipartimento di Scienze Economiche e Metodi Matematici

Southern Europe Research in Economic Studies
S.E.R.I.E.S.

WORKING PAPER NO. 0010

# A Model of Partial Regulation in the Maritime Ferry Industry

Angela S. Bergantino, Etienne Billette de Villemeur and Annalisa Vinella

# A Model of Partial Regulation in the Maritime Ferry Industry[*]

Angela S. Bergantino[†] Etienne Billette de Villemeur[‡] Annalisa Vinella[§]

## Abstract

In this paper, we study how maritime ferry industries should be regulated. This is a fundamental issue in so far as maritime transport between islands and mainland is a service of general interest. We argue that the policy design crucially depends on the goals the collectivity pursues (pure efficiency, fairness) as well as on the relevant industry structure (monopoly, oligopoly). We show that the regulator needs to prevent inefficient crowding out, whenever room exists for access of new providers to former monopolies. By properly allocating traffic across shippers, the regulated firm's budget constraint can then be relaxed. We subsequently shed light on the implications of adopting the *territorial continuity principle* to boost social fairness. We establish that the incumbent's *public service obligations* dump the entrant's incentives to provide connections in the low season; conversely, soft competition encourages the entrant to operate in the high season, when it pockets a net rent. As to customers, our model predicts that the islanders, whose consumption is partly subsidized by the non-residents, patronize the incumbent and that liberalization directly benefits the non-residents who switch to the entrant.

Keywords: Maritime transport; Price and frequency; Partial regulation; Territorial continuity

*J.E.L.* Classification Numbers: L51, L92, R48

---

[*] We gratefully acknowledge comments from the participants at the XVII Scientific Meeting of the Società Italiana di Economia Pubblica (University of Pavia) and the 4th Conference on Applied Infrastructure Research (WIP Center, Berlin University of Technology). We would like to thank David Gillen for particularly useful suggestions. The usual disclaimers apply.

[†] University of Bari, Department of Economics, Via C. Rosalba, 53, 70124 Bari (Italy); NARS, Ministry of Economics and Finance, Rome (Italy). E-mail: a.bergantino@dse.uniba.it

[‡] University of Toulouse, IDEI and GREMAQ, Manufacture des Tabacs, Aile Jean-Jacques Laffont, Bureau MF414, 21 Allée de Brienne, 31000 Toulouse (France). E-mail: etienne.devillemeur@univ-tlse1.fr

[§] University of Toulouse, GREMAQ, Manufacture des Tabacs, Aile Jean-Jacques Laffont, Bureau MF007, 21 Allée de Brienne, 31000 Toulouse (France); University of Bari, Department of Economics, Via C. Rosalba, 53, 70124 Bari (Italy). *Corresponding author.* E-mail: annalisa.vinella@univ-tlse1.fr

# 1 Introduction

Democratic Constitutions recognize individual mobility (broadly intended) as a human fundamental right. For instance, Art. 16 of the Italian Constitution states: "Every citizen can circulate (...) in any part of the national territory (...)"; this freedom is viewed as a means to the individual full development and effective participation in the Country's organization, both of those promoted by the Italian Republic (Art. 1).

Hinging on the generalized constitutional recognition, the *universal service principle*, which translates into the *territorial continuity principle* as far as mobility is concerned, is called upon for the purpose of limiting the geographic impediments and the resulting socioeconomic difficulties, which penalize the people leaving on the islands. This amounts to ensuring that the islanders are connected to the continental territory in ways as close as possible to the mainland inhabitants at affordable charges.

Maritime transportation critically contributes to secure the national cohesion and integrity, hence it is perceived to be a service of general interest. Administrative prescriptions for service provision have traditionally stemmed from this circumstance, lacking any convincing theoretical background. For several years, ferry companies have operated as monopolists, eventually entitled with exclusive rights to serve specific geographical areas. Public undertakings have been entrusted with operation in a plurality of countries, namely Italy, Spain and France. In general, long-term concession contracts (20 to 25 years) have been awarded without public tendering procedures, either in consideration of the public nature of the company or because, at the time, there was no European norm on the matter; a good example is given by the Corsica system, which was inaugurated in 1976 and is still in place.

At the European level, the configuration of the maritime ferry sector is destined to evolve in the close future. Many of the long-term contracts mentioned above are approaching expiration. Some of the publicly owned companies are supposed to be privatised in the short run. To some extent, entry of unregulated shippers is currently registered, after the service freedom principle has been extended to cabotage and short-hauls connections by the EU Regulation 3577/92 [16]. Yet even the guidelines the European Commission has provided to discipline the (transition to the) ultimate organization of the industry do not rest on a comprehensive economic foundation.

In the present paper, we address the issue of how appropriate institutional settings should be designed for the operation of maritime ferry services. We first take a pure efficiency perspective, which corresponds to the case where social welfare coincides with total surplus. We subsequently concentrate on the *public service obligations* (PSOs) which ought to be imposed "upon a carrier to ensure the provision of service satisfying fixed standards of continuity, regularity, capacity and pricing (...)" (EC [15]) and discuss the far-reaching distributional implications that are associated.

So far, this subject has received incredibly little attention even from the specialized literature. The lack of interest might have been justified by the relatively small size of the industry, as compared to other transport sectors. Researchers have generally believed that it was enough to study air transportation to know all that matters about maritime transportation. Analogously, in reality, maritime transportation has typically been regarded as a minor substitute for air transportation. An example of this attitude can be found again in the Corsica system, which makes tariff reductions for residents significantly wider in air transportation than in ferry services[1]. In our view, this approach is unsatisfactory; instead, specific analysis is required in the light of the distinctive features of the service. Moreover, given the amount of resources involved, it is misleading to affirm that the shipping market be negligible with respect to the economy of the various countries and of the EU as a whole.

In our work, we focus attention on the institutional design of the sole industry structures which are destined to be relevant, given the way the sector is likely to evolve in the European context, namely monopoly and duopoly.

Monopolies, whether public or private, survive in scenarios where the cabotage liberalization process has no impact on the industry structure. Whenever this is the case, the level of competition remains negligible and cannot be reasonably expected to improve soon. In such a perspective, our analysis shares the same spirit as the one performed by Billette de Villemeur [3]. Indeed, the latter focuses on situations of similar kind, which materialize in the air transportation sector, despite the 1997 liberalization.

On the opposite, oligopolies (are destined to) realize in the event that partial deregulation does induce access by additional operators. If entry occurs, then the new shippers play the market game as followers *vis-à-vis* the regulated incumbents, hence *vis-à-vis* the regulatory authority. Again this is not a peculiarity of the maritime ferry industry. Biglaiser and Ma [2] refer to the long-distance telephone segment in the telecommunication sector as an example of analogous phenomena appearing in the other utilities that have recently been opened up to competition.

In a complete-information environment, we characterize the optimal monopoly regulation as well as the optimal duopoly partial regulation. More precisely, we determine which *prices* the compelled shipper should charge and how many *connections* it should operate for the social objectives to be achieved. From the firm's standpoint, these constitute duties which, to rephrase the EU Regulation 3577/92 [16], would not be assumed, as long as pure commercial interests were to prevail.

The main point is that the optimal regulatory policy crucially follows from the goals it is meant to pursue. Indeed, other is to target pure efficiency, other is to target distributional aims. In particular, the price-and-frequency bundle, which represents the most (constrained) efficient performance of the industry for a utilitarian society, does not need to correspond to the one which secures a reasonable level of territorial continuity.

To stress this difference, we first characterize the regulatory policy which is pinned down when society has a utilitarian attitude and is essentially concerned that the market equilibrium be as efficient as feasible. We as well argue that it can be implemented by imposing a properly structured constraint to the regulated shipper, in which the relevant decision variables are combined to provide desirable incentives.

At later stage, we highlight that the regulatory solution might need be amended for

---

[1] The principle of residential ferry tariffs is made conditional on the event that the islanders transfer also their cars.

equity considerations to be incorporated in favour of the people who are penalized by the drawbacks of insularity. We find that, in order to fund the costs of the territorial continuity system, it might be necessary to require the non-residents to provide implicit subsidies for the islanders' consumption of ferry services. We also demonstrate that, under duopoly, such subsidies can be somewhat escaped by patronizing the entrant. Yet any advantage associated to the presence of the unregulated shipper comes at the price of letting it pocket a net rent.

On the opposite, the regulated operator never obtains positive benefits, as long as the optimal regulation is implemented, whatever the social objectives. Nevertheless, in all regimes, we require that its budget constraint be met. This might appear in contrast with the circumstance that, in Europe, transfers have traditionally been and are still feasible. In fact, it is less so than one would perceive at a first glance.

To some extent, the diffusion of public shippers explains the long-lasting history of *ex post* diluted (direct and indirect) subsidies; indeed, as Martimort [21] underlines, when the State owns a firm, it is likely unable to refrain from using public funds to transfer resources in favour of the firm. A good example is given by the Italian shipping industry; a substantial part of the latter's traffic is subsidized and the yearly expense for the public budget is ultimately close to 250 million euros (see Bergantino [1]). Nevertheless, the list of countries concerned by the subvention practice also includes those where private shippers are active; the resulting bill is not less significant. In the UK, where only some of the lines off the Scottish coast are subsidized, the associated cost exceeds 50 million euros per year. In their turn, Greece, Ireland, Portugal, Germany, Denmark, Finland, all have subsidized ferry services (see European Commission [14]). This suggests that the subvention habit hinges also on considerations other than the ownership structure, namely the necessity to secure that the service be provided on lines, in areas and in periods that are not self-financing.

The European Commission has recently intervened to remove the *abusive* aspect of the tradition. For this purpose, it has ruled in the direction of containing the amount of aids Member States can provide to maritime transport (see European Commission [15] and [12]). On one side, this should prevent too generous an attitude toward public shippers and might possibly accelerate privatization in countries which have strong laws against budget deficits and restrictions on borrowing[2]. On the other side, it is meant to preserve justifiable supporting measures. Indeed, according to the current norms, subsidies can be granted to compensate for public service obligations; furthermore, operators involved in public service contracts (PSCs) are entitled to be refunded the extra costs incurred by supplying the service, provided that the reimbursement is "directly related to the calculated deficit" (EC [15]).

In analytical terms, satisfying the operator's budget constraint encompasses both environments where transfers from the government are not allowed and environments where the regulated firms can be awarded subventions. Indeed, the solution is formally (though not

---

[2] Again, see Martimort [21], who argues that it is generally easier to enforce laws which prevent regulators from providing *ex post* transfers to the regulated firms rather than laws which interdict Treasury manipulations. Therefore, the State can more credibly commit to hard budget constraints as a regulator rather than as a proprietor.

numerically) equivalent, once the shadow cost associated to the participation constraint is replaced by the social cost of transferring money. Therefore, the budget-balance modelling device has the advantage of remaining neutral with respect to the subsidy/non-subsidy option, while better representing the European conservative attitude.

The paper is organized as follows. In Section 2, we present the model; we first develop a detailed description of passengers' preferences and behaviour; we subsequently illustrate the supply side of the market by focusing on the shippers' technologies and profit functions. In Section 3, we characterize the utilitarian first-best benchmark. In Section 4, we assume that society pursues efficiency objectives and determine the optimal monopoly regulation accordingly; we then illustrate how it can be decentralized. In Section 5, after assessing the impact of the incumbent's actions on the entrant's decisions, we characterize the optimal partial regulation and explain how it should be decentralized. Step by step, the duopoly results are paralleled to the monopoly ones. Section 6 is devoted to the distributional concerns of society; the implications of applying the territorial continuity principle are discussed. Section 7 concludes.

## 2 The Model

We consider a domestic ferry industry, which provides maritime transportation services connecting localities that are separated by the sea, such as the islands and the continental territory of a country.

In our stylized market, travellers are assumed to be heterogeneous, the source of heterogeneity being twofold. Firstly, each individual is characterized by a taste parameter $\alpha$, which is assumed to be distributed over the compact interval $[0, +\infty)$, according to the cumulative distribution function $H(\alpha)$ with density $h(\alpha)$. Secondly, each agent exhibits a time value $\tau$, which ranges over the interval $[0, +\infty)$, according to the cumulative distribution function $G(\tau)$ with density $g(\tau)$, and expresses the opportunity cost of the time spent waiting for a transfer. Furthermore, the population of passengers classify into two essential categories, namely the residents of the islands (market segment $r$) and the non-residents (market segment $n$).

We initially concentrate on the case where a dominant firm (enterprise $I$) operates as a regulated monopolist. We subsequently envisage the possibility that a (potential) competitor (enterprise $E$) considers to access the industry; if it does enter, then it supplies the service as an unregulated follower, whereas shipper $I$ acts as a regulated leader.

The basic period of operation is considered to be the year; nevertheless, to capture the significant seasonality of the industry activities, we identify two main seasons, which we denote by $s = l, h$, where $l$ stays for low season and $h$ for high season.

The service is characterized by both a monetary and a quality dimension, which constitute the relevant choice variables in the industry. The monetary dimension is given by the price that is charged by the operator supplying the service; each category of passengers can be offered a different price in each season[3]. On the other hand, the quality dimension consists in the number of performed transfers, which is allowed to vary on a seasonal basis.

---

[3] Price discrimination is a common practice in transportation industries (see, for instance, Wilson [27]).

Once both dimensions are accounted for, the transportation services provided in duopoly can be viewed as perfect substitute products. Stemming on the substitution property, we suppose that passengers may behave in either of the ways described in the following Section.

## 2.1 The Preferences and Demands

We hereafter illustrate how people make their travel decisions, hence how the demand for the transportation service is formed. Though we perform the investigation for the shipping market specifically, we are fairly confident that it might be extended to alternative contexts, namely bus, train and air transportation.

We initially adopt the perspective of the single traveller. We subsequently use the results achieved at the individual level to derive the relevant aggregate functions. For the time being, the classification of travellers into residents and non-residents is irrelevant and so neglected. It will matter as soon as the firms' and the regulator's standpoints are introduced into the picture, hence we will come back to it at that stage.

For sake of shortness, we content ourselves with studying passenger behaviour for the case where two shippers are active in the industry; instead, we renounce to detail over the monopoly situation. As it will become rapidly evident, the latter should simply be viewed as a special, much simpler case of the scenario we focus on.

Some travellers fully exploit the option of screening the more suitable market proposal. This involves that they select the operator whose price-and-frequency policy makes them better off and choose the number of tickets to purchase from it. Reasonably enough, these customers exhibit regular and recurring transfer necessities; for instance, they need to reach their job every day. Hence, they are able to systematically plan their movements. For simplicity, we say that these are the passengers of type 1.

The remaining customers (hereafter, type-2 passengers) take advantage of the first available connection, indifferently of the price they need to pay for the ticket and whatever the operating firm. One can imagine that these passengers mainly travel for occasional reasons, such as touristic visits. To their impatience they sacrifice the option of choosing between operators. As a result of this attitude, they perceive the transportation service as a unique good, as if they were faced with an "aggregate monopoly", albeit they actually randomize over the two services.

