Footloose monopolies: regulating a "national champion"*

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Abstract

We analyze the design of optimal regulation of a domestic monopolist that also competes in an unregulated foreign market. We show how foreign activities affect regulation, consumers' surplus, national welfare and firm's profits. Although expansion in unregulated foreign markets amplifies the distortions that are caused by the regulator's limited information, we also show that allowing the firm to compete abroad does not necessarily harm domestic consumers. We analyze if and when the firm's decision to expand abroad coincide with national interests.

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1 Introduction

In more and more network industries, such as energy, telecoms and transport, we observe a continuing trend towards the introduction of competition in at least one segment of the business. In particular, in many cases the regulated monopolist enters the competitive segments in *foreign* markets. EdF, Enel and RWE are important examples of this type in energy industries. The Dutch firm TPG Post is integrated with TNT and competes in courier services throughout Europe. Another prominent example is Deutsche Post that, currently integrated with DHL and Postbank, offers solutions for the management and transport of goods, information and payments, in more than 220 countries. This firm is a regulated (and well protected) company in Germany, where the "reserved" monopoly area is quite large contemplating the distribution of all letters below a certain weight, and at the same time it competes worldwide as a logistic group, with significant cost "synergies" (reported by the European Commission ruling against Deutsche Post for abuse of dominant position, October 2004).

In these cases, which are often due to deregulation processes taking place at different paces in different countries, we often observe national governments trying to help domestic monopolists (the "national champions") in foreign markets, possibly via public aid, which for instance might give the monopolist the financial resources to enter and compete in a foreign market. Furthermore, when state aid is forbidden[1], national governments may be tempted to resort to more legitimate –and possibly more efficient– means of helping their "champions". For instance, when there are technical spillovers (i.e. when costs at home and abroad are not independent, as it is the case with Deutsche Post), making the home firm produce a large output level might either help (with economies of scope) or hinder (with scope dis-economies) its activities abroad, affecting the domestic policy and at the same time the profit it can obtain there. The international facet of regulatory policies has recently come to the forefront of the European policy debate on "national champions", where it has become evident that some governments "push" their home champions into foreign markets, counting on the home protection and on the openness of other markets.

These possibilities raise novel issues since a firm's activities abroad may affect its behavior in the regulated market, its associated rents and ultimately affect home consumers in the regulated market. Hence, it can be argued that the public policy towards a monopoly should also take into account what the firm does outside national boundaries. In this paper we tackle these issues, studying optimal regulatory schemes when a domestic regulated firm extends its operations to a foreign unregulated market competing on quantities, and we discuss under what conditions this entails a trade-off between the monopolist's interest and national welfare.

Although our simple model lacks the richness of actual regulatory environments, it provides useful insights about issues and properties of regulatory policies that should be relevant in practice. In particular

[1] For example, this prohibition is present both in EU rules and the WTO Agreement on Subsidies and Countervailing Measures. See Besley and Seabright (1999) and also Martin and Valbonesi (2006).

we show that there are two main channels which connect the firm's activities at home and abroad.

First, independently of the information on firm's costs, the profits earned in foreign markets affect regulation because the regulator may positively evaluate foreign profits *per-se* and may also substitute profits earned at home with foreign ones. This is relevant since, if spillovers generate economies of scope, the domestic regulator could also boost foreign profitability through an expansion of domestic production, and vice-versa in case of dis-economies of scope.

However, it is well known that the effectiveness of regulation is significantly limited by the regulator's lack of information on the firm's cost structure and this brings about the second link between home regulation and foreign activities in our analysis.[2] On the one hand, the mere fact the regulator cares about foreign profits matters to the distortion due to asymmetric information. On the other hand, foreign production itself may be an additional source of informational asymmetry for the regulator, thus further distorting regulation. Hence, the possibility to enhance the national champion's foreign profitability as discussed above may be impaired by the regulator's lack of information.

Combining these elements (i.e. related productions for different countries and asymmetric information possibly also on foreign activities), we encompass several realistic and interesting cases, such as when domestic and foreign markets are the same sector (with the foreign having already deregulated contrary to the domestic market) or when they are different sectors, such as water and energy respectively for home and foreign market. Hence, the comparison of regulated prices and quantities with and without foreign production allows us to illustrate the overall effects of foreign unregulated activities on domestic regulation and we ask whether or not allowing the regulated firm to compete abroad harms domestic consumers and welfare.

We show that although foreign activities may amplify informational distortions, if the regulator's lack of information only refers to domestic production (for example because foreign activities take place in a competitive market in which information is widespread) and there are economies of scope, the firm has a substantial coincidence of interests with home consumers and national welfare. The firm expands in unregulated markets precisely when its decision also brings about a reduction in the regulated price and an increase of national welfare (and vice-versa).

With diseconomies of scope, when the firm expands abroad the home price increases. As for the firm's profit, two effects emerge. First, the firm has a larger reservation profit (that can obtain operating abroad), but it will be penalized by a lower "variable" profit, and this entails a trade off. We show that an inefficient firm will prefer to diversify abroad, while an efficient firm, starting from high domestic profits, prefers to stick to the home market. Hence, a contrast between the firm's choice and national interests may emerge when (i) there are dis-economies of scope and (ii) the firm is relatively inefficient.

[2] The issue of regulator's limited information is considered a main ingredient of the analysis of regulation since the seminal works of Baron and Myerson (1982) and Laffont and Tirole (1993).

Things are more complex if production in the unregulated market also worsens the regulator's knowledge of costs. In this case we show that the task of regulation may became so cumbersome, that the regulator is obliged to give up screening the firms' costs and to offer a uniform policy with a fix price independent of firm's efficiency. Moreover, foreign diversification increases the firm's informational rents and distorts regulated price. We show that in this case home customers may be worse off even if there are economies of scope (similarly considering national welfare).

We also document a number of interesting facts that emerge in consequence of foreign activities. For example, the firm may gain larger profits if it has to compete with more foreign rivals, thus in a more competitive unregulated market. Again, the regulated price decreases and the firm's profits increase with the size of the foreign market, and contrary to standard models of regulations, the regulated price may be an increasing function of the regulator's weight on (domestically earned) profits.

The literature on optimal regulation (for a recent survey see Armstrong and Sappington, 2007) has shown how the wedge between regulated price and marginal cost is the consequence of a trade-off between productive efficiency and allocative efficiency. One limitation of this literature – that we try to relax – is that the firm is generally assumed to produce only for the regulated domestic market. Some more recent papers develop on the relationship between regulation and competition in vertically and horizontally related markets and share some similarities with our analysis. Studying the desirability of integration of upstream and downstream activities Vickers (1995) illustrates the way downstream competition affects upstream regulation (on a similar environment see also De Fraja, 1999, and Helm and Jenkinson, 1997). On the one hand, since the regulator cares for downstream welfare, integration is desirable because it gives the integrated firm an advantage with respect to its competitors and thus limits excessive downstream entry. On the other hand, the firm then tries to curb regulation to increase its profitability against downstream rivals. In our environment the "other" activities performed by the regulated firm take place abroad so that the regulator is not concerned about welfare and efficiency in the foreign market and cannot expropriate foreign profits (on the contrary in Vickers' model downstream profits are extracted by the regulator). Furthermore, with our environment we show that, although foreign expansion may be beneficial also to the home regulator by allowing to substitute domestic with foreign earned profits, the drawback of foreign activities consists in making the regulator's task more difficult, as previously illustrated.

Our model is also related to the literature on regulated firms that diversify into horizontally related markets which may be regulated or not. Braeutigam and Panzar (1989), Brennan and Palmer (1994) and Sappington (2003) studied the possibility for an integrated firm to attribute to the regulated activity costs that actually pertain non-regulated ones. Cost shifting allows to obtain higher regulated prices, while at the same time behaving more aggressively in the unregulated sectors. This second effect is also relevant to our analysis but, contrary to those papers, here it is not necessarily a negative consequence of integration since the domestic regulator may want to boost foreign profitability of the regulated firm. Lewis and Sappington (1989) and Iossa (1999) show that informative externalities among activities of a multi-product regulated firm generate countervailing incentives which in turn affect regulation and the desirability of integration. In Calzolari and Scarpa (2006) we consider a regulated multi-utility that operates in several sectors of the same country, with cost spillovers that are *per-se* a source of asymmetric information. In these papers regulation is affected by the firm being active also in other markets, as in our model of foreign expansion, and the desirability of multiple activities performed by the firm is associated with the ability of the regulator to secure at least part of the additional firm's profit to consumers in the several markets through a reduction of prices.

Contrary to all these papers, in our model the domestic regulator does not care for foreign firms and consumers, and regulation is then designed (also) to boost foreign profitability. This environment makes possible to analyze the relationship between national vested interests and firm's profits, a theme absent in the previous literature but that has recently come to the forefront of the policy debate. With our analysis we thus investigate to what extent policies that "push" national champions into foreign markets are viable when these firms are regulated at home.

With this respect, a related stream of literature is the one on strategic trade policies (e.g., Brander and Spencer, 1985). One basic finding of this literature is that with quantity competition, the home firm should be subsidized. With this respect we show the interplay between (imperfect) regulation in the domestic market and the presence of a foreign market with competitors. In our model the domestic regulator faces a trade-off between reducing firm's rent (which requires smaller home production) and increasing the foreign profits of the domestic firm.

Finally, in Calzolari (2004) a multinational firm serves two countries and is regulated by two independent national authorities. Since internationalization of firms' activities goes hand in hand with the process of de-regulation, our analysis complements that paper by allowing competition in the foreign country. When instead the firm is also regulated abroad and regulation is imperfect, national regulations induce distortions on regulated outputs in other countries (regulatory externalities) that, in the end, may be beneficial: independent national authorities obtain a welfare larger than if they acted cooperatively. This result on the desirability of non-cooperating national regulators, here parallels our results on the positive effect of firm's foreign expansion in the unregulated market.

The paper is organized as follows. Section 2 lays down a simple model also providing an efficiency benchmark. The base model is then fully developed in Section 3. Section 4 analyses foreign production as an additional source of the lack of information. Section 5 concludes the paper. All proofs are in the Appendix.

2 Baseline model setup

A firm has the option to serve two countries: in country h (home) it would operate as a regulated monopolist and in country f (foreign) it would compete against other n foreign firms. Firm's outputs are y_h, y_f respectively for market h and f so that total output in the two markets is $Y_h = y_h$ and $Y_f = y_f + ny_f^*$ where y_f^* is output produced by any of the identical firm's competitors in country f. The (inverse) demand in market i is $p_i(Y_i)$ and the two markets are separated. Competition takes place in quantities.