Hinging on the behavioural features previously illustrated and assuming that all relevant costs and benefits are correctly anticipated and incorporated into the personal programmes, we can write the net utility (surplus) function of either type of traveller. In particular, for a type-1 customer exhibiting taste parameter $\alpha$ and time value $\tau$, we have

$$S\left(\alpha, \tau; x_j^{s,1}\right) = \sum_s \left[\alpha U\left(x_j^{s,1}\right) - \left(p_j^s + \frac{\tau}{2f_j^s}\right) x_j^{s,1}\right]. \tag{1a}$$

In (1a), $U(\cdot)$ is the gross utility function, increasing and concave in the argument $x_j^{s,1}$; the latter represents the number of tickets the $(\alpha, \tau)$ −individual buys from the selected firm $j$ in season $s$. Furthermore, $p_j^s$ is the tariff charged and $f_j^s$ the number of connections supplied by operator $j$ in season $s$. The sum $\left(p_j^s + \tau/2f_j^s\right)$ measures the so-called *generalised cost*, which is given by the monetary price together with the disutility $\tau/2f_j^s$ associated to the departure delay; hence, it is the total unit cost the passenger bears. In particular, the ratio $1/2f_j^s$ is determined under the hypothesis that the ideal departure time is uniformly distributed along the time interval between any two departures[4]. The functional form in (1a) is inherited from Billette de Villemeur [3], who adopts it in a model of air transport monopoly regulation; nevertheless, the present framework is richer than his, as both seasons and customer types are allowed for.

The surplus function of the type-2 $(\alpha, \tau)$ −traveller is a modification of the previous one; it is given by

$$S\left(\alpha, \tau; x^{s,2}\right) = \sum_s \left[\alpha U\left(x^{s,2}\right) - \left(p^{s,e} + \frac{\tau}{2f^s}\right) x^{s,2}\right], \tag{1b}$$

where $x^{s,2}$ expresses the total number of tickets he buys from both firm $j$ and $k$ in season $s$ and $f_E^s = \left(f_j^s + f_k^s\right)$ the total amount of connections offered by the industry in the same season[5]. Furthermore, $p^{s,e} = \left(f_j^s p_j^s + f_k^s p_k^s\right)/f^s$ indicates the price the customer expects to pay, which is perceived to be a weighed sum of the tariffs $p_j^s$ and $p_k^s$, weights being the relative frequencies $f_j^s/f^s$ and $f_k^s/f^s$ respectively. It follows that the generalised cost $(p^{s,e} + \tau/2f^s)$ is now represented by the sum of the perceived price and the disutility associated to the departure delay[6].

The optimal type-1 demand for travels $x_j^{s,1}\left(\alpha, \tau; p_j^s, f_j^s\right)$ is characterized by the condition

$$\alpha U'\left(x_j^{s,1}\left(\alpha, \tau; p_j^s, f_j^s\right)\right) = p_j^s + \frac{\tau}{2f_j^s}, \ \forall s, \tag{2a}$$

while the type-2 demand $x^{s,2}\left(\alpha, \tau; \mathbf{p}^s, \mathbf{f}^s\right)$ is determined by

$$\alpha U'\left(x^{s,2}\left(\alpha, \tau; \mathbf{p}^s, \mathbf{f}^s\right)\right) = p^{s,e} + \frac{\tau}{2f^s}, \ \forall s, \tag{2b}$$

where we have defined the price vector $\mathbf{p}^s$ as $\left(p_j^s, p_k^s\right)$ and the frequency $f^s$ vector as $\left(f_j^s, f_k^s\right)$. Both (2a) and (2b) suggest that, at the individual optimum, the utility the consumer derives from the last purchased ticket, provided that his taste parameter is $\alpha$, equals the generalised cost he bears. Moreover, the above conditions show that $\alpha$ has a direct impact on the demand volume; indeed, fixing the generalised cost, the larger $\alpha$, the smaller the marginal utility $U'$, hence the bigger the optimal number of travels.

Observe that (2a) and (2b) can be used to establish the relationship between demand

---

[4] Mohring *et Alii* [22] report that, in modelling bus route, it is commonly assumed that, on average, a patron's waiting time for transportation service is half the scheduled headway between subsequent buses. The Authors observe that this assumption might look questionable, if it is considered that regular passengers are likely to know the approximate frequencies at the time they travel. Yet the probability of matching a connection operated by one or the other firm depends on the characteristics of the bus services, rather than on patrons' actions.

[5] In the text, the masculine pronoun (he) is used for the individual customer. At later stage, the feminine pronoun (she) will be introduced for the regulator.

[6] At this stage, it should be clear that, under monopoly, the sole relevant type of passengers is the first one because type-2 behaviour collapses onto type-1.

variations, as induced by changes in firm $j$'s price and frequency, assuming that the pair $(p_k^s, f_k^s)$ remains fixed. Indeed, since (2a) and (2b) hold for any $p_j^s$, we can differentiate both of them with respect to $p_j^s$ and obtain

$$\alpha U'' \frac{\partial x_j^{s,1}}{\partial p_j^s} = 1, \ \forall s \tag{3a}$$

and

$$\alpha U'' \frac{\partial x^{s,2}}{\partial p^{s,e}} = 1, \ \forall s, \tag{3b}$$

respectively. In particular, (3b) is obtained by noticing that

$$\frac{dp^{s,e}}{dp_j^s} = \frac{f_j^s}{f^s}, \ \forall s,$$

meaning that, since for the type-2 passengers the service constitutes a unique good, the variation in $p_j^s$ works through the impact it causes on the perceived price $p^{s,e}$.

(3a) and (3b) reveal that a unitary increase in price $p_j^s$ induces a unitary increase in the marginal utility of the service for the $\alpha-$passenger, whatever his behavioural type, through the variation intervened in his demand. Furthermore, the increment in marginal utility is decreasing in the individual taste for the service; hence, whenever price $p_j^s$ is diminished by one unit, the marginal utility reduces relatively less for the passengers who benefit more from travelling. This suggests that their consumption is less negatively affected by price increases than the others'.

On the other hand, (2a) and (2b) are true for any $f_j^s$; hence, differentiating both of them with respect to this variable returns

$$\alpha U'' \frac{\partial x_j^{s,1}}{\partial f_j^s} = -\frac{\tau}{2\left(f_j^s\right)^2}, \ \forall s \tag{4a}$$

and

$$\alpha U'' \frac{\partial x^{s,2}}{\partial f^s} = \frac{f_k^s}{f^s}\left(\frac{p_j^s - p_k^s}{f^s}\right) - \frac{\tau}{2\left(f^s\right)^2}, \ \forall s, \tag{4b}$$

respectively. Notice that (4b) is found by using the results

$$\frac{dp^{s,e}}{df_j^s} = \frac{\left(p_j^s - p_k^s\right) f_k^s}{\left(f^s\right)^2}, \ \forall s$$

and

$$\frac{df^s}{df_j^s} = 1, \ \forall s,$$

meaning that, as long as type-2 customers are concerned, any change in the number of transfers $f_j^s$ operates through the impact it provokes on both the perceived price $p^{s,e}$ and the aggregate frequency $f^s$. The interpretation of (4a) and, above all, (4b) is less intuitive than that of (3a) and (3b); nevertheless, paralleling one expression to the other helps comprehension.

(4a) reveals that a unitary increase in frequency induces a reduction equal to $\tau/2\left(f_j^s\right)^2$ in the marginal utility of the type-1 $(\alpha,\tau)$ −customer, through the change in his demand. Observe that the higher the frequency initially provided by firm $j$, the smaller the variation in marginal utility induced by further scheduling. Indeed, when the enterprise already offers very frequent transfers, receiving more causes a relatively small increase in the demand for the service; it follows that the associated change in marginal utility is limited as well.

(4b) suggests that the variation induced by a unitary frequency increase in the marginal utility of the type-2 individual with taste $\alpha$ equals the ratio $\left[f_k^s\left(p_j^s-p_k^s\right)-\tau/2\right]/\left(f^s\right)^2$. This can be interpreted by noticing that, as an additional transfer is offered by firm $j$, two effects are provoked. First of all, similarly to the type-1 case, the type-2 customer's marginal utility decreases by an amount $\tau/2\left(f^s\right)^2$, which measures the *gross* variation caused by the fact that the total number of available connections is increased. The second effect is expressed by the term $f_k^s\left(p_j^s-p_k^s\right)/\left(f^s\right)^2$, the presence of which follows from the circumstance that the frequency effect shows up through a double channel. This term reveals that not only the disutility from time waste, but also the spread between prices and the frequency supplied by the rival operator are relevant. More precisely, the ratio $\left(p_j^s-p_k^s\right)/f^s$ represents the per-transfer price wedge; it is positive if firm $j'$s price is larger than firm $k'$s and negative in the converse case. On the other hand, the ratio $f_k^s/f^s$ is the portion of connections provided by the rival firm $k$ over the total number of supplied transfers. Therefore, the product of the two terms synthesizes either the relative savings which are realized when firm $j'$s transfer is taken, rather than a transfer operated by the more expensive firm $k$, or the relative penalty to be borne, in the event that the cheaper travel is forgone. After the gross variation is corrected by this term, the right-hand side of (4b) measures the *net* variation in the marginal utility of the type-2 $(\alpha,\tau)$ −individual.

One more remark about type-2 passenger behaviour should be made. According to (4b), an increment in $f_j^s$ causes a negative variation in type-2 marginal utility[7], through demand increase, in either of the two following cases[8].

1. $p_k^s > p_j^s$. Whenever the price charged by the firm whose frequency grows is lower than the rival price, any type-2 passenger increases his demand, independently of the individual time value[9]. Intuitively, any traveller is better off as the frequency (hence, the probability) of the cheaper enterprise becomes larger.

2. $p_j^s > p_k^s$ and $f_k^s\left(p_j^s-p_k^s\right) < \tau/2$. The price charged by firm $j$ is smaller than the generalised cost the traveller would bear by patronizing firm $k$. As it becomes more likely that the first available transfer be operated by enterprise $j$, the service gets overall more attractive for sufficiently impatient passengers[10].

At this stage of the study, a natural question arises as to how behavioural types en-

---

[7] That is, we have $\left[f_k^s(p_j^s-p_k^s)-\tau/2\right]<0$.

[8] It is possible to show that the variation in marginal utility can never be positive. In other words, it never happens that type-2 passengers travel *less* as the quality of the more expensive service increases.

[9] Indeed, one has $2f_k^s\left(p_j^s-p_k^s\right)<0<\tau$, $\tau$ being (weakly) positive by assumption.

[10] Manipulating the inequalities in the text, one can show that it is $p_k^s<p_j^s<(p_k^s+\tau/2f_k^s)$. It follows that 2. realizes for $\tau>2f_k^s\left(p_j^s-p_k^s\right)$.

dogenously follow from the individual characteristic structuring passengers' preferences. In Appendix A, we provide the analytical details of the reply to this question, from which firms' aggregate demand functions can be derived; in the following Proposition, we summarize the major results.

**Proposition 1** *In a duopolistic shipping industry, there exists a cutoff time value such that people exhibiting smaller* $\tau$ *behave as type-1 passengers and patronize the cheaper operator, whereas people with larger* $\tau$ *act as type-2 passengers.*

Observe that the relevant cutoff time value, separating type-1 from type-2 passengers, depends on the elements hereafter listed:

1. the wedge between the prices the two operators charge;
2. the frequency offered by the cheaper provider, which is patronized by type-1 customers.

Let us firstly comment on 1. Having a large price gap means that travelling with one firm is much more expensive than it is with the other. This circumstance makes the cheaper operator relatively more convenient for a wider range of time values, hence the marginal value of $\tau$ moves upward over the total support. Similarly, turning to 2., as the quality supplied by the cheaper operator increases, its service becomes relatively more attractive for a wider interval of time values, which has analogous impact on the position of the cutoff $\tau$.

The previous considerations suggest that, for the infra-marginal type-1 customers, the main concern is given by the price paid for travelling. In other words, for those passengers, smaller price is more important, as compared to quality; hence, it is preferred, even when associated to the poorer quality. On the other hand, the amount of connections operated by the cheaper firm matters at the margin, in that it contributes to tilt type-1 behaviour to type-2. Precisely the passage from one behaviour to the other rules out the circumstance that people whose time value is smaller than the cutoff $\tau$ reduce their demand for transportation service, as they become more likely to use the more expensive connection.

Notice that the individual taste parameter does not directly enter the unit generalised costs that each traveller compares in order to choose at his best. Conversely, the individual time value does have a direct effect, as it shows up in the unit generalised costs. Nevertheless, the prices and frequencies the firms offer (and the single traveller takes as given) actually depend on the distribution of $\alpha$ and of $\tau$ in the population. Intuitively, *ceteris paribus*, the more favourable the distribution of the taste parameter, the larger the willingness to pay for the service, the higher the prices operators can charge.

One last point we need to make. All along the sequel of our work, the investigation is performed at the aggregate level, because this is the relevant perspective for both firms and regulatory bodies. It is therefore necessary to determine the aggregate demand functions. The analysis so far performed, together with the results achieved in Appendix A, provides us with the appropriate information. In particular, we are able to establish that, whenever it is $f_j^s > f_k^s$ and $p_j^s > p_k^s$, aggregate demand functions are given by

$$X_k^s\left(\mathbf{p}^s, \mathbf{f}^s\right) = X_k^{s,1}\left(p_k^s, f_k^s\right) + \frac{f_k^s}{f^s} X^{s,2}\left(\mathbf{p}^s, \mathbf{f}^s\right), \ \forall s$$

and

$$X_j^s\left(\mathbf{p}^s, \mathbf{f}^s\right) = \frac{f_j^s}{f^s} X^{s,2}\left(\mathbf{p}^s, \mathbf{f}^s\right), \ \forall s$$

for firm $k$ and $j$ respectively, where one has

$$X_k^{s,1}\left(p_k^s, f_k^s\right) = \int_0^{\tau_{mg}^{s,2,k}} \int_\alpha x_k^{s,1}\left(\alpha, \tau; p_k^s, f_k^s\right) h\left(\alpha\right) g\left(\tau\right) d\alpha d\tau, \ \forall s$$

and

$$X^{s,2}\left(\mathbf{p}^s, \mathbf{f}^s\right) = \int_{\tau_{mg}^{s,2,k}}^{+\infty} \int_\alpha x^{s,2}\left(\alpha, \tau; \mathbf{p}^s, \mathbf{f}^s\right) h\left(\alpha\right) g\left(\tau\right) d\alpha d\tau, \ \forall s.$$

Conversely, with $f_j^s > f_k^s$ and $p_j^s < p_k^s$, demand functions write as

$$X_k^s\left(\mathbf{p}^s, \mathbf{f}^s\right) = \frac{f_k^s}{f^s} X^{s,2}\left(\mathbf{p}^s, \mathbf{f}^s\right), \ \forall s$$

and

$$X_j^s\left(\mathbf{p}^s, \mathbf{f}^s\right) = X_j^{s,1}\left(p_j^s, f_j^s\right) + \frac{f_j^s}{f^s} X^{s,2}\left(\mathbf{p}^s, \mathbf{f}^s\right), \ \forall s,$$

where it is

$$X^{s,2}\left(\mathbf{p}^s, \mathbf{f}^s\right) = \int_{\tau_{mg}^{s,2,j}}^{+\infty} \int_\alpha x^{s,2}\left(\alpha, \tau; \mathbf{p}^s, \mathbf{f}^s\right) h\left(\alpha\right) g\left(\tau\right) d\alpha d\tau, \ \forall s$$

and

$$X_j^{s,1}\left(p_j^s, f_j^s\right) = \int_0^{\tau_{mg}^{s,2,j}} \int_\alpha x_j^{s,1}\left(\alpha, \tau; p_j^s, f_j^s\right) h\left(\alpha\right) g\left(\tau\right) d\alpha d\tau, \ \forall s.$$

One can also compute the aggregate indirect utility functions by plugging the individual demands into the individual surplus functions (1a) and (1b) and then summing up over the relevant ranges of time value in the population. For sake of shortness, we omit this exercise.

## 2.2 The Technologies and Profits

So far we have sketched out the essential characteristics of the demand side of the maritime ferry market. In the present Section, we describe the supply side and, in particular, the most important features of the technologies. Again, for expositional reasons, we look at both operators at once; nevertheless, one should keep in mind that only firm $I$ matters, in the event that the sector is monopolistic. Moreover, we reintroduce the passenger classification into the two categories (namely, residents and non-residents) we mentioned when we presented the model. We denote by $X_j^{s,i}\left(\mathbf{p}^{s,i}, \mathbf{f}^s\right)$ firm $j$'s aggregate demand on market segment $i$ in season $s$, $\forall j, s, i$, which depends on the vector of relevant prices $\mathbf{p}^{s,i} = \left(p_j^{s,i}, p_k^{s,i}\right)$ as well as on the vector of relevant frequencies $\mathbf{f}^s = \left(f_j^s, f_k^s\right)$[11].

We are now ready to focus on technologies. We assume that, for either operator, the cost function consists in three main components, which we hereafter illustrate.

The first component is purely operational and is to be attributed to the used capacity. More precisely, it includes the costs associated to shipping personnel, passenger transferring, boarding and debarking operations and various related expenses. The utilized capacity, which we denote by $K_j^s$, represents the number of seats on firm $j'$s ships which are occupied in season $s$. This capacity depends on both faced traffic $X_j^s = \sum_i X_j^{s,i}$ and offered connection frequencies $f_j^s$; indeed, it equals the ratio $X_j^s / f_j^s$. Observe that, for any given level of traffic, the larger the frequency, the smaller $K_j^s$; in the presence of increasing returns to scale, this involves higher per-passenger cost. The marginal cost of operation is assumed to be constant for either shipper; more precisely, it is given by $a$ for firm $E$ and $(a + \gamma)$ for firm $I$ respectively. The hypothesis that the incumbent has larger marginal cost is in line with Cremer *et Alii* [8]; the latter capture the fact that equally skilled workers are frequently over-remunerated in public enterprises through the hypothesis that the latter pay a premium to their employees, an extra cost which appears as a budget component[12]. The total per-year costs associated to the used capacity amount to $aK_E^s f_E^s = a \sum_s X_E^s$ for the entrant and to $(a + \gamma) \sum_s K_I^s f_I^s = (a + \gamma) \sum_s X_I^s$ for the dominant operator respectively. Hence, this cost component proportionally increases in the traffic size.

The second component is specifically associated to the number of transfers performed with the available capacity, independently of whether the latter is fully occupied or remains (partially) idle. For instance, the activities related to mooring and sailing are executed at each travel, no matter how many passengers occupy the seats. In the long run, shippers adjust installed capacity according to the observed traffic, taking into account that, in the short run, they will benefit from seasonal flexibility in frequency; therefore, installed capacity is finally equivalent to $Sup\left\{K_j^l, K_j^h\right\} \equiv \overline{K}_j$, that is to the capacity that is actually used in the season during which no excess is registered[13]. We assume that it generates a cost $\phi_j\left(\overline{K}_j\right)$ so that the overall associated burden amounts to $\phi_j\left(\overline{K}_j\right) \sum_s f_j^s$. We also suppose that it is $\phi_E > \phi_I$. Hence, while the incumbent is operationally less efficient than the entrant, it exhibits a cost advantage in terms of capital. This is explained if one recalls that, in the real-world sectors we refer to, the dominant enterprise is frequently the statutory provider, formerly or still public; such a status is perceived to be a guarantee for

---

[11] This notation should not generate a confusion as to aggregate demand functions. The aggregate demand we refer to in the current Section forms precisely as illustrated in the previous Section. The only difference is that we now consider a category-classification, rather than a type-classification.

[12] Martimort [21] reports that, according to Lopez-de-Silvanes *et Alii* (1997), wages in the public sector are 10 to 20 percent higher than those that are paid for similar jobs in the private sector. This matter of fact partially explains the wave of strikes that perturbed the French ferry service during fall 2005, when the employees of the public shipping company SNCM strongly opposed the French government's intention to privatize the firm.

[13] At the operational stage, the firm's cost function is, in fact, a short-run function. The size of capacity is a matter of long-run strategy and should be viewed as the first decision variable in a two-stage game in which enterprises anticipate the subsequent price-and-frequency choice.

repayment, hence it helps obtain better financing conditions, which translates into lower cost of capital. This is relevant because, beyond some amount of frequencies, providing further transfers requires having larger fleets; under our assumption, disposing of bigger capacity is relatively more affordable for shipper $I$[14].

Thirdly, each firm bears a pure fixed cost $F_j$, mainly associated to maintenance of ships and accessory equipment as well as to administration, advertising, insurance; hence, it is to be incurred even when no transfer is performed.

Finally, letting $\sum\limits_{s,i} X_j^{s,i} p_j^{s,i}$, $\forall j$, represent the total revenues firm $j'$s service generates all over the year on the two market segments and putting things together, we can write shipper $I'$s yearly profit function as

$$\pi_I(\mathbf{p},\mathbf{f}) = \sum_{s,i} X_I^{s,i} p_I^{s,i} - \left[(a+\gamma)\sum_s X_I^s + \phi_I \sum_s f_I^s + F_I\right], \tag{7a}$$

whereas operator $E'$s is given by

$$\pi_E(\mathbf{p},\mathbf{f}) = \sum_{s,i} X_E^{s,i} p_E^{s,i} - \left(a\sum_s X_E^s + \phi_E \sum_s f_E^s + F_E\right). \tag{7b}$$

Each of the previous functions is twice continuously differentiable and strictly concave everywhere in the firm's actions.

## 3 The Utilitarian Social Optimum

In the previous Section, we have outlined the relevant demand and supply features of the maritime ferry market. In what follows, we explore the first-best benchmark for the sector under scrutiny; we allow for two shippers to serve passengers, though the by now familiar appraisal about the monopoly case continues to apply in the current context.

The final objective of the present Section consists in characterizing the prices and frequencies which maximize the following social welfare function

$$W(\mathbf{p},\mathbf{f};\boldsymbol{\tau}) = V(\mathbf{p},\mathbf{f};\boldsymbol{\tau}) + \sum_{j=I,E} \pi_j(\mathbf{p},\mathbf{f}), \tag{8}$$

that is the *unweighed* sum of aggregate consumer surplus $V(\cdot) = \sum\limits_{s,i} V^{s,i}$[15] and operators' profits $\pi_j(\mathbf{p},\mathbf{f})$. The utilitarian functional form in (8) captures the circumstance that, for the time being, efficiency is taken to be the sole relevant scope. Moreover, at this stage, providers are not required to break even; one may imagine that their participation in the market operation be ensured under the hypothesis that the government covers their extra costs (including the cost of capital) from its budget, by providing subsidies at no cost of public funds.

---

[14] Martimort [21] points that firms which lack reputational capital, as the entrant in our shipping industry, may experience some difficulties at accessing financial markets.

[15] $V^{s,i}$ is the aggregate indirect utility function of category $i$ in season $s$ we mentioned but omitted at the end of Section 2.1. $V(\cdot)$ sums up over categories and seasons.

Yet, before determining the first-best prices and frequencies, we find it important to establish when and whether it is socially optimal that either firm operates, given the cost structures. For this purpose, we need to compare shippers' per-passenger costs, as obtained by dividing variable costs by total traffics. More precisely, we have

$$PPVC_I^s = a + \gamma + \frac{\phi_I f_I^s}{X_I^s} \tag{9a}$$

for the incumbent and

$$PPVC_E^s = a + \frac{\phi_E f_E^s}{X_E^s} \tag{9b}$$

for the entrant[16]. For the industry per-passenger variable cost to be minimized, firm $I$ should operate for all the values of $X_I^s$, $X_E^s$, $f_I^s$ and $f_E^s$ such that, given $\gamma$, $\phi_I$ and $\phi_E$, it is

$$PPVC_I^s < PPVC_E^s \quad \Leftrightarrow \quad \gamma < \left( \frac{\phi_E f_E^s}{X_E^s} - \frac{\phi_I f_I^s}{X_I^s} \right). \tag{10}$$

Provided that $\gamma > 0$, a necessary condition for (10) to hold is given by $\phi_E f_E^s / X_E^s > \phi_I f_I^s / X_I^s$, meaning that the entrant's per-passenger cost of transfer in season $s$ must exceed the dominant enterprise's. Observing that $\gamma$ measures the difference between shippers' per-passenger operational costs, one concludes that (10) is satisfied whenever the additional per-passenger cost firm $I$ imposes on society in terms of operation, as compared to firm $E$, is smaller than the per-passenger cost savings it allows for in terms of connections. Under this circumstance, service provision by the dominant operator yields a net per-passenger benefit, hence it is relatively more desirable for the collectivity[17]. Clearly, the condition $\phi_E f_E^s / X_E^s > \phi_I f_I^s / X_I^s$ is not sufficient for shipper $I$ to dominate in a first-best environment; according to (10), enterprise $E$ rather dominates for $\gamma$ sufficiently large. In particular, given capacities, the value of $\gamma$ triggering the entrant's preferability depends on the discrepancy between $\phi_E$ and $\phi_I$. Furthermore, it is better to solely entitle firm $E$ with the provision of transportation service whenever one has $\phi_E f_E^s / X_E^s < \phi_I f_I^s / X_I^s$, in which case (10) cannot be met. In this scenario, firm $I$ exhibits both higher per-passenger cost of frequency and higher per-passenger cost of operation; therefore, letting this shipper supply the service would generate a net per-passenger penalty, which is not induced, instead, by the other provider.

At the social optimum, marginal cost pricing entails for either operator; we have

$$p_I^{FB} = a + \gamma \tag{11a}$$

---

[16] In the text, we abstain from considering the fixed cost components for two reasons. Firstly, at least in a short-run perspective, fixed costs are sunk and do not affect the optimal allocation. Secondly, in a first-best environment, shippers are not required to be viable in the long run without public financing. Clearly, in a second-best world with budget balance requirements, things would differ. If the social planner can decide whether to have one or two operators in the shipping market, then the presence of fixed costs does affect the ultimate choice, to the extent that, once the decision is made, all active firms need to break-even without relying on public resources. See Cremer *et Alii* [8] for a similar argument; see also Laffont [19] for a more general discussion as to how duplication of fixed costs may lead to sub-optimal allocations.

[17] A special case arises when shippers share the same level of used capacities, so that the right-hand side of (10) is necessarily positive.

and

$$p_E^{FB} = a \tag{11b}$$

for firm $I$ and $E$ respectively, the superscript $FB$ staying for first best. Observe that, as marginal costs stay the same whatever the season, the first-best tariffs remain constant all over the year. Moreover, they do not reflect the heterogeneity characterizing the two categories of customers; rather, the difference in prices solely expresses the difference in marginal costs, so that it is $p_I^{FB} > p_E^{FB}$. Though this might not be satisfactory on a distributional perspective, it is so on pure efficiency grounds.

Given the cost functions and applying the marginal cost pricing rules, the optimal scheduling, which we denote by $f_j^{s,FB}$, is characterized by the condition

$$\frac{\partial V^s}{\partial f_j^s} = \phi_j, \ \forall s, j, \tag{12}$$

where we have $V^s = \sum_i V^{s,i}$, $\forall s$. (12) states the equality between marginal benefit and marginal cost of transfer; it suggests that, at the social optimum, shipper $j$ should increase frequency until the additional benefit to consumers, which is generated by the last connection, is fully offset by the incremental cost it imposes on the provider. Observe that, differently from prices, first-best frequencies may well adjust on a seasonal basis, as they are determined not only by firms' technologies but also by the demand side of the industry.

We finally rely on the results summarized in Proposition 1 to deduce how travellers allocate between operators in a first-best environment with both firms active. The relevant cutoff time value is equal to $2\gamma f_E^{s,FB}$; passengers whose $\tau \in \left[0, 2\gamma f_E^{s,FB}\right)$ patronize the entrant, those with $\tau \in \left(2\gamma f_E^{s,FB}, +\infty\right)$ take the ship sailing next. As one may recall, this is so because, when the time value is little, the most relevant element resides in the price. Since shipper $E$ offers the cheaper service, this is the operator type-1 customers prefer. Saving over time becomes more important as the penalty from waiting gets larger; then passengers are better off by departing as soon as possible, which leaves room to both shippers' activities. In this perspective, operation by the dominant enterprise appears essentially beneficial to type-2 customers, to whom it provides additional connections.

## 4 The Regulated Monopoly

In the previous Section, we pointed that, for conditions (11a), (11b) and (12) to become attainable, it should be possible to fund the uncovered costs of provision by means of subventions taken from the general budget of the State without creating efficiency losses. In reality, this is hardly feasible because, in general, resource collection requires levying distorting taxes. Therefore, the rules listed above remain ideal reference points.

It is now time to concentrate on more realistic scenarios. In the present Section, we focus on a monopolistic ferry industry whose unique shipper is compelled to implement the policy the regulator designs. This situation has persistently had, and still often has, undeniable practical relevance in most European countries.

In the framework under scrutiny, the unique shipper (firm $I$) is instructed to pursue the social interests compatibly with budget balance. As long as society aims at achieving efficiency, solving the social problem amounts to maximizing the utilitarian welfare function under the constraint that profits be non-negative. The programme writes as

$$\underset{\left\{p_I^{s,i},f_I^s\right\}_{\forall s,i}}{Max} \quad V\left(\mathbf{p}_I,\mathbf{f}_I;\boldsymbol{\tau}\right)+\pi_I\left(\mathbf{p}_I,\mathbf{f}_I\right)$$

$$\text{subject to} \tag{13}$$

$$\pi_I\left(\mathbf{p}_I,\mathbf{f}_I\right)\geq 0,$$

where $\mathbf{p}_I=\left(p_I^{h,r},p_I^{h,n},p_I^{l,r},p_I^{l,n}\right)$ and $\mathbf{f}_I=\left(f_I^h,f_I^l\right)$ are the vectors of prices and frequencies to be regulated.