The regulated firm's total production cost is $C(y_h, y_f; \theta)$ with the property that, if the firm is active in both countries, production in one country affects the marginal cost for production in the other country, i.e. $\partial^2 C/(\partial y_h \partial y_f) \neq 0$. We will consider both the cases of dis-economies of scope, i.e. $\partial^2 C/(\partial y_h \partial y_f) > 0$ and economies of scope, i.e. $\partial^2 C/(\partial y_h \partial y_f) < 0$. The cost function may exhibit non-separability for several reasons. This is, for example, the case when the two (different) products y_h and y_f first require production of a common intermediate input, such as headquarter activities, R&D, technological knowledge, patents, brand name, or firm reputation. Clearly, when production of this common input exhibits (dis-)economies of scale, then final outputs y_h and y_f will be related by (dis-)economies of scope. This also shows that (final) production of y_h and y_f need not take place in the same country but can be conducted by two different divisions respectively located in country h and f. As an example, the domestic market h could the regulated water sector in Italy and the foreign market f is deregulated energy production in UK.

Economies of scope (as a consequence, for example, of increasing returns to scale in production of a common intermediate inputs) is probably the most relevant case from an empirical viewpoint. However, in order to investigate if and when a regulated firm may find it profitable to expand abroad, we will also analyze the case with scope dis-economies (e.g. with decreasing returns to scale for the intermediate input and in presence of non-reproducible assets or inputs that final producing units compete for). It is also worth noticing that if y_h and y_f are homogeneous products, the previous definitions correspond to the cases of economies and dis-economies of scale. In this case, one can imagine the firm jointly producing y_h and y_f within the same production line (either at home or abroad) and then exporting to the other country. Since the process of de-regulation is currently taking place at different paces in different countries (for example in the case of energy production), the same segment can be regulated at home but de-regulated abroad.

The parameter θ is an (inverse) efficiency measure for home production: the smaller θ the more efficient is the firm in producing the regulated output y_h. In particular, in the base model we will assume that $\partial C/\partial \theta \geq 0$, $\partial^2 C/(\partial \theta \partial y_h) \geq 0$ and $\partial^2 C/(\partial \theta \partial y_f) = 0$ so that θ uniquely affects domestic production. Moreover, θ is the firm's private information so that the home regulator knows that θ is distributed over $\Theta = [\underline{\theta}, \overline{\theta}]$ according to the cumulative distribution $F(\theta)$ with density $f(\theta) > 0$ satisfying the usual monotone (inverse) hazard rate property, i.e. $d[F(\theta)/f(\theta)]/d\theta \geq 0$ for any $\theta \in \Theta$. In the foreign market the n competitors have identical cost function $C^*(y_f^*)$ and, as it will be clear in the following, it is irrelevant whether foreign rivals know θ or not.

In the current setup θ is relevant only for domestic production. This may be indeed the case when the home and foreign sectors are two different ones. Consider, for example, water services y_h at home with a cost affected by the quality θ of raw domestic water, and postal services abroad y_f that are clearly unrelated to θ. Alternatively, the domestic and foreign sectors may by the same but the inputs used in the two production processes at home and abroad are not the same, since they are not mobile across countries.[3] In Section 4 we will allow for a different informational structure in which θ also affects foreign production.

In the following sections, when an explicit formulation for demand and costs will be used for the sake of concreteness, we will assume the following simple functional forms that satisfy all the properties discussed above,

$$\begin{cases} Y_i = s_i(a - p_i), \quad i = h, f, \\ C\left(y_h, y_f; \theta\right) = \theta y_h + \theta^* y_f + \lambda y_h y_f, \\ C^*(y_f^*) = \theta^* y_f^*, \end{cases} \tag{1}$$

where $s_i > 0$ captures the dimension of market i with $a > 0$, $\theta^* \geq 0$ is a publicly known parameter and λ is negative or positive, respectively in the case of economies and dis-economies of scope.

The home regulator maximizes a utilitarian objective function which is a weighted sum of net consumer surplus, regulated firm's profits and taxes (or transfers). Let $V\left(y_h\right)$ denote gross consumer surplus in country h, the welfare function maximized by the regulator is,

$$W = V\left(y_h\right) - y_h p_h\left(y_h\right) + T + \alpha \Pi_h + \beta \Pi_f, \tag{2}$$

where $\alpha \geq 0$ and $\beta \geq 0$ are the weights for profits earned by the regulated firm respectively at home Π_h and abroad Π_f and T is a regulatory instrument (tax or transfer). As it is standard in the literature on regulation, we will assume that $\alpha < 1$ (so as to avoid uninteresting limit cases, see Baron and Myerson, 1982). Although α and β may well be equal, it is useful to distinguish them, considering the case $\alpha = \beta$ as a particular case. In general, profits earned by the domestic firm in the home market and abroad need not be equally valued by the regulator. On the one hand, one could argue that home profits may be more valuable to a national authority because, depending on the fiscal regime abroad, foreign profits may not generate tax revenues in terms of general fiscality. Alternatively, the statutory mandate of the regulator may contemplate an objective function where only domestic profits are relevant (i.e. $\alpha > 0$ and $\beta = 0$), but at the same time the regulator may be captured by the firm and induced to put a larger stake on foreign profits (thus leading to $\beta > 0$). On the other hand, for distributional concerns it may