Let $\lambda^{RM}$ the Lagrange multiplier which quantifies the effect that is induced by a variation in the fixed cost included in the budget constraint on the optimal value of the objective function. The superscript $RM$ is meant to indicate the regulated monopoly regime. The first-order conditions which characterize the (constrained) optimal prices $p_I^{s,i,RM}$ and frequencies $f_I^{s,RM}$ are given by

$$\frac{\partial\pi_I}{\partial p_I^{s,i}}=-\frac{\partial V^{s,i}}{\partial p_I^{s,i}}\frac{1}{1+\lambda^{RM}},\ \forall s,i, \tag{14a}$$

and

$$-\frac{\partial\pi_I}{\partial f_I^s}=\frac{\partial V^s}{\partial f_I^s}\frac{1}{1+\lambda^{RM}},\ \forall s, \tag{14b}$$

respectively. (14a) means that the incremental profits firm $I$ obtains on the last unit increase in price should equal the reduction induced in consumer surplus, discounted according to the shadow value of the budget constraint. Similarly, (14b) suggests that the decrease in the shipper's profits over the last provided transfer oughts to equal the associated increment in consumer surplus, again discounted by the cost $\lambda^{RM}$.

Altogether, (14a) and (14b) synthesize how, in the words of the Regulation 3577/92 [16], the authority forces the firm to "obligations which, if considering its own commercial interest, it would not assume". Combining the two conditions yields

$$\frac{\partial\pi_I/\partial f_I^s}{\partial\pi_I/\partial p_I^{s,i}}=\frac{\partial V^s/\partial f_I^s}{\partial V^s/\partial p_I^{s,i}},\ \forall s,i. \tag{15}$$

The left-hand side of (15) is the rate at which price and frequency can be substituted away for the shipper benefits to remain unchanged[18]. Similarly, the right-hand side is the rate of substitution between frequency and price, such that consumer surplus is left unaffected[19]. Overall, (15) suggests that, by equalizing these rates, the least possible amount of social welfare is sacrificed to the budgetary requirements of the monopolist.

Furthermore, defining $\varepsilon_I^{(s,i)(s,i)}\equiv\left(p_I^{s,i}/X_I^{s,i}\right)\left(-\partial X_I^{s,i}/\partial p_I^{s,i}\right)$ the (absolute value of

---

[18] As long as the budget constraint is binding, this means that the shipper benefits remain equal to zero.

[19] In (15), we use the derivative $\partial V^s/\partial p_I^{s,i}$ so that the right-hand side of the equality is the rate of substitution we illustrate in the text. Notice, however, that the derivative is equal to $\partial V^{s,i}/\partial p_I^{s,i}$, as aggregate consumer surplus is additive in $s$ and $i$.

the) elasticity of demand $X_I^{s,i}$ to own price, (14a) becomes

$$\frac{p_I^{s,i}-(a+\gamma)}{p_I^{s,i}} = \frac{1}{\varepsilon_I^{(s,i)(s,i)}}\frac{\lambda^{RM}}{1+\lambda^{RM}}, \ \forall s, i. \tag{16a}$$

(16a) identifies the Ramsey-Boiteux criterion, according to which the price $p_I^{s,i,RM}$ reflects both market and technological conditions. Indeed, the relative margin associated to segment $i$ and season $s$ is directly proportional to the term $\lambda^{RM}/\left(1+\lambda^{RM}\right)$, which depends on costs; moreover, it is inversely proportional to the price elasticity of demand $X_I^{s,i}$, hence the adverse impact of a price increase becomes progressively more important, the more such demand is price elastic. Under (16a), the monopolist just covers all production costs and the welfare loss associated to consumption rationing is minimized; therefore, a socially desirable compromise entails between social welfare and shipper's viability.

Two further remarks emerge from (16a). Firstly, as prices are related to demand elasticities, they depend on the distribution of passenger individual characteristics. This would not be the case in a first-best environment where, as highlighted in the previous Section, they would solely reflect the technological conditions.

Secondly, prices also depend on quality. Nevertheless, the *norm* governing their optimal choice is invariant in the circumstance that the frequency is simultaneously selected. Rewriting (14b) more extensively as

$$-\left\{\sum_i \left[p_I^{s,i}-(a+\gamma)\right]\frac{\partial X_I^{s,i}}{\partial f_I^s}-\phi_I\right\} = \frac{\partial V^s}{\partial f_I^s}\frac{1}{1+\lambda^{RM}}, \ \forall s, \tag{16b}$$

makes it explicit how the prices charged on the two market segments, hence the respective margins $\left[p_I^{s,i}-(a+\gamma)\right]$, are tied to finance the common cost of quality $\phi_I$, taking into account the marginal impact of quality on discounted consumer surplus.

Nothing prevents the (constrained) optimal amount of transfers to differ across seasons. The extent to which this happens depends on the values the terms $\partial X_I^{s,i}/\partial f_I^s$ and $\partial V^s/\partial f_I^s$ take for each $s$. It is reasonable to expect relatively fewer transfers to be ensured in the low season, when traffic appreciably shrinks albeit, in the regulated environment, connections are no longer as rare as they would in an unregulated industry.

### 4.1 Decentralization through a Global Price-and-Frequency Constraint

Conditions (14a) and (14b) characterize the prices and the number of connections that are chosen by a utilitarian welfare-maximizing informed regulator, as long as the shipping industry has monopoly structure. These (constrained) optimal prices and frequencies can be decentralized to a profit-maximizing operator by imposing the quality-adjusted price cap proposed by De Fraja and Iozzi [9]. In what follows, we briefly illustrate how this mechanism applies to the specific context of the maritime ferry sector.

The regulator requires firm $I$ to satisfy a constraint, which sets an upper bound on the difference between a weighed average of the charged prices and a weighed average of the amount of operated transfers. Both the bound and the weights are exogenously determined. In formal terms, the operator's programme writes as

$$\begin{gathered}\underset{\left\{p_I^{s,i},f_I^s\right\}_{\forall s,i}}{Max} \quad \pi_I\left(\mathbf{p}_I,\mathbf{f}_I\right)\\ \text{subject to} \\ \sum_{s,i}\beta_{DMR}^{s,i}p_I^{s,i}-\sum_{s}\alpha_{DMR}^{s}f_I^{s}\leq P_{DMR},\end{gathered} \tag{17}$$

where $\beta_{DMR}^{s,i}$ and $\alpha_{DMR}^{s}$ are the weights attributed to prices and frequencies respectively and $P_{DMR}$ is the upper bound. The script $DMR$ stays for *decentralized monopoly regulation.*

As De Fraja and Iozzi [9] explain, by attributing a positive weight to frequency $f_I^s$ $\left(\alpha_{DMR}^s>0\right)$, the shipper is induced to increase this quality dimension. Indeed, by doing so, a change is triggered in the price constraint, which allows for an increment in the average price $\sum_{s,i}\beta_{DMR}^{s,i}p_I^{s,i}$. Conversely, omitting the average frequency component would provide an incentive to the firm to shirk on quality for the purpose of reducing costs, so that larger stake would residue under the price cap[20].

The first-order conditions of (17) with respect to prices and frequencies are respectively given by

$$\frac{\partial\pi_I}{\partial p_I^{s,i}}=\lambda^{DMR}\beta_{DMR}^{s,i},\ \forall s,i \tag{18a}$$

and

$$-\frac{\partial\pi_I}{\partial f_I^{s}}=\lambda^{DMR}\alpha_{DMR}^{s},\ \forall s, \tag{18b}$$

$\lambda^{DMR}$ being the Lagrange multiplier associated to the regulatory constraint. For the choice of the vector $\left(\mathbf{p}_I^{RM},\mathbf{f}_I^{RM}\right)$ to be decentralized, such vector has to solve (18a) and (18b) for the appropriate value of $\lambda^{DMR}$. This is the case whenever the equality

$$\lambda^{DMR}=\frac{1}{1+\lambda^{RM}} \tag{19a}$$

holds together with

$$\beta_{DMR}^{s,i}=-\frac{\partial V^{s,i,RM}}{\partial p_I^{s,i}},\ \forall s,i \tag{19b}$$

and

$$\alpha_{DMR}^{s}=\frac{\partial V^{s,RM}}{\partial f_I^{s}},\ \forall s. \tag{19c}$$

(19b) reveals that the appropriate weight for each price consists in the value the aggregate marginal surplus attains at the regulated solution $\left(-\partial V^{s,i,RM}/\partial p_I^{s,i}\right)$. In a quasi-linear world, such value coincides with the level of the aggregate demand $X_I^{s,i,RM}$. This constitutes the standard result which is found when global price caps are designed. For

---

[20] Billette de Villemeur [3] as well proposes a price-and-frequency cap for the purpose of implementing the second-best allocation in a monopoly providing air transportation. He formulates the constraint so that the generalised price paid by consumers (that is, the sum of monetary price and disutility from waiting) is smaller than an exogenously set upper bound. De Fraja and Iozzi [9]'s more general approach better suits the present context, as multiple prices and frequencies are here to be delegated.

instance, Billette de Villemeur *et Alii* [4] prove that it holds for a postal sector in which mail distribution is performed together with a composite activity. Nevertheless, their constraint is a pure price cap as, in their framework, no quality dimension is considered. Conversely, the latter represents a crucial peculiarity of the maritime ferry industry; as (19c) suggests, the appropriate weight for each quality dimension is given by the marginal net benefit consumers obtain at the regulated monopoly solution $\left(\partial V^{s,RM}/\partial f_I^s\right)$.

Once weights are set as in (19b) and (19c), for (19a) to be met, it suffices to choose the value of $P_{DMR}$ which binds the regulatory constraint[21].

# 5 The Partially Regulated Duopoly

Under the EU Regulation 3577/92 [16], the principle of service freedom has been extended to maritime transportation as from 1999. Regular passenger transport services, ferry transport and cabotage services with the islands of five Member States of the European Union (Spain, France, Italy, Portugal and Greece[22]) have been opened up to all the beneficiaries of the Regulation, namely "the Community shipowners who have their ships registered in, and flying the flag of a Member State, provided that these ships comply with all conditions for carrying out cabotage in that Member State" (Art. 1).

Yet the persisting opportunity of regulating the ferry sector is recognized "in cases where the operation of market forces would not ensure a sufficient service level" (Art. 9 of the Guidelines on State Aid to the Maritime Sector [15]). Under such circumstances, the imposition of regulatory obligations for the provision of scheduled services is considered to be compatible with liberalized environments.

As for a plurality of other utilities opened up to competition, entry of new operators in the shipping industry is expected to follow and, indeed, it has sometimes followed from liberalization and partial deregulation, thereby leading to *partially regulated oligopolies*. Nevertheless, this phenomenon does not occur systematically. Anecdotal evidence suggests that the scope (eventually) left for profitable access to markets where regulated incumbents rely on solid customer bases, sensibly differ across scenarios.

As long as a regulated industry is concerned, it is of crucial importance to understand how this circumstance depends on the specific institutional features; indeed, a necessary condition for the regulatory policy to be properly designed is that its impact on the surrounding and perspective environment be as unambiguous as possible. Some of the Sections which follow are actually meant to assess how regulation of a dominant firm (shipper $I$) affects the access and operational decisions of a potential entrant (shipper $E$).

In the same vein as Cremer *et Alii* [8], we point that the authority which regulates a dominant firm needs to take a sophisticated behaviour when access opportunities exist: she has to anticipate the ultimate market outcome resulting from the actions she delegates to the incumbent; this amounts to making her decisions hinging on *ex post* market realities.

---

[21] De Fraja and Iozzi [9] further show how their quality-adjusted price cap translates into two constraints (namely, the quality adjusted Vogelsang-Finsinger constraint and the distance constraint), which allow for a practical (low informationally demanding) implementation of the theoretical cap.

[22] Greece was granted a special exemption from full application of the Regulation until 2004, in consideration of the relevance of the inter-islands connections for the country.

In the sequel of our analysis, when we characterize the optimal partial regulatory policy, we assume this to be the case, indeed.

In our maritime ferry sector, the outcome to be forecasted consists in a Stackelberg equilibrium, where as much room is left to the entrant as efficiency requires[23]. This means that access is encouraged and accommodated to the extent that it is socially efficient. The regulator so does by becoming herself a leader *vis-à-vis* the new operator and playing the first stage of the market game on behalf of the dominant firm she controls.

Precisely as the public authority is assumed to be foresighted, so is the potential follower. To be more rigorous, the latter is persuaded that its actions will not trigger a reaction in the industry leader; in this sense, it is a myopic agent. Nevertheless, it bases its choices on the policy the regulator will impose if entry is anticipated. Consequently, if the sector is originally organized as a regulated monopoly and access subsequently occurs, then both regulator and entrant are taken to perceive the ultimate market outcome as the reference point of their decisional processes.

## 5.1 The Unregulated Entrant

As previously mentioned, we devote the present Section to investigate whether and under which circumstances firm $E$ decides to enter our stylized shipping sector and, if so, how it selects prices and frequencies in its best interests, so that its profit function entails a maximum. It takes shipper $I'$s regulated actions as given and makes its own choices accordingly. As the study proceeds, it will become clear that the role of a Stackelberg follower grants to the entrant a decisional flexibility the leader lacks.

Turning to the formal analysis, suppose that the pair of vectors $(\mathbf{p}_I, \mathbf{f}_I)$ synthesizes the incumbent's actions. Given the latter, enterprise $E$ finds it convenient to enter the market whenever there exist policies $(\mathbf{p}_E, \mathbf{f}_E)$ such that

**a.** $(\mathbf{p}_E, \mathbf{f}_E) \neq (\mathbf{0}, \mathbf{0})$, that is $p_E^{s,i} > 0$ and $f_E^s > 0$ for at least some $i$ and $s$;

**b.** $\pi_E(\mathbf{p}, \mathbf{f}) > 0$, that is positive profits are generated[24].

Intuitively enough, for the shipping activity to be undertaken, the associated return has to be at least as large as the one promised by the best outside opportunity, which is here normalized to zero. Depending on the market conditions, the firm may well decide to be active only in one season/segment, in the event that it would bear losses by doing otherwise[25]. Choosing to stay temporarily out is part of the flexibility we mentioned above.

Conditionally on the favourable entry decision, shipper $E$ sets $\partial\pi_E/\partial p_E^{s,i} = 0$, $\forall s, i$, to select the (unique) price $p_E^{s,i}$ at which the profit function entails a maximum[26]. This char-

---

[23] In Cremer *et Alii* [8] the outcome is, instead, a Nash-Cournot equilibrium.

[24] In the text, we use the notation $(\mathbf{p}, \mathbf{f})$ to represent the full vector of prices and frequencies of both shippers.

[25] Notice that, once firm $E$ decides to operate in season $s$, it cannot refuse to serve one category of passengers and only accept the other. Nevertheless, a similar result can be achieved by properly adjusting the pricing policy, so that travellers belonging to the "unwanted" category only patronize the rival shipper.