[3] Raw water may not be of the same quality in Italy and Germany and it is not easily exportable between the two countries. Similarly for locally available workforce.

seem natural to have $\beta > \alpha$ because the national regulator should be less concerned that the firm earns profits abroad rather than at home. Weights to profits may also reflect domestic ownership. In this case if foreign activities are performed through a controlled but separate firm we may then have $\beta \leq \alpha$ when part of the foreign unit's shares are in the hands of foreign shareholders. We prefer to avoid a clear commitment on any one interpretation, and thus we postpone the discussion of these possibilities. For simplicity and no qualitative effects on results, we assume that the shadow cost of public funds is zero. For the sake of concreteness, we also assume that consumer surplus in country h is sufficiently high, so that the regulator always prefers to have the firm producing for the home market.

The firm's total profit is

$$\Pi\left(y_h, y_f; \theta\right) \equiv \sum_{i=h,f} y_i p\left(Y_i\right) - C\left(y_h, y_f; \theta\right) - T. \tag{3}$$

Given that the cost function is non-separable in the two outputs, defining home and foreign profits can not be done in an unambiguous way. We thus assume that the splitting rule the regulator has to employ is the following:

$$\begin{aligned} \Pi_h\left(y_h; \theta\right) &= y_h p_h\left(y_h\right) - SAC\left(y_h; \theta\right) - T, \\ \Pi_f\left(y_h, y_f\right) &= y_f p_f\left(Y_f\right) - IC\left(y_h, y_f\right), \end{aligned} \tag{4}$$

where $SAC\left(y_h; \theta\right) \equiv C\left(y_h, 0; \theta\right)$ is the stand-alone cost that the firm incurs in case it only produces for the home market, and $IC\left(y_h, y_f\right) \equiv C\left(y_h, y_f; \theta\right) - C\left(y_h, 0; \theta\right)$ is the incremental cost the firm pays when producing for the foreign market as well.[4] The profit obtained by the firm in the home market is the one the firm would gain producing only for the domestic market. The foreign profit is the *extra-gain* the firm can obtain expanding its activities in the foreign market. Note that this profit splitting rule is consistent in the sense that $\Pi_h\left(y_h; \theta\right) + \Pi_f\left(y_h, y_f\right) = \Pi\left(y_h, y_f; \theta\right)$ and it has also a long tradition in both the regulatory and accounting literature.[5] Finally, if the firm decides to be active either in country h or in country f alone, the total profit is consistently defined respectively as $\Pi\left(y_h, 0; \theta\right) = \Pi_h\left(y_h; \theta\right)$ and $\Pi\left(0, y_f; \theta\right) = \Pi_f\left(0, y_f\right)$.

We see the essence of incentive regulation as the need to delegate some of the decisions to the regulated firm due to its superior information, which in turn allows the firm earn informational rent (Vogelsang, 2002). The regulatory mechanisms we are going to use are those standard in the theory of regulation with the important twist of being used by the regulator to interact with firm's foreign activity. In particular, the regulator naturally internalizes that the firm may operate abroad thus offering a menu

[4] The parameter θ does not affect $IC\left(y_h, y_f\right)$ because $\partial^2 C / \left(\partial\theta\partial y_f\right) = 0$. This will not be the case in the model of Section 4.

[5] See for example, McRae (1970) and Bradley et al. (1997). The issues involved in the problem of allocating joint costs are well understood (both in theory and in practice). The EU requires public utilities to have some "unbundling" of the accounts for different activities.

of regulations, one for a purely domestic firm and another for a firm expanding abroad. Hence, although the regulator cannot forbid foreign expansion of the domestic firm, as well as it cannot impose it, she can condition the regulatory policy on the firm's decision to expand abroad which we naturally view as publicly observable. In particular, she designs a policy $T(y_h)$ the firm must select if it decides to expand abroad and a policy $\tilde{T}(\tilde{y}_h)$ in case it decides to operate uniquely in the domestic market with associated output $\tilde{y}_h$.[6] The different T and $\tilde{T}$ clearly reflect into real world policies with foreign active firms being treated and regulated differently than standard domestic firm.

The timing of the game is the following. The regulated firm privately learns θ. The regulator designs the welfare maximizing policies T and $\tilde{T}$. If the firm wants to be active abroad, it selects T, otherwise it selects $\tilde{T}$. Finally, regulation is enforced and competition in the foreign market takes place.

Few comments are in order. The regulator is here a Stackelberg leader with respect to the foreign market activities. This assumption is motivated by the existence of constraints in changing regulatory policies and by the fact that regulated output y_h (or price p_h) is publicly observable since everybody knows the price of a regulated service. The fact that regulatory responses are in general substantially slower than competitive industry changes is also well documented. More specifically, the general principles of regulatory policies are usually dictated by norms, and even their application cannot be easily modified.[7]

The regulatory mechanism described above is characterized by some natural contract incompleteness since the regulator cannot impose or forbid foreign expansion and cannot directly control or regulate the firm's output y_f in the foreign unregulated market. With respect to the first incompleteness notice that offering the menu $\{T, \tilde{T}\}$ the regulator adapts regulation to the firm's important decision on foreign expansion. The second type of incompleteness implies that the regulator cannot condition the policy T on foreign production. This incompleteness naturally emerges for two reasons. First, regulatory powers are naturally limited within domestic boundaries. Second, foreign production may well be difficult to observe (also ex-post) for the regulator.