[26] Both for prices and frequencies, uniqueness is ensured by the assumption of strict concavity of the profit functions. We as well suppose that the unique solution exists and is interior, so that choosing on the boundary of the feasible set of actions is suboptimal.

acterizes the reaction function $p_E^{s,i}\left(p_I^{s,i}\right)$ that provides the optimal choice of $p_E^{s,i}$ depending on the incumbent's price $p_I^{s,i}$. Then firm $E$'s markup

$$\frac{p_E^{s,i}-a}{p_E^{s,i}}=\frac{1}{\varepsilon_E^{(s,i)(s,i)}},\ \forall s,i, \tag{20a}$$

is inversely proportional to the (absolute value of the) elasticity of demand $X_E^{s,i}$ to price $p_E^{s,i}$, which is defined as $\varepsilon_E^{(s,i)(s,i)}\equiv\left(p_E^{s,i}/X_E^{s,i}\right)\left(-\partial X_E^{s,i}/\partial p_E^{s,i}\right)$. (20a) reveals that the shipper is more wary of the perverse impact of a high price on consumption when travellers react to a price increment by largely reducing their demand for the service. Provided that firm $E$ clings on the inverse elasticity rule, it is, in fact, a monopolist *vis-à-vis* the market share it serves.

The first-order condition with respect to $f_E^s$, namely $\partial\pi_E/\partial f_E^s=0$, $\forall s$, characterizes the reaction function $f_E^s\left(f_I^s\right)$ that makes the optimal choice of $f_E^s$ contingent on the incumbent's frequency $f_I^s$ and yields

$$\sum_i\left(p_E^{s,i}-a\right)\frac{\partial X_E^{s,i}}{\partial f_E^s}=\phi_E,\ \forall s. \tag{20b}$$

(20b) suggests that, at the firm's optimum, the variation induced by a frequency increase in the profit margins over all the marginal traffic units on both market segments must equal the cost of the last provided transfer.

Combining (20a) and (20b), we further obtain

$$\sum_i X_E^{s,i}p_E^{s,i}\frac{\eta_E^{(s,i)(s)}}{\varepsilon_E^{(s,i)(s,i)}}=f_E^s\phi_E,\ \forall s, \tag{21}$$

where $\eta_E^{(s,i)(s)}\equiv\left(f_E^s/X_E^{s,i}\right)\left(\partial X_E^{s,i}/\partial f_E^s\right)$, $\forall s,i$, measures the elasticity of demand $X_E^{s,i}$ to frequency $f_E^s$. The condition above is interesting in that it identifies the relationship between the price elasticity and the frequency elasticity of demand at the entrant's optimum. One should first notice that, while the price elasticity of demand from category $i$ refers to the price charged to the same category $i$, the frequency elasticity of demand from category $i$ refers to the frequency provided to *both* categories of passengers. This follows from the event that connections cannot differentiate per market segment, whereas so can prices. One should as well observe that the left-hand side of (21) is a weighed sum of the revenues shipper $E$ obtains from the tickets sold on the two market segments $\left(X_E^{s,i}p_E^{s,i}\right)$, the weights being the ratios between frequency and price elasticity for each segment $\left(\eta_E^{(s,i)(s)}/\varepsilon_E^{(s,i)(s,i)}\right)$. In turn, the right-hand side of (21) is given by the total cost of providing transfers by means of the available fleet in each season $\left(f_E^s\phi_E\right)$. Overall, (21) suggests that profits $\pi_E$ are maximized when such sums of revenues and costs are balanced.

It is noteworthy that things would somewhat differ, if quality did not matter. For a moment, imagine to be in such a scenario. Then, conditionally on the decision to offer a positive amount of transportation service, firm $E$ supplies the quantity that maximizes its profits, taking the incumbent's price as given. In the absence of the quality dimension, its reaction function to shipper $I'$s policy is just the competitive supply curve. Therefore, $p_E^{s,i}$ is set equal to $p_I^{s,i}$[27].

## 5.2 The Impact of the Incumbent's Actions on the Entrant's Decisions: Propensity to Access and Strategic Relationships

By now, it should be clear that firm $E'$s choices crucially depend upon firm $I'$s actions. To fully understand the entrant's decisional process and the way it relates to the incumbent's behaviour, we hereafter investigate the impact of the latter on shipper $E'$s propensity to access the industry. Furthermore, we analyse the strategic nature of the relationship which arises between rival policies at the operational stage.

First of all, it is important to establish how reactive firm $E'$s profits are to shipper $I'$s prices. For this purpose, we differentiate $\pi_E$ with respect to the rival price $p_I^{s,i}$, which yields

$$\frac{\partial \pi_E}{\partial p_I^{s,i}} = \left(p_E^{s,i} - a\right) \frac{\partial X_E^{s,i}}{\partial p_I^{s,i}}, \ \forall s, i. \tag{22}$$

Since $\partial X_E^{s,i} / \partial p_I^{s,i}$ is positive, so is $\partial \pi_E / \partial p_I^{s,i}$, provided that the margin $\left(p_E^{s,i} - a\right)$ is larger than zero in its turn[28]. Therefore, the entrant's profits are (strictly) increasing in the rival price. This suggests that, *ceteris paribus*, the higher the monetary charge proposed by firm $I$, the larger the room for profitable entry by operator $E$. Said it differently, increments (resp., reductions) in the incumbent's prices have a positive (resp., negative) impact on the entrant's propensity to access the industry.

It is next relevant to understand which strategic relationship exists between rival prices. The latter shows up through the sign of the following derivative

$$\frac{\partial p_E^{s,i}}{\partial p_I^{s,i}} = - \frac{\left(p_E^{s,i} - a\right) \dfrac{\partial^2 X_E^{s,i}}{\partial p_E^{s,i} \partial p_I^{s,i}} + \dfrac{\partial X_E^{s,i}}{\partial p_I^{s,i}}}{\left(p_E^{s,i} - a\right) \dfrac{\partial^2 X_E^{s,i}}{\partial \left(p_E^{s,i}\right)^2} + \dfrac{\partial X_E^{s,i}}{\partial p_E^{s,i}}}, \ \forall s, i^{29}. \tag{23}$$

If the demand $X_E^{s,i}$ is concave (or, at least, not too convex), then the denominator of (23) is negative and we have

$$sign \left(\frac{\partial p_E^{s,i}}{\partial p_I^{s,i}}\right) = sign \left[\left(p_E^{s,i} - a\right) \frac{\partial^2 X_E^{s,i}}{\partial p_E^{s,i} \partial p_I^{s,i}} + \frac{\partial X_E^{s,i}}{\partial p_I^{s,i}}\right], \ \forall s, i.$$

As services are substitutes, the sign of the second term in the right-hand side is positive. On the other hand, reasonably enough, the cross partial derivative of $X_E^{s,i}$ with respect to the rival price is not too negative ($\partial^2 X_E^{s,i} / \partial p_E^{s,i} \partial p_I^{s,i} < 0$ and $\left|\partial^2 X_E^{s,i} / \partial p_E^{s,i} \partial p_I^{s,i}\right|$ small); this means that, as the rival commodity gets more expensive, the decrement that is induced

---

[27] See Varian [26] for further details.

[28] Since firm $E$ can decide not to operate in unprofitable conditions, we take the margin to be, indeed, positive (recall the observation we made in footnote **??**).

[29] (23) is obtained by differentiating the identity $\partial \pi_E \left(p_E^{s,i}, p_I^{s,i}\right) / \partial p_E^{s,i} \equiv 0$, which implicitly defines the entrant's reaction curve $p_E^{s,i} \left(p_I^{s,i}\right)$, with respect to $p_I^{s,i}$ and then by solving for $\partial p_E^{s,i} / \partial p_I^{s,i}$.

in $X_E^{s,i}$ by an increase in $p_E^{s,i}$ becomes less important. Hence, we can conclude that firm $E'$s reaction curve is upward sloping, so that it is $\partial p_E^{s,i}/\partial p_I^{s,i} > 0$. This involves that prices are *strategic complements*: the higher (resp., lower) the monetary charge proposed by the incumbent, the higher (resp., lower) the price the entrant can set in its turn.

We now turn to the impact induced by a variation in the incumbent's frequency on firm $E'$s entry decision. Differentiating $\pi_E$ with respect to $f_I^s$ yields

$$\frac{\partial \pi_E}{\partial f_I^s} = \sum_i \left(p_E^{s,i} - a\right) \frac{\partial X_E^{s,i}}{\partial f_I^s}, \ \forall s. \tag{24}$$

The demand $X_E^{s,i}$ decreases in the amount of connections offered by the dominant firm. Therefore, with positive margins, one has $\partial \pi_E/\partial f_I^s < 0$ : all else equal, the entrant's profits are a decreasing function of the rival number of transfers. This involves that the more (resp., fewer) travels shipper $I$ operates, the less (resp., more) attractive entry is to the new operator.

Finally, we need to investigate the impact of the incumbent's scheduling on the entrant's marginal profits. This is characterized by the sign of the derivative

$$\frac{\partial f_E^s}{\partial f_I^s} = -\frac{\sum_i \left(p_E^{s,i} - a\right) \dfrac{\partial^2 X_E^{s,i}}{\partial f_E^s \partial f_I^s}}{\sum_i \left(p_E^{s,i} - a\right) \dfrac{\partial^2 X_E^{s,i}}{\partial \left(f_E^s\right)^2}}, \ \forall s\text{[30]}. \tag{25}$$

Taking the margins as non-negative and supposing that demand is concave in scheduling $\left(\partial^2 X_E^{s,i}/\partial \left(f_E^s\right)^2 < 0\right)$, the denominator in (25) is negative and one has

$$sign\left(\frac{\partial f_E^s}{\partial f_I^s}\right) = sign\left[\sum_i \left(p_E^{s,i} - a\right) \frac{\partial^2 X_E^{s,i}}{\partial f_E^s \partial f_I^s}\right], \ \forall s.$$

The previous equality reveals that the strategic relationship between rival frequencies ultimately depends on how firm $E'$s marginal demand reacts to increases in the number of transfers operated by the opponent. It is reasonable to expect the cross-partial derivative $X_E^{s,i}$ with respect to the rival frequency to be negative $\left(\partial^2 X_E^{s,i}/\partial f_E^s \partial f_I^s < 0\right)$, meaning that an improvement in the quality of the rival product reduces the growth that is caused in $X_E^{s,i}$ by adding own connections. It follows that $\partial f_E^s/\partial f_I^s$ is negative, that is qualities are *strategic substitutes*. *Ceteris paribus*, the more numerous (resp., fewer) the connections supplied by the dominant shipper, the fewer (resp., the more) the ones the opponent operates. Hence, when the incumbent offers many transfers to the population of passengers, to some extent, the entrant gets crowded out.

The following Proposition summarizes the results achieved in this Section.

**Proposition 2** *In the shipping industry, as long as aggregate demands satisfy some reasonable properties, firm $E'$s propensity to entry increases in firm $I'$s prices and decreases in firm $I'$s amount of transfers. Moreover, since rival prices are strategic complements*

---

[30] Similarly to (23), (25) is obtained by differentiating the identity $\partial \pi_E \left(f_E^s, f_I^s\right)/\partial f_E^s \equiv 0$, which implicitly defines the entrant's reaction curve $f_E^s\left(f_I^s\right)$, with respect to $f_I^s$ and then by solving for $\partial f_E^s/\partial f_I^s$.

*and rival frequencies strategic substitutes, the entrant's marginal profits augment in the incumbent's prices and reduce in the incumbent's amount of connections.*

## 5.3 The Optimal Price-and-Frequency Policy

Once the regulator is aware of the effects firm $I'$s actions induce on shipper $E'$s decisions (as synthesized in Proposition 2), she can properly design the partial regulatory regime. One should recall that this amounts to directly shaping the incumbent's market behaviour, whereas the entrant operates as an unregulated profit-maximizer.

In formal terms, the regulator characterizes the prices and frequencies $\left(\mathbf{p}_I^{PR}, \mathbf{f}_I^{PR}\right)$ which solve the utilitarian social programme

$$\begin{gathered} \underset{\left\{p_I^{s,i}, f_I^s\right\}_{\forall s,i}}{Max} \quad W\left(\mathbf{p}_I, \mathbf{f}_I, \mathbf{p}_E^{PR}\left(\mathbf{p}_I\right), \mathbf{f}_E^{PR}\left(\mathbf{f}_I\right); \boldsymbol{\tau}\right) \\ \text{subject to} \qquad (26) \\ \pi_I\left(\mathbf{p}_I, \mathbf{f}_I\right) \geq 0. \end{gathered}$$

In (26), $W(\cdot)$ is the unweighed sum of consumer surplus and firms' profits; moreover, $\mathbf{p}_E^{PR}\left(\mathbf{p}_I\right)$ and $\mathbf{f}_E^{PR}\left(\mathbf{f}_I\right)$ are the vectors of contingent choices the entrant performs, clinging on the optimal private rules (20a) and (20b). The superscript $PR$ stays for *partial regulation*. As under monopoly regulation, the dominant shipper's budget is secured.

The optimal prices and frequencies respectively satisfy the first-order conditions

$$\frac{d\pi_I}{dp_I^{s,i}} = \left(-\frac{\partial V^{s,i}}{\partial p_I^{s,i}} - \frac{\partial \pi_E}{\partial p_I^{s,i}}\right)\frac{1}{1+\lambda^{PR}}, \ \forall s,i \qquad (27a)$$

and

$$-\frac{d\pi_I}{df_I^s} = \left(\frac{\partial V^s}{\partial f_I^s} + \frac{\partial \pi_E}{\partial f_I^s}\right)\frac{1}{1+\lambda^{PR}}, \ \forall s, \qquad (27b)$$

where $\lambda^{PR}$ is the shadow cost associated to the break-even constraint when shipper $I$ is subject to partial regulation. As compared to (14a) and (14b), (27a) and (27b) display two major changes, which we hereafter illustrate.

Firstly, the left-hand sides contain the (absolute values of the) *total*, rather than the partial, derivatives of profits $\pi_I$ with respect to the price $p_I^{s,i}$ and to frequency $f_I^s$, namely

$$\frac{d\pi_I}{dp_I^{s,i}} = \frac{\partial \pi_I}{\partial p_I^{s,i}} + \frac{\partial \pi_I}{\partial p_E^{s,i}}\frac{\partial p_E^{s,i}}{\partial p_I^{s,i}}$$

and

$$-\frac{d\pi_I}{df_I^s} = -\left(\frac{\partial \pi_I}{\partial f_I^s} + \frac{\partial \pi_I}{\partial f_E^s}\frac{\partial f_E^s}{\partial f_I^s}\right)$$

respectively. This is due to the by now familiar event that, while choosing $\left(\mathbf{p}_I^{PR}, \mathbf{f}_I^{PR}\right)$, the impact to be caused by firm $I'$s actions on the rival policy is anticipated.