2.1 Competition and efficient regulation

Provided the regulated firm finds it profitable to be active in the foreign market as well (this will be discussed below), competition abroad leads to outputs $y_f(y_h)$, $y_f^*(y_h)$ for the firm and its rivals. To make our analysis interesting, we assume that y_f and y_f^* are positive for any $y_h \geq 0$. The cost function for output y_h which is relevant at the regulation stage can be then written as

$$C(y_h, \theta) \equiv C(y_h, y_f(y_h); \theta), \tag{5}$$

[6] Variables indicated with a tilde will refer to cases in which the firm is not active abroad.

[7] For instance, the $RPI - x$ system (the most common way to put into practice the notion of "incentive prices") envisages a price rule which remains fixed for a period of time from three to five years (Armstrong *et al.*, 1997).

and similarly $\Pi_f(y_h) \equiv \Pi_f(y_h, y_f(y_h))$ and $\Pi(y_h;\theta) \equiv \Pi(y_h, y_f(y_h);\theta)$. Under standard assumptions on equilibrium and stability in the foreign market, we also have, in line with intuition,

$$\frac{\partial y_f(y_h)}{\partial y_h} \propto -\frac{\partial^2 C}{\partial y_h \partial y_f}; \quad \frac{\partial y_f^*(y_h)}{\partial y_h} \propto \frac{\partial^2 C}{\partial y_h \partial y_f}, \quad \frac{\partial \Pi_f}{\partial y_h} \propto -\frac{\partial^2 C}{\partial y_h \partial y_f} \tag{6}$$

With scope (dis-)economies, the regulated firm earns larger (smaller) profits abroad when home production is larger.

We can now turn to the benchmark case of *regulation by a fully informed regulator* and consider first the optimal policy when the firm decides to be active in the foreign market. The regulator has to guarantee the firm a profit, that would make it prefer to be active also in the domestic market. If the firm decides to operate only abroad and to abandon domestic activities, its profit is $\Pi_f^0 \equiv y_f^0 p_f\left(Y_f^0\right) - IC\left(0, y_f^0\right) > 0$ where $y_f^0 = y_f(0)$, $Y_f^0 = y_f(0) + ny_f^*(0)$. Hence, the policy designed for a firm that will be active in the foreign market must satisfy

$$\Pi(\theta) \equiv \Pi_h(\theta) + \Pi_f(\theta) \geq \Pi_f^0, \ \forall\, \theta \in \Theta, \tag{7}$$

where $\Pi_h(\theta) \equiv \Pi_h(y_h(\theta);\theta)$ and $\Pi_f(\theta) \equiv \Pi_f(y_h(\theta))$.[8] Substituting the transfer T and Π_h into the regulator's objective function (2), welfare becomes

$$W(y_h;\theta) \equiv V_h(y_h) - SAC(y_h;\theta) - (1-\alpha)\Pi(y_h;\theta) + (1-\alpha+\beta)\Pi_f(y_h) \tag{8}$$

which shows that the regulated firm's (total) profit Π represents a cost in terms of distributional efficiency because $\alpha < 1$, contrary to foreign profit Π_f which increases national welfare proportionally to $1-\alpha+\beta \geq 0$ for reasons that we discuss below. Absent informational issues, the regulator thus maximizes (8) with respect to y_h (for any value of θ), subject to the participation constraint (7) and anticipating the firm's and its rivals' reactions in market f.

To achieve distributional efficiency the regulator will reduce as much as possible Π and then make (7) binding for any θ. On the other hand, if the firm obtains a larger profit abroad Π_f, the regulator is able to reduce the costly domestic profits Π_h without violating the participation constraint since foreign and home profits are "equally good" in meeting the participation constraint. This explains why foreign profits is not only weighted according to β but also with the additional weight $1-\alpha$. Optimal regulated output and price $p_h^{FI}(\theta)$ (FI stands for full information) must then account (also) for these effects, so

[8] In the analysis of Section 4 the outside option Π_f^0 will also depend on θ.

that efficient regulation requires,

$$p_h(y_h) - \frac{\partial SAC(y_h;\theta)}{\partial y_h} + (1-\alpha+\beta)\frac{d\Pi_f(y_h)}{dy_h} = 0. \tag{9}$$

Consider now the policy designed for a firm only active in the domestic market. In this case the participation constraint is simply $\Pi_h(\theta) \geq 0$ and optimal price $\tilde{p}_h^{FI}(\theta)$ is simply obtained by the standard pricing rule $p_h = \partial SAC/\partial y_h$ (implicitly defining output $\tilde{y}_h^{FI}(\theta)$).

The *equilibrium* price when the firm is active in both countries can be conveniently written as $p_h^{FI}(\theta) = \tilde{p}_h^{FI}(\theta) + D^{FI}(\theta)$ where the last term is the distortion induced by the foreign activity of the firm. Furthermore, since the firm has a larger outside option Π_f^0, it will always decide to be active abroad when the regulator is fully informed (this will not be always the case when the regulator is uninformed).

Proposition 1 (Efficient regulation) *With full-information and with respect to a domestic firm, foreign activities induce a regulated price distortion $D^{FI}(\theta)$ which is negative (positive) for (dis-)economies of scope.*

The (absolute value of the) distortion decreases in α and increases in β; For the model in (1), with economies of scope it increases in s_h, s_f, $|\lambda|$ and is ambiguously affected by n; with dis-economies it decreases in s_h, increases in s_f, n and is ambiguously affected by λ.

The regulator has the possibility to help the firm to boost foreign profit since this increases welfare for the two reasons discussed above. With economies of scope, this can be obtained increasing home production and the opposite holds for dis-economies. Hence, with scope economies the defence of consumers' interest, national welfare and the pursuit of firms' foreign profits do not clash, a result that will be challenged and further discussed in the next sections.

The comparative statics of regulated price $p_h^{FI}(\theta)$ also delivers some interesting results. For example, a more competitive foreign market (i.e. larger n) further increases the domestic price with dis-economies of scope and may increase or reduce it with scope economies. The reason is that increasing y_h boosts profitability of foreign activities which in turn may increase or decrease in n so that, for sufficiently large scope economies, tougher foreign competition favors not only foreign consumers but also domestic ones.

What are the limits to these policies when the regulator lacks the relevant information on firm's costs? When the regulator is not fully informed on the firm's costs, do foreign activities worsen or alleviate the distortion in the domestic market induced by the limited information of the regulator? Does the foreign activity of the regulated firm harm consumers in the domestic market? What about the effects on national welfare? The answer to these and other related questions will be addressed in the next sections.

3 Regulating a privately-informed footloose monopoly

To understand whether the firm wants ultimately to expand abroad and the effects of this decision on optimal regulation, domestic welfare and consumer surplus, one must rely on optimal incentive schemes since then any answer to our previous practical and policy relevant questions will be based on the best regulatory scheme. To this end we first address the issue of the optimal policy designed for a firm active in the foreign market. Then, we will derive the policy in case the firm decides not to expand abroad, and finally analyze the firm's decision concerning foreign expansion.

As usual with asymmetric information, the regulator faces a trade off between allocative and distributive efficiency. The latter requires to limit the firm's profit, which in turn positively depends on regulated output so as to induce the firm to make an announcement $\hat{\theta}$ equal to its true type θ.[9] Hence, the regulator is ready to reduce y_h, increase and distort the regulated price p_h thus sacrificing allocative efficiency. What is important to notice here is that when providing the firm with the incentives for truthful revelation, if the regulator did not explicitly take into account that the firm also operates abroad, then she would almost certainly fail to induce the firm to reveal its true costs. In fact, although the true parameter θ does not affect foreign profitability, by misbehaving in the domestic market (e.g. announcing a $\hat{\theta}$ that induces a larger y_h with scope economies), the firm may increase foreign profitability and induce a larger foreign profit.

The following Lemma shows how the trade-off is affected when the firm operates in a foreign market (AI will stand for asymmetric information).

Lemma 1 (Regulation with asymmetric information and foreign activities) *Optimal regulation with asymmetric information requires*

$$p_h(y_h) - \frac{\partial SAC(y_h;\theta)}{\partial y_h} + (1-\alpha+\beta)\frac{d\Pi_f(y_h)}{dy_h} + (1-\alpha)\frac{F(\theta)}{f(\theta)}\frac{\partial^2\Pi(y_h;\theta)}{\partial\theta\partial y_h} = 0 \tag{10}$$

where $\frac{\partial^2\Pi(y_h;\theta)}{\partial\theta\partial y_h} = -\frac{\partial^2 SAC(y_h;\theta)}{\partial\theta\partial y_h} < 0$. *The equilibrium price for any* θ *is* $p_h^{AI}(\theta) = p_h^{FI}(\theta) + D^{AI}(\theta)$ *where* $D^{AI}(\theta) \geq 0$ *is the distortion caused by asymmetric information when the firm also operates abroad. Equilibrium profit is*

$$\Pi^{AI}(\theta) = \int_{\theta}^{\bar{\theta}} \frac{\partial SAC\left(y_h^{AI}(u);u\right)}{\partial\theta} du + \Pi_f^0, \tag{11}$$

increasing both in θ *and in* $y_h^{AI}(\theta)$.

To study the effects of foreign expansion we also need to derive the optimal policy with asymmetric

[9] We are employing the Revelation Principle and since foreign output is a moral hazard variable, in the current setting the Generalized Revelation Principle of Myerson (1982) is the appropriate reference for direct mechanisms. The technical and standard details are in the Appendix.

information when the firm is not active abroad. In this case, the analysis follows the seminal paper by Baron and Myerson (1982) (BM henceforth) and it is well known that optimal regulation when the privately informed firm is only active in the domestic market requires

$$p_h(y_h) - \frac{\partial SAC(y_h;\theta)}{\partial y_h} - (1-\alpha)\frac{F(\theta)}{f(\theta)}\frac{\partial SAC(y_h;\theta)}{\partial \theta} = 0 \tag{12}$$

with profits

$$\tilde{\Pi}^{BM}(\theta) = \int_{\theta}^{\bar{\theta}} \frac{\partial SAC\left(\tilde{y}_h^{BM}(u);u\right)}{\partial \theta} du. \tag{13}$$