Secondly, the right-hand sides include the marginal effect of the incumbent's actions not only on consumer surplus $(-\partial V^{s,i}/\partial p_I^{s,i} = X_I^{s,i}$ and $\partial V^s/\partial f_I^s)$, but also on the rival profits ($-\partial\pi_E/\partial p_I^{s,i}$ and $\partial\pi_E/\partial f_I^s$), meaning that partial regulation forces the targeted firm to more comprehensive obligations than so does monopoly regulation. To make this point more evident, we manipulate (27a) and (27b) and get the equality

$$\frac{d\pi_I/df_I^s}{d\pi_I/dp_I^{s,i}} = \frac{\partial\left(V^s + \pi_E\right)/\partial f_I^s}{\partial\left(V^s + \pi_E\right)/\partial p_I^{s,i}},\ \forall s, i. \tag{28}$$

As under monopoly, the left-hand side of (28) is the rate at which the regulated prices and frequencies can be substituted away for the shipper's profits to remain unchanged (and null), except that now it embodies the indirect impact of the controlled variables through the entrant's. Instead, the right-hand side differs from the monopoly case: it expresses the substitution rate such that consumer surplus *together with* rival profits, that is the benefits of all economic agents but the regulated shipper, are kept constant[31].

The most striking consequence of also embodying the effect on rival profits is summarized in the following Proposition.

**Proposition 3** *Under partial regulation, the dominant shipper's prices and number of connections are determined so that the public sector does not inefficiently crowds out the unregulated operator, given the latter's technology.*

The essential message Proposition 3 conveys is that the incumbent's prices and frequencies are optimally chosen by the regulator so that passengers are encouraged to travel with the entrant to the extent that it is efficient to do so. Recall that shipper $E$'s unit cost of connections is larger than shipper $I$'s $(\phi_E > \phi_I)$ ; on the other hand, the unit cost firm $E$ bears in terms of traffic volume is smaller than the one of firm $I$ $(a < a + \gamma)$ . Due to this circumstance, allocating passengers suitably between shippers constitutes a delicate task; in particular, it requires more caution than it would in a duopoly where the quality dimension did not matter. Indeed, in that case, the entrant would produce a positive output, at equilibrium, only if the dominant firm beard an unambiguous cost disadvantage[32].

Remarkably, having shipper $E$ enter the industry makes it easier to cover the costs of the regulated operator. The way this occurs shows up as soon as one studies the case in which no budget concern arises. This is a limit scenario, but it helps intuition. Imposing $\lambda^{PR} = 0$, (27a) rewrites as

$$\left[p_I^{s,i} - (a + \gamma)\right]\left|\frac{dX_I^{s,i}}{dp_I^{s,i}}\right| = \left(p_E^{s,i} - a\right)\frac{\partial X_E^{s,i}}{\partial p_I^{s,i}},\ \forall s, i. \tag{29}$$

The margin $\left[p_I^{s,i} - (a + \gamma)\right]$ in the left-hand side of (29) measures the distortion associated to the (absolute value of the) variation induced by a unit increase in the regulated price in shipper $I$'s demand $\left(dX_I^{s,i}\right)$. The margin $\left(p_E^{s,i} - a\right)$ in the right-hand side is, instead, the distortion associated to the variation caused by the same price increase in firm $E$'s

---

[31] Recall that, as already pointed in a previous footnote, under our assumptions about the demand side of the shipping market, it is $\partial V^{s,i}/\partial p_I^{s,i} = \partial V^s/\partial p_I^{s,i}$, $\forall s, i$.

[32] See Estrin and de Meza [11], who prove this result for a mixed oligopoly in which competition occurs between State-owned and private firms.

demand $\left(\partial X_E^{s,i}\right)$. For the purpose of minimizing the two distortions, the regulator has to account for shipper $E'$s positive margin and concede a rent to the regulated firm as well. Therefore, under partial regulation, the unregulated entrant makes positive profits, even if the regulator is perfectly informed about all relevant conditions; moreover, in the absence of break-even preoccupations, also the regulated incumbent enjoys a rent.

Conditionally on entry and no budget concerns, there exists a scenario where no rent is given up: this realizes if services are completely unrelated, in which case firm $E'$s profits are insensitive to variations in the leader's price. Conversely, with substitutability, in this ideal world, both shippers obtain net benefits. Notice that, all else equal, as long as the cross-price effect $\partial X_E^{s,i}/\partial p_I^{s,i}$ is important, the negative effect of a price increment on firm $I'$s traffic volume is largely compensated by the positive impact on the entrant's demand. This reduces the need to significantly increase the regulated price; furthermore, since prices are strategic complements, this also prevents the rival price from growing excessively.

The more realistic case for $\lambda^{PR} > 0$ requires that, *ceteris paribus,* the incumbent's margins be larger; nevertheless, because the budget constraint is now saturated, no net rent is awarded to shipper $I$, but the task of cost recovering is facilitated.

We are finally able to state the following Proposition, which collects the main results of the present Section.

**Proposition 4** *Under partial regulation, the unregulated shipper operates to the extent that its activity is socially efficient and pockets a rent, even in a complete information environment. Also the regulated provider would obtain a rent, in the event that its budget constraint were slack. Since, in practice, this constraint binds, the regulated firm gets zero profits, but the presence of the rival in the industry facilitates cost recovering.*

### 5.4 Decentralization through a Global Price-and-Frequency Constraint

In this Section, we show how the quality-adjusted price cap proposed by De Fraja and Iozzi [9] should be modified for the policy $\left(\mathbf{p}_I^{PR}, \mathbf{f}_I^{PR}\right)$ to be decentralized to a profit-maximizing operator, which (eventually) competes as a market leader with an unregulated follower.

Formally speaking, in the scenario under scrutiny, firm $I$ is required to meet a constraint that is similar to the one in (17), so that its programme writes as

$$\underset{\left\{p_I^{s,i}, f_I^s\right\}_{\forall s,i}}{Max} \quad \pi_I\left(\mathbf{p}_I, \mathbf{f}_I\right)$$

$$\text{subject to} \tag{30}$$

$$\sum_{s,i} \beta_{DPR}^{s,i} p_I^{s,i} - \sum_s \alpha_{DPR}^s f_I^s \leq P_{DPR},$$

where the script $DPR$ means *decentralized partial regulation.* The interpretation is exactly the same as the one we illustrated for (17) and we do not repeat it here. The first-order conditions of (30) with respect to prices and frequencies are respectively given by

$$\frac{d\pi_I}{dp_I^{s,i}} = \lambda^{DPR}\beta_{DPR}^{s,i},\ \forall s, i \tag{31a}$$

and

$$-\frac{d\pi_I}{df_I^s} = \lambda^{DPR}\alpha_{DPR}^{s},\ \forall s, \tag{31b}$$

$\lambda^{DPR}$ being the Lagrange multiplier associated to the regulatory constraint in (30). If the regulator wants the previous conditions to hold for the appropriate value of $\lambda^{DPR}$, she needs to make sure that the equalities

$$\lambda^{DPR} = \frac{1}{1+\lambda^{PR}}, \tag{32a}$$

$$\beta_{DPR}^{s,i} = -\frac{\partial V^{s,i,PR}}{\partial p_I^{s,i}} - \frac{\partial \pi_E^{PR}}{\partial p_I^{s,i}},\ \forall s, i \tag{32b}$$

and

$$\alpha_{DPR}^{s} = \frac{\partial V^{s,PR}}{\partial f_I^s} + \frac{\partial \pi_E^{PR}}{\partial f_I^s},\ \forall s \tag{32c}$$

are simultaneously satisfied. Observe that the superscript $PR$ is used to mean that the functions are evaluated at the solution $\left(\mathbf{p}_I^{PR}, \mathbf{f}_I^{PR}\right)$.

Manipulating the derivatives of firm $E'$s profits with respect to $p_I^{s,i}$ and to $f_I^s$, (32b) and (32c) respectively become

$$\beta_{DPR}^{s,i} = \underbrace{-\frac{\partial V^{s,i,PR}}{\partial p_I^{s,i}}}_{X_I^{s,i,PR}} \underbrace{+X_E^{s,i,PR}\left(\frac{\partial X_E^{s,i,PR}/\partial p_I^{s,i}}{\partial X_E^{s,i,PR}/\partial p_E^{s,i}}\right)}_{<0},\ \forall s, i, \tag{33a}$$

and

$$\alpha_{DPR}^{s} = \frac{\partial V^{s,PR}}{\partial f_I^s} + \underbrace{\sum_i X_E^{s,i,PR}\left(\frac{\partial X_E^{s,i,PR}/\partial f_I^s}{-\partial X_E^{s,i,PR}/\partial p_E^{s,i}}\right)}_{<0},\ \forall s\text{[33]}. \tag{33b}$$

(33a) and (33b) are quite instructive. First of all, it is fundamental to remark the presence of a second term in the right-hand side of either formula, which does not show up under monopoly regulation. In (33a), the term at stake is given by the demand faced by shipper $E$, evaluated at the partial regulation solution, times the marginal rate of substitution between rival prices, which leaves such demand unchanged. In (33b), the additional term is given by a weighed sum of the demands faced by firm $E$ in the two market segments; the weights consist in the marginal rates of substitution between own prices and rival frequency, which preserve those demands unvaried. Therefore, (33a) and (33b) suggest that, despite partial regulation does not directly concern the entrant, the decentralization of the optimal policy to the incumbent should be based also on the traffic

---

[33] More precisely, the second term in (33a) and (33b) is obtained by using the first-order condition of shipper $E'$s profit-maximization programme with respect to price $p_E^{s,i}$, which yields $\left(p_E^{s,i} - a\right) = -X_E^{s,i}/\left(\partial X_E^{s,i}/\partial p_E^{s,i}\right)$.

served by shipper $E$ as well as on the sensitivity of the latter to own and rival relevant variables.

An important implication of the previous result is that the authority should be allowed to use the available knowledge (if any) and/or to extract information (otherwise) about *both* the regulated and the unregulated shipper. This might posit practical difficulties in contexts where regulatory bodies are restricted to solely use information about the targeted operators (if available). Nevertheless, in real-world situations, restrictions are more often imposed as to the usage of information concerning other markets, rather than competing operators in the same regulated market[34]. As long as this is the case, regulators face no additional difficulties than those arising from standard information eliciting.

Secondly, the negative signs reported in (33a) and (33b) imply that $\beta^{s,i}_{DPR} < X^{s,i,PR}_{I}$ and $\alpha^{s}_{DPR} < \partial V^{s,PR}/\partial f^{s}_{I}$, whereas the analogous relationships, namely (19b) and (19c), hold as equalities when decentralization is performed under monopoly. Since all relevant quantities are endogenous, explicit comparisons are to be cautiously made. Nevertheless, we can at least affirm that if, under partial regulation, the dominant firm faced the same demand and if its scheduling induced the same marginal impact on consumer surplus, as if this shipper were a monopolist, then decentralization would require smaller weights than under monopoly regulation. Indeed, if all other things were equal, the regulated leader would be compelled to higher prices and fewer connections than the regulated monopolist, as one can verify by paralleling (27a) to (14a) and (27b) to (14b).

## 6 Addressing Distributional Concerns: the Territorial Continuity Principle

In their work about optimal pricing in the postal sector, Billette de Villemeur *et Alii* [4] raise the observation that both the optimal solution and the decentralization scheme are likely to significantly change, if the social planner also points to distributional objectives. This issue, which remains unaddressed in their paper, acquires prominent importance as far as the maritime ferry industry is concerned. This is so because society believes that the drawbacks associated to the physical disconnection of the islands from the mainland should be limited and the penalized people compensated for those disadvantages by means of sufficiently favourable transport conditions. Such a value judgement is embodied in the *universal service principle* or, better, in its specification as *territorial continuity principle.*

In the same vein as Billette de Villemeur *et Alii* [4], we need to stress that the policies so far characterized may fail to guarantee that a reasonable level of territorial continuity be achieved. To see this, consider the low season: during this period, traffic is scarce and essentially composed by islanders. Given the limited size of the demand, it may prove suboptimal, on pure efficiency grounds, to require the shipper to provide as large a number of transfers as it would be satisfactory from different perspectives. On the other hand, as residential customers are highly captive and the regulated tariffs depend on the

---

[34] Yardstick competition mechanisms precisely hinge on the fact that information revealed by different agents is plaid against one another for the purposes of performance improvement and rent extraction.

price elasticity of demand[35], efficiency criteria can make transportation services hardly affordable precisely to those who most need to travel.

For regulatory policies supporting a specific interest group (namely, the islanders) to be drawn, it is necessary to amend the social planner's programme, so that a weight larger than unity is attributed to the islanders in the welfare function[36]. In this pro-residents world, the optimal (constrained) policies under monopoly regulation and duopoly partial regulation are then characterized by proceeding exactly as in the previous Sections.

The duties the regulated provider bears when distribution is an issue are *territorial continuity* (or *public service*) *obligations*. Not so are, instead, the regulatory requirements imposed for pure efficiency purposes. A similar point is made by Cremer *et Alii* [6] for the provision of postal services; these Authors stress that universal service constraints (the analogous of the territorial continuity obligations in the postal sector) cannot be justified on efficiency grounds. Indeed, in so far as those requirements favour the customers who induce relatively higher provision costs, as it is the case by their same nature, they cannot be supported in the absence of redistributive preoccupations toward these individuals.

Observe that in Cremer *et Alii* [6], the equity concerns are addressed by assigning different weights in the welfare function to different economic agents. This is what we suggested above. These Authors show that, by proceeding like this, the outcome is the most efficient equilibrium which is feasible under the budget constraint.

Yet attributing a weight to one of the utility components in the objective of the decision-maker sounds quite abstract and, in practice, it might prove hard to do so. An alternative option, often adopted in reality, is as follows. The social planner keeps on pursuing *utilitarian* welfare, that is her objective remains the same as in (13) and (26) for monopoly and duopoly respectively. However, hinging on the inner sphere of social judgments, she calibrates prices $P^{s,r}$, $\forall s$, and frequency $F^l$ according to the collective pro-islander bias[37]. For this policy to be more favourable to the islanders, as compared to $\left(\mathbf{p}_I^{RM}, \mathbf{f}_I^{RM}\right)$ and $\left(\mathbf{p}_I^{PR}, \mathbf{f}_I^{PR}\right)$ under monopoly and duopoly respectively, one should have $F^l > f_I^{l,RM}$ and $F^l > f_I^{l,PR}$, together with $P^{s,r} < p_I^{s,r,RM}$ and $P^{s,r} < p_I^{s,r,PR}$; this is assumed to be the case.

Notice that the formulation we have adopted accommodates for the possibility that different tariffs be set in different seasons, though this does not need to happen. The decision actually depends on how concerned society is with islanders' welfare. Indeed, a uniform price $P^r$ is rather imposed, if society also cares about smoothing the residents' pattern of expenses in shipping consumption all over the year. Conditionally on the chosen values, the other relevant variables can then be optimally characterized.

In formal terms, once the regulator commits to the initial decisions in favour of the

---

[35] The most immediate way to realize this is to recall the Ramsey-Boiteux formula in (16a).

[36] As Martimort [21] stresses, this formulation is the one used by Shapiro and Willig (1990) to model a biased political principal. Following these Authors, in turn, Martimort [21] multiplies the rent of the regulated supplier by a parameter $\beta > 1$ in the objective function of a regulator who is captured by the industry. The situation here considered, that of a decision-maker who devotes prior consideration to (a specific category of) customers, coincides with the case for $\beta < 1$ (regulator biased against the firm).

[37] We focus on the sole low-season frequency because, during the high season, the traffic is large enough to generate interesting business opportunities, so that public service obligations, beyond "standard" regulation, are probably unnecessary.

islanders, such decisions enter the social problem as additional constraints. Therefore, it is a matter of solving the programme

$$
\begin{gathered}
\underset{\left\{p_I^{s,i},f_I^s\right\}_{\forall s,i}}{Max} \quad W \\
\text{subject to} \qquad (34) \\
f_I^l = F^l \text{ and } p_I^{s,r} = P^{s,r},\ \forall s \\
\pi_I \geq 0.
\end{gathered}
$$

Observe that, since (34) incorporates the same objective function as (13) and (26) but a wider set of constraints, the programme under-performs, as compared to (13) and (26). That is, the very structure of this programme involves that some efficiency be forgone for equity to be pursued, a pitfall which would be avoided if a weighed social welfare function were maximized[38]. The relevant variables, other than the committed ones, are determined according to (14a) and (14b), if a monopoly is regulated, and to (27a) and (27b), if a duopoly is partially regulated. Importantly, despite those *rules* are still valid, the solution they yield does change.

An appraisal is owed at this stage. In some European Member States, the price-cap methodology, even in the pure version without quality adjustments, is not yet applied to the shipping activities. For instance, according to the Italian Law 343/95, the tariffs of the services provided by the maritime companies that receive subsidies from the State are to be disciplined after the Law 856/86[39]. As a result, the services previously said are administratively deliberated by the Ministry of Economics and Finance, as supported by the NARS (Nucleo consulenza Attuazione linee guida Regolazione Servizi di pubblica utilità), together with the Ministry of Infrastructure and Transports. This circumstance has been generally perceived as a weakness of the wide regulatory reorganization process, which has concerned several other utilities during the last decade. The approach described above suggests that it might rather represent a feasible means to express a social preference, which would be hardly reflected otherwise. Nevertheless, it is difficult to rationalize why more rigorous procedures are neither adopted for the selection of the remaining relevant variables, except if one may responsibly claim that social preoccupations, other than efficiency, drive all such choices as well.

The preference society expresses amounts to having the available market served, however thin it happens to be. For this universal service purpose, the regulated shipper is explicitly required to ensure the provision of a given number of connections even in the low season $\left(F^l\right)$, when traffic is essentially composed by residents and operation is hardly convenient[40]; it is as well obliged to charge the islanders with a price $\left(P^{s,r}\right)$ society judges

---

[38] Technically speaking, instead of determining all the incumbent's tariffs and frequencies through a global optimization procedure, the regulator follows a multi-stage process, through which first the distributional concerns and then the efficiency issues are addressed. With a global procedure, all choice variables would be simultaneously pinned down after a tatonnement process were completed. Hence, the performance would be as good as feasible, *given the objective.*

[39] The tariffs of the services of general interest, other than the ferry services, are generally subject to the rules established in Art. 10, Law 537/93, hence the price-cap methodology applies.

[40] The Convention signed for Corsica in 1976 by the French State with the maritime company SNCM

to be sufficiently affordable, independently of the fact that this renders the activity not self-financing.

Notice that securing frequency generates benefits also for the non-residents if, by any chance, they travel during the concerned season; however, this occurs to a limited extent. Conversely, whatever the season, price bounds can be targeted solely to the residents. Altogether these circumstances involve that the burden associated to further scheduling is essentially borne by a restricted segment of the overall population of travellers. Let us try to understand how the story goes, in order to identify the concerned segment and the resulting implications from the firms' standpoint.

For the regulated firm's budget to be met, it is necessary to adjust the non-resident prices, that is cross-subsidization is called upon. Though this is the case under either industry structure, the (potential) presence of a second operator creates a difference between the two market scenarios, which should not be neglected.

In monopoly, there is no way the non-residents can avoid to fund the favourable conditions awarded to the residents because no outside option is available to them[41].

In duopoly, to some extent, the unregulated shipper can attract non-residents by (slightly) undercutting the incumbent during the high season. Interestingly, this provides a reason why the presence of a competitor, which is not compelled to social duties, can benefit some of those passengers: it offers them the possibility of partially escaping the subsidy they implicitly owe to the islanders. On the opposite, the entrant is provided no incentive to supply a positive amount of service during the low season, that is entry is unlikely to occur during this period.

The conclusion drawn above as to cross-subsidization requires further qualification, as far as a duopolistic sector is at stake. At this aim, we hereafter rely on the result we summarized in Proposition 1, namely that, whenever two shippers are active on the market, people exhibiting low time value behave as type-1 passengers and patronize the cheaper operator. On the other hand, people whose time value is relatively larger act as type 2 and take the first available ship.

As soon as partial regulation reflects the territorial continuity principle, the result previously recalled involves that the residents behave as type-1 passengers and patronize the regulated shipper, provided that the conditions secured in their interests are sufficiently favourable[42]. On the other side, as long as the wedge between rival prices is not too large, though type-1 non-residents tend to patronize the entrant, type-2 non-residents still randomize over the two shippers. Therefore, during the high season, either supplier serves a portion of such travellers, depending on the relative number of provided connections. As a matter of fact, diffuse evidence is found of such situations materializing in real-world shipping sectors: the non-residents manifest a certain tendency to allocate to the entrant, whereas the islanders generally patronize the regulated operator all over the year.

---

compels the shipper to ensure seven daily ferry tours (plus the mixed cargo ones) during the winter. The number of such tours the firm offers during the summer is, instead, much larger; it amounts to about 50.

[41] A natural outside option might be given by an alternative transportation mode. Nevertheless, in the present work, we restrain our attention to the ferry services and neglect the availability of other means.

[42] It is important to keep in mind that passengers' type allotment *endogenously* follows from the relationships between rival prices and frequencies. As previously said, the incumbent's offer is such that shipper $E$ is crowded out during the low season and travellers are actually faced with a monopolist.

Overall, a few interesting conclusions can be derived, which we hereafter catalog.

1. In duopoly, the travellers who mainly bear the burden associated to the distributional concerns of society are not the non-residents as a whole, rather those such travellers who display particularly high disutility from waiting. This form of subsidization occurs *across market segments and seasons.*

2. Under the policy at stake, high-$\tau$ non-residents are required to provide implicit subsidy to the benefit of the residents even when the latter have equally high time value.

3. The presence of an unregulated shipper proves to be especially beneficial for type-1 non-residents, the ones who exhibit a limited degree of impatience; interestingly enough, this is the same as in the first-best environment we previously investigated, where pure efficiency were pursued.

4. In the high season, the residents can be asked to implicitly subsidize their same consumption in the low season, to the extent that the revenues collected on the islander segment during the high season contributes to cover the cost of the regulated service provision during the low season. In this perspective, subsidization occurs also *within market segment across seasons.* In duopoly, the subsidy involved is increasingly important, the more (type-1) non-residents patronize firm $E$, as this hardens the regulated operator's budget constraint[43].

5. In duopoly, the savings that become available to the low-$\tau$ non-residents, by travelling with the unregulated shipper, are seriously restrained by the strategic relationships existing between rival policies. The softer the competition the follower faces on the nonresidential market during the high season, the more significant the rent it enjoys.

Conclusion 5. deserves a few more words. As previously explained, given the social preferences, the partial regulator determines the incumbent's prices and frequencies so that the room she leaves to shipper $E$ is just the one the operator's technological efficiency dictates. Therefore, conditionally on the need to discipline access and to ensure that the incumbent's activity is as socially desirable as possible under budget balance, the obtained solution is optimal, hence so is the associated rent. Yet, in a world where distributional concerns matter, giving up a net benefit to (part of) the industry is likely to raise a new delicate issue. In the following Section, we sketch a tentative discussion concerning the extraction of this rent.

---

[43] The within-category effect can be expected to be sensitive to whether a uniform yearly price, which averages across low and high season, or different seasonal tariffs are charged.

## 6.1 The Unregulated Shipper's Rent: An Open Issue

If it were possible to transfer resources from industry to customers[44], rather than across customers, then the pro-residents bias would *per se* work as a rent-extraction device. For this to occur, it would be necessary to ensure that rendering public service obligations more severe would cause a reduction in the profitability of the entrant's activity, other things being the same. However, except if subsidies can be attributed for uncovered costs, there is a limit to how heavy the incumbent's duties can be made. And even in the event that subventions are admitted, distorting taxation is then called for.

In the end, it is a matter of confronting the two following alternatives:

1. Allowing for passenger cross-subsidization and giving up a rent to the entrant.
2. Tightening the regulatory requirements to the (direct and/or indirect) benefit of *both* categories of customers, but increasing taxpayers' burden, and extracting the entrant's rent.

When option 1. prevails, one may still consider to pursue the rent-extraction objective by imposing a tax and envisage that collected resources be subsequently used to compensate the non-residents who provide an implicit subsidy to the islanders. Nevertheless, taxation represents a questionable remedy, as long as the maritime transport industry is concerned.

The choice of the appropriate tax would not be straightforward. For instance, it is not clear that it would pay to levy a tax on the level of sales[45]. To make sure that it would, one should be able to unambiguously assess the *economic* incidence of the tax. For imperfectly competitive sectors, this is generally a tricky task[46]. A preferable alternative would probably consist in a tax on economic profits. A proportional tax on the latter would change neither marginal cost nor marginal revenue. The targeted shipper would have no incentive to change its decisions about service provision and the prices paid by the passengers would not vary. To see this, suppose that the Government sets a tax rate $t_\pi$ on economic profits. Then, shipper $E'$s objectives consists in maximizing its after-tax profits $(1 - t_\pi)\,\pi_E$. Clearly, whatever strategy maximizes before-tax profits $\pi_E$ also maximizes after-tax profits $(1 - t_\pi)\,\pi_E$. It follows that the operator bears the whole tax burden and customers are not made worse off[47].

Albeit a tax on profits would not distort choices at the margin, it should still be regarded with caution. Indeed, nowadays, the European fiscal climate is highly unattractive

---

[44] As far as transfers from the industry to passengers are concerned, resources could solely be taken away from the shipper which enjoys a net benefit, namely the entrant. Conversely, transfers from the regulated operator remain unfeasible, as long as the latter makes no profits.

[45] One may think about a tax which conditions the liability on the traffic volume to be sufficiently large. This might amount to imposing a tax solely on the activity performed during the high season.

[46] The theory of tax incidence in oligopoly is poorly developed. A remarkable result is the one achieved by Delipalla and Keen [10], who show that, when the sales of an imperfectly competitive industry are subject to a tax, firms contract their outputs, but this is not necessarily detrimental to them. Of course, for any given level of before-tax profits, the providers are worse off, because they have to pay the tax; but as outputs are contracted, firms move closer to the cartel solution, hence their before-tax profits increase. Depending on how much outputs are cut back, it is theoretically possible for before-tax profits to increase by so much that suppliers are overall better off.

[47] See Rosen [24] for a discussion on the matter.

for ship-owners; this concern is seriously perceived at the European level, as it is evident from the following statement of the Commission communication C(2004) 43 drawing the Community guidelines on State aid to maritime transport [12]: "Many third countries have developed significant shipping registers, attracting ship-owners through a fiscal climate which is considerably milder than within Member States. (...) the cost savings available to ship-owners through third country registers are considerable. (...) many Member States have taken special measures to improve the fiscal climate for ship-owing companies". Therefore, adding further fiscal burden might prove in contradiction with the increasing adoption of support measures for maritime transport in Member States, especially as far as newly entered operators are concerned[48].

After all, one should not be persuaded that the investigation about the appropriate regulation of the maritime ferry industry be exhausted once the (constrained) optimal pricing and scheduling are characterized and decentralizing devices are found. Distributional considerations raise several surrounding issues, some of which remain open to debate. It is beyond the scope of the present work to convincingly develop all of those, however interesting they are. For the time being, we content ourselves with acknowledging the relevance of the ones we do not go through, as a first step toward the more comprehensive treatment they deserve.

# 7 Conclusions

How should maritime ferry industries be regulated? So far, this question has received no economically founded reply. Yet it raises an issue of fundamental importance, in so far as maritime transportation between islands and mainland is a service of general interest. As a matter of fact, it critically contributes to secure the national cohesion and integrity of countries which have islands and to promote the constitutionally recognized individual right to mobility (intended in a broad sense).

The question previously asked has been addressed in the present paper. We have argued that the appropriate design of regulatory policies crucially depends on whether society points to pure efficiency and/or to distributional objectives. Indeed, the efficient policy does not need to coincide with the one which guarantees effective territorial continuity and tutelage of the residents, the customers who are more seriously penalized by the drawbacks of insularity. Pursuing equity aims generally requires imposing PSOs other than the regulatory duties efficiency calls for.

For the purpose of stylizing the peculiar features of the shipping sector, we have adopted a number of specific modelling devices. First of all, we have classified passengers into residents and non-residents, to whom different prices can be offered. Secondly, we have accounted for the significant traffic seasonality by identifying a high and a low

---

[48] One such support measure is the flat rate tonnage taxation system ("tonnage tax"). According to the Commission communication C(2004) 43 [12], the tonnage tax entered into force first in Greece and was subsequently extended to several other States. Moreover, in the same communication, it is stated: "The Commission recognizes that launching short-sea shipping services may be accompanied by substantial financial difficulties which the Member States may wish to attenuate in order to ensure the promotion of such services". Short-sea shipping actually includes maritime ferry services such as the cabotage with the islands.

season and allowing for a different amount of connections to be operated in each of those. Under the previous circumstances, the prices charged on the two market segments are tied to finance the common cost of the provided transfers representing the quality dimension of the service. Thirdly, we have restricted attention to the industry structures that are relevant in the European panorama, namely a monopoly and a duopoly, where the regulator imposes obligations which would not be assumed for pure commercial interests, as the EU Regulation 3577/92 [16] prescribes. Finally, in either regime, we have required that the regulated shipper's budget constraint be met in order to capture the European Commission's willingness to break too long a tradition of soft budgets and abusively diluted subsidies.

Within the framework recalled above, we have drawn and discussed a set of interesting results, some of which leading to new debatable subjects. To begin with, we have established that the optimal rule which governs the choice of each relevant variable (be it price or frequency) does not depend on the fact that other variables are simultaneously chosen. Moreover, because such variables relate to demand elasticities, they are contingent on the distribution of the individual characteristics, such as taste for the service and value of waiting time. Our findings reveal that this is so both when pure efficiency concerns are addressed and when the residents are assumed to over-contribute to social welfare. On the opposite, in the (ideal) first-best environment, prices exclusively reflect technological conditions. In turn, the pricing and scheduling PSOs, that are exogenously fixed to favour the islanders, solely embody the social value judgments.

We have as well concluded that, in situations in which entry matters, the (potential) presence of an unregulated shipper brings about advantages and create difficulties at once.

The rule which dictates how the regulated prices and frequencies should be optimally substituted, at the margin, becomes more complex when a second provider is active. Indeed, under duopoly, the regulated firm's viability needs be traded off against more composite interests, those of customers *and* rival operator, than under monopoly, where passengers are the only economic agents other than the shipper. Interestingly enough, the public sector has to make sure that the follower be not inefficiently crowded out, given the technology it uses. At the decentralization stage, this involves that the authority be able to use/elicit information about *both* the regulated and the unregulated shipper. By allocating a portion of the traffic to the entrant, the planner can be relatively less requiring *vis-à-vis* the regulated shipper, which indirectly facilitates cost recovering for the latter.