We can now compare the *equilibrium prices* when the firm is or is not active in the foreign market. From (12) the equilibrium price with no foreign expansion can be written as $\tilde{p}_h^{BM}(\theta) = \tilde{p}_h^{FI}(\theta) + D^{BM}(\theta)$, where $D^{BM}(\theta) \geq 0$ is the distortion induced by asymmetric information. Consider now the difference between equilibrium prices:

$$p_h^{AI}(\theta) - \tilde{p}_h^{BM}(\theta) = D^{FI}(\theta) + D^{AI}(\theta) - D^{BM}(\theta). \tag{14}$$

This way of representing the effects of foreign activities illustrates the interplay between the regulator's incentive to increase foreign profitability and her limitation in this process due to her lack of information. On the one hand, the regulator is ready to modify the price in the domestic market so as to boost the firm's foreign activities, and this is measured by $D^{FI}(\theta)$, i.e. the effect of foreign activities had the regulator full information. On the other hand, asymmetric information affects differently the regulated price depending on whether the firm is or is not active abroad, as measured by the difference

$$D^{AI}(\theta) - D^{BM}(\theta) = \left[p_h^{AI}(\theta) - p_h^{FI}(\theta)\right] - \left[\tilde{p}_h^{BM}(\theta) - \tilde{p}_h^{FI}(\theta)\right],$$

where the first square brackets is the effect of asymmetric information of a firm that does operate abroad, whilst the second bracket when the firm does not operate abroad. When does the lack of information affect regulated price the most: when the firm operates abroad or when it does not? In other terms, what is the sign of $D^{AI}(\theta) - D^{BM}(\theta)$? To answer this question, let us consider figure 1.

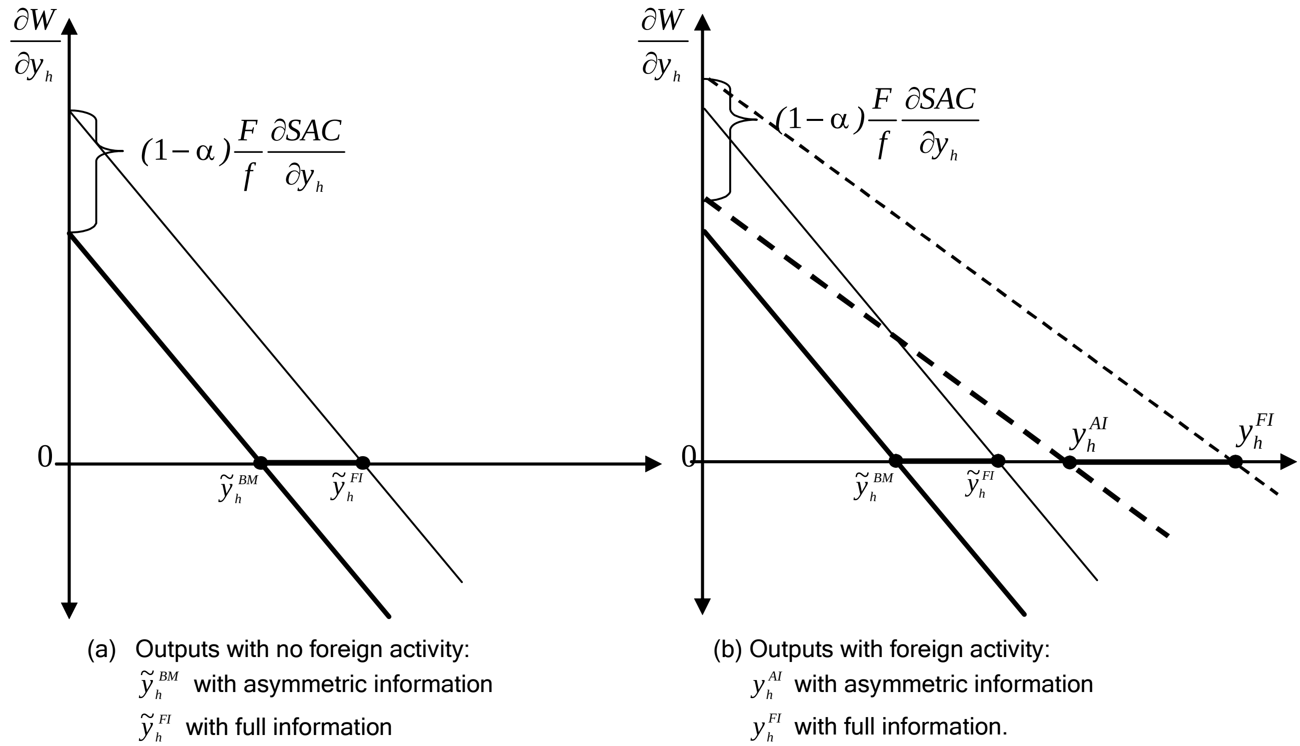

Figure 1. Marginal welfare as a function of regulated output, with scope economies.

In figure 1 (a) for the simple model defined by (1) with $\lambda < 0$ and for a given θ, we plot the two pricing conditionswhen the firm does not operate abroad and the regulator is uninformed (bold line) or informed (thin line) so that the vertical distance between the two lines is simply the distortion due to asymmetric information in (12). Optimal quantities are determined by the points in which the pricing conditions intersect the horizontal axis (so that the first order condition is met). In figure 1-(b), we add two (dashed) lines which refer to the case when the firm operates abroad: the thin line is the pricing rule with full information as in (9), the bold line refers to asymmetric information as in (10).

For what stated above, in figure 1 (b) the vertical difference between the dashed lines (with foreign activities) is the same as the one between the solid lines (no foreign activities). However, this does not imply that the difference in *equilibrium* prices and outputs induced by asymmetric information is also the same (that would imply $D^{AI}(\theta) = D^{BM}(\theta)$). This would be the case uniquely if the presence of foreign activities induced only a *fixed effect* on the pricing condition for y_h thus simply shifting the two dashed lines above the two solid lines, without altering their slope. However, being active abroad also induces a *variable effect* which makes the dashed lines flatter. In fact, imagine an expansion of domestic production y_h. With scope economies, this would imply an expansion of foreign production y_f which in turn would increase the benefits of further increasing y_h. What we have named the "variable effect" is thus positive, so that the dashed lines in figure 1 (b) are higher but also flatter than the solid lines, which implies that the *horizontal* distance between the two pairs of lines is not the same and $D^{AI}(\theta) \geq D^{BM}(\theta)$.[10]

This shows that foreign activities exacerbate the distortions due to asymmetric information. It also highlights that the overall effect of foreign activities on the home price (measured by $p_h^{AI}(\theta) - \tilde{p}_h^{BM}(\theta)$ as in (14)) is made of two potentially *countervailing terms*. On the one hand, foreign activities worsen the asymmetric information distortion (since $D^{AI}(\theta) \geq D^{BM}(\theta)$). On the other hand, with economies of scope the regulator boosts y_h and reduces p_h so as to make the firm more competitive in the foreign market (since $D^{FI}(\theta) \leq 0$). Nevertheless, we obtain the following results.

Proposition 2 (Effects of foreign activities on regulation) *The firm's decision to operate abroad favors home consumers (i.e. $p_h^{AI}(\theta) \leq \tilde{p}_h^{BM}(\theta)$) and increases domestic welfare when costs exhibit economies of scope. With dis-economies foreign expansion certainly hurts consumers (i.e. $p_h^{AI}(\theta) \geq \tilde{p}_h^{BM}(\theta)$), although it may increase welfare when β is large and diseconomies are not too strong.*

Concerning equilibrium prices and consumers' surplus in the domestic market, this result shows that notwithstanding the negative interplay between foreign activities and the lack of information at the regulatory stage, the presence of economies or dis-economies of scope prevails. The following Corollary further characterizes the effect of foreign expansion with a comparative statics analysis on prices and distortions.

Corollary 1 (Comparative statics) *Consider the model defined by (1).*

(i) $D^{AI}(\theta)$ increases in all parameters except for being decreasing in α and $\lambda \leq 0$.

(ii) $p_h^{AI}(\theta)$ increases in $\lambda \leq 0$ and also s_f if $\lambda \geq 0$; It decreases in β, s_h and s_f if $\lambda \leq 0$; It is ambiguously affected by n and α. The comparative statics of $p_h^{AI}(\theta) - \tilde{p}_h^{BM}(\theta)$ is the same as that for $p_h^{AI}(\theta)$, except for this difference being decreasing in α for $\lambda \geq 0$.

(iii) $D^{AI}(\theta) - D^{BM}(\theta)$ increases in all parameters except for being decreasing in α and $\lambda \leq 0$.

Turning to the equilibrium price $p_h^{AI}(\theta)$ and the associated distortion, a comparison of the results in Proposition 1 and Corollary 1 shows that parameters have often opposite effects on the two distortions $D^{FI}(\theta)$ and $D^{AI}(\theta)$ thus inducing some unexpected results. For example, although a more competitive market (i.e. larger n) increases the asymmetric information distortion $D^{AI}(\theta)$, it could reduce $D^{FI}(\theta)$ (see Proposition 1) so that regulated output may increase. Furthermore, since we know from Lemma 1 that firm's profit is increasing in regulated output, it follows that a more competitive foreign market may also increase firm's total profit.

[10] With dis-economies an expansion of y_h would trigger a reduction of y_f, which in turn would reduce costs associated with dis-economies thus allowing for an expansion of home production y_h. Ultimately we have again $D^{AI}(\theta) \geq D^{BM}(\theta)$ as discussed below in the text.

We now turn to the firm's decision on foreign expansion. As explained above, the idea is that the regulator cannot directly forbid or impose foreign expansion, but can control it with the menu of policies it designs respectively when the firm remains domestic $\tilde{T}$ or expands abroad T.

Proposition 3 (Firm's decision on foreign expansion) *With economies of scope the regulated firm expands abroad. With dis-economies, inefficient types (i.e. types $\theta \geq \tilde{\theta}$ with $\tilde{\theta} < \bar{\theta}$) expand abroad and efficient types (i.e. $\theta < \tilde{\theta}$) remain domestic.*

With economies of scope, expanding abroad involves no trade-offs for the firm. This decision allows the firm both to get a larger outside option (Π_f^0 as compared to zero for domestic activities) and a larger regulated output which, in turn, increases profits as shown by (11) and (13). It is important to notice that this result does not trivially follow from the possibility for the regulated firm to benefit of reduced costs with scope economies. In fact, the participation constraint (7) allows the regulator to reap most of the cost