At later stage, we have shed some light on the implications which follow, when the regulator puts forward the territorial continuity principle and addresses equity preoccupations by imposing PSOs on the incumbent. First of all, as these duties are particularly severe during the low season, when the traffic is essentially represented by islanders, the entrant's incentives to operate during this period are dumped. On the opposite, during the high season, budget requirements prevent the leader from vigorously competing on the nonresidential segment. Then soft competition shields activity profitability, so that the entrant is induced to provide its service by (slightly) undercutting the regulated leader.

As to the social aspects, our model predicts that a pro-residents planner needs to heavily rely on cross-subsidization and transfer the burden of the collective bias onto the nonresidential part of the population. More precisely, under duopoly, the burden is passed onto those non-residents who exhibit high value of time, hence large disutility from waiting. Importantly, this suggests that liberalization does not equally affect all customers; direct beneficiaries appear to be the non-residents displaying relatively low penalty from waiting. The latter can (partially) escape the implicit subsidy owed to the islanders because they are sufficiently patient to wait for the transfers operated by the unregulated firm and exclusively patronize this provider. Of course, no such outside option exists as long as the service is monopolistically supplied. Yet one should be cautious about the savings that become available in duopoly; the latter are limited by the strategic complementarity between rival prices and, as a result, the entrant pockets a net rent. In a world where distribution matters, this last circumstance can be expected to raise new issues.

We would like to conclude with a few more points, which suggest directions of further research. Firstly, the whole analysis has been performed and the conclusions drawn under the (implicit) assumption that shippers charge linear prices. Nevertheless, in real-world ferry industries, frequent customers are usually offered the possibility of benefiting from quantity discounts, so that the unit price decreases as the number of purchased tickets gets larger. Formally speaking, this circumstance might be represented by allowing operators to propose two-part tariffs. Intuitively, the adoption of more sophisticated pricing instruments might induce a different allotment of passengers between providers. In particular, it would be interesting to explore whether and under which circumstances two-part tariffs might replace the pricing PSOs we have characterized.

Secondly, we have allowed for a single potential entrant. Yet we are not able to assess whether and to what extent this restriction affects the predictions of our model. In fact, this is a limit our analysis shares with several other works about access and competition in (partially) liberalized sectors. In their model about entry in postal markets, Cremer *et Alii* [7] have a similar word of caution on the matter.

Thirdly and lastly, we have characterized all regulatory policies in conditions of complete information. We acknowledge that this approach might not be fully convincing because, as it is documented, in transport industries informational asymmetries significantly beset the relationships between firms and authorities. Yet we would like to make an appraisal. For some scenarios, we have put forward a decentralization mechanism which has been shown to be little informationally demanding and, as such, implementable in practice (namely, the global price-and-frequency constraint *à la* De Fraja and Iozzi [9] in monopolistic sectors). More generally, we are persuaded that it was worth initiating the investigation of the regulatory framework in a frictionless scenario, to be perceived as a preliminary contribution to subsequent, more definitive, predictions.

# References

[1] Bergantino, A. S. (2003), "Aspetti e problemi dell'attuale sistema di regolamentazione dei servizi di trasporto marittimo in Italia", *Atti del Convegno Annuale SIET*, Palermo, 13-14 November 2003

[2] Biglaiser, G., and C. A. Ma (1995), "Regulating a dominant firm: unknown demand and industry structure", *RAND Journal of Economics*, 26 (1): 1-19

[3] Billette de Villemeur, E. (2004), "Regulation in the Air: Price-and-Frequency Caps", *Transportation Research Part E*, 40: 465-476

[4] Billette de Villemeur, E., H. Cremer, B. Roy and J. Toledano (2003), "Optimal Pricing and Price-Cap Regulation in the Postal Sector", *Journal of Regulatory Economics*, 24 (1): 49-62

[5] Bulow, J., J. Geanakoplos and P. Klemperer (1985), "Multimarket Oligopoly: Strategic Substitutes and Complements", *Journal of Political Economy*, 93, 488-511

[6] Cremer, H., M. De Rycke and A. Grimaud (1997), "Service Quality, Competition, and Regulatory Policies in the Postal Sector", *Kluwer Academic Publishers*

[7] Cremer, H., J.-P. Florens, A. Grimaud, S. Marcy, B. Roy and J. Toledano (2001), "Entry and Competition in the Postal Market: Foundations for the Construction of Entry Scenarios", *Journal of Regulatory Economics*, 19(2), 107-121

[8] Cremer, H., M. Marchand and J. F. Thisse (1989), "The Public Firm as an Instrument for Regulating an Oligopolistic Market", *Oxford Economic Papers*, 41: 283-301

[9] De Fraja, G., and A. Iozzi (2004), "Bigger and Better: A Dynamic Regulatory Mechanism for Optimum Quality", *CEPR*, *Discussion Paper* No. 4502, available online at: www.cepr.org/pubs/dps/DP4502.asp

[10] Delipalla, S., and M. Keen (1992), "The comparison between ad valorem and specific taxation under imperfect competition", *Journal of Public Economics*, 49, 351-367

[11] Estrin, S., and D. de Meza (1995), "Unnatural Oligopoly", *Journal of Public Economics*, 57: 471-488

[12] European Commission (2004), *Updated Guidelines on State Aid to the Maritime Sector*, C(2004) 43, Bruxelles

[13] European Commission (2003), *Communication on the Interpretation of the Cabotage Regulation*, IP/03/1483, Bruxelles

[14] European Commission (2002), *Fourth report on the implementation of Regulation 3577/92*, COM(2002) 203 def, Bruxelles

[15] European Commission (1997), *Guidelines on State Aid to the Maritime Sector*, OJ C 205/97, Bruxelles

[16] European Council (1992), *Cabotage Regulation 3577/92*, OJ L 364, 12.12.1992, Bruxelles

[17] Finsinger, G., and I. Vogelsang (1979), "Regulatory Adjustment Process for Optimal Pricing by Multiproduct Firms", *Bell Journal of Economics*, 10, 157-171

[18] Helm, D., and T. Jenkinson (1998), Ed., *Competition in Regulated Industries*, Oxford University Press, Oxford

[19] Laffont, J.-J. (1990), *Fundamentals of Public Economics*, The MIT Press, Cambridge

[20] Laffont, J.-J., and J. Tirole (1993), *A Theory of Incentives in Procurement and Regulation*, The MIT Press, Cambridge

[21] Martimort, D. (2005), "An Agency Perspective on the Costs and Benefits of Privatization", *Journal of Regulatory Economics*, forthcoming

[22] Mohring, H., J. Schroeter and P. Wiboonchutikula (1987), "The Walues of Waiting Time, Travel Time, and a Seat on a Bus", *The RAND Journal of Economics*, 18(1), 40-56

[23] Oum, T. H., J. S. Dogson, D. A. Hensher, S. A. Morrison, C. A. Nash, K. A. Small and W. G. Waters II (1997), Ed., *Transport Economics, Selected Readings*, Harwood Academic Publishers

[24] Rosen, H. S. (2005), *Public Finance*, McGraw-Hill International Edition, New York

[25] Tirole, J. (1988), *The Theory of Industrial Organization*, The MIT Press, Cambridge

[26] Varian, H. R. (1992), *Microeconomic Analysis*, Norton, London

[27] Wilson, R. B. (1992), *Nonlinear Pricing*, Oxford University Press

# APPENDIX

## A The Passengers' Endogenous Allotment

We start from the comparison between the $(j,k)-$option and the $j-$option. The $\tau-$passenger is better off by behaving as type 2, rather than patronizing firm $j$, whenever a relatively lower generalised cost is involved. The condition for this to be the case writes as

$$p^{s,e}+\frac{\tau}{2f^s}<p_j^s+\frac{\tau}{2f_j^s}\quad\Leftrightarrow\quad\tau>2f_j^s\left(p_k^s-p_j^s\right). \tag{35a}$$

In the event that $p_k^s>p_j^s$, we can define $\tau_{mg}^{s,2,j}\equiv 2f_j^s\left(p_k^s-p_j^s\right)$ the time value of the marginal customer[49]: people exhibiting larger $\tau$ behave as type 2, whereas those with smaller $\tau$ are better off by choosing firm $j$. In the opposite circumstance, that is with $p_k^s<p_j^s$, there does not exist $\tau_{mg}^{s,2,j}>0$; hence, all passengers prefer to act as type 2, rather than patronizing firm $j$.

Let us next compare the $(j,k)-$option with the $k-$option. The condition for the $\tau-$consumer to be type-2, instead of choosing firm $k$, is given by

$$p^{s,e}+\frac{\tau}{2f^s}<p_k^s+\frac{\tau}{2f_k^s}\quad\Leftrightarrow\quad\tau>2f_k^s\left(p_j^s-p_k^s\right). \tag{35b}$$

With $p_j^s>p_k^s$, we can identify the cutoff time value $\tau_{mg}^{s,2,k}\equiv 2f_k^s\left(p_j^s-p_k^s\right)$, such that people with higher $\tau$ act as type 2, those with lower $\tau$ prefer travelling with firm $k$ to being type 1. Conversely, with $p_j^s<p_k^s$, everybody is better off by using a unique aggregate service, rather than choosing always enterprise $k$. Remarkably, it is impossible that $\tau_{mg}^{s,2,j}$ and $\tau_{mg}^{s,2,k}$ simultaneously exist: whenever passengers split between patronizing firm $j$, say, and being type 2, nobody prefers firm $k$ to acting as type 2. In the extreme event that $p_j^s=p_k^s$, we have $\tau_{mg}^{s,2,k}=\tau_{mg}^{s,2,j}=0$, that is both cutoff values collapse onto the bottom of the support. In this scenario, those customers who suffer no disutility from waiting are indifferent between type-1 and type-2 behaviour, whereas all the others are better off by acting as type 2.

The previous results allow to refine one of the conclusions deduced from the investigation about type-2 passengers, namely that people whose time value is smaller than the cutoff value should, in principle, reduce their demand for transportation services, as they become more likely to use the more expensive connection. In the light of (35a) and (35b), we can rule out such a scenario, because the low-$\tau$ passengers at stake do not behave as type 2.

We finally compare the preference for firm $j$ to that for firm $k$. The $\tau-$consumer is better off with the former if the associated generalised cost is relatively smaller, that is if

$$p_j^s+\frac{\tau}{2f_j^s}<p_k^s+\frac{\tau}{2f_k^s}.$$

---

[49] This and all the other cutoff types we identify are indifferent between the two options they separate.

Supposing, without loss of generality, that $f_j^s > f_k^s$, from the previous inequality we easily obtain

$$\tau > 2 f_j^s f_k^s \left( \frac{p_j^s - p_k^s}{f_j^s - f_k^s} \right). \tag{37}$$

In the event that $p_j^s > p_k^s$, the time value which identifies the cutoff point over the support is given by $\tau_{mg}^{s,1} \equiv 2 f_j^s f_k^s \left( p_j^s - p_k^s \right) / \left( f_j^s - f_k^s \right)$. Therefore, all customers with $\tau > \tau_{mg}^{s,1}$ prefer enterprise $j$ to $k$; conversely, people with $\tau < \tau_{mg}^{s,1}$ are better off with firm $k$. Notice that, under the previous assumption about frequencies, the condition on prices that is required for the existence of $\tau_{mg}^{s,1}$ is the one under which $\tau_{mg}^{s,2,j}$ does not exist, whereas $\tau_{mg}^{s,2,k}$ does exist.

We are now equipped with all the information we need to identify the preference ordering structure; in what follows, we address this issue by describing passengers' behaviour in each possible scenario, namely $f_j^s > f_k^s$ together with $p_j^s > p_k^s$ (Scenario 1) and $f_j^s > f_k^s$ together with $p_j^s < p_k^s$ (Scenario 2). Observe that we do not need to investigate also the case for $f_j^s < f_k^s$ : this would provide no additional lesson, as results hold symmetrically.

## A.1 Scenario 1: $f_j^s > f_k^s$ and $p_j^s > p_k^s$

Whenever the operator charging higher price also provides larger frequency, the following outcomes are realized:

- $\exists \tau_{mg}^{s,1} > 0$ : Passengers with $\tau > \tau_{mg}^{s,1}$ prefer firm $j$ to firm $k$; those with $\tau < \tau_{mg}^{s,1}$ prefer firm $k$ to firm $j$.
- $\nexists \tau_{mg}^{s,2,j} > 0$ : Whatever the time value, passengers prefer behaving as type 2 rather than patronizing operator $j$.
- $\exists \tau_{mg}^{s,2,k} > 0$ : Passengers with $\tau > \tau_{mg}^{s,2,k}$ prefer acting as type 2 to choosing enterprise $k$; those with $\tau < \tau_{mg}^{s,2,k}$, instead, prefer the $k-$option.

In order to relate the first point to the final one, we compare $\tau_{mg}^{s,1}$ to $\tau_{mg}^{s,2,k}$ and check whether any relation can be established between the two cutoff values. Indeed, it turns out that $\tau_{mg}^{s,2,k} < \tau_{mg}^{s,1}$. As a result, passengers' behaviour classifies as follows:

- Firm $k$ is patronized by travellers whose $\tau \in \left[0, \tau_{mg}^{s,2,k}\right)$.
- The $(j,k)$ $-$option prevails for travellers whose $\tau \in \left(\tau_{mg}^{s,2,k}, +\infty\right)$.

As it is evident, $\tau_{mg}^{s,1}$ is irrelevant because travellers whose $\tau \in \left(\tau_{mg}^{s,2,k}, \tau_{mg}^{1}\right)$ prefer $(j,k)$ to $k$ and $k$ to $j$.

## A.2 Scenario 2: $f_j^s > f_k^s$ and $p_j^s < p_k^s$

We now consider the case where the operator (here, firm $j$) which offers the cheaper service also provides better quality. We have:

- $\nexists \tau_{mg}^{s,1} > 0$ : Whatever the time value, passengers prefer patronizing operator $j$ rather than operator $k$.
- $\exists \tau_{mg}^{s,2,j} > 0$ : Passengers with $\tau > \tau_{mg}^{s,2,j}$ are better off if they act as type 2 rather than waiting for firm $j'$s transfers; the converse is true for those with $\tau < \tau_{mg}^{s,2,j}$.
- $\nexists \tau_{mg}^{s,2,k} > 0$ : Whatever the time value, passengers prefer behaving as type 2 rather than patronizing operator $k$.

Clearly, the only cutoff time value, which matters as to the classification of passengers' behaviour, is now $\tau_{mg}^{s,2,j}$; hence, the following results are achieved:

- Firm $j$ is patronized by travellers whose $\tau \in \left[0, \tau_{mg}^{s,2,j}\right)$.
- The $(j,k)$ $-$option prevails for travellers whose $\tau \in \left(\tau_{mg}^{s,2,j}, +\infty\right)$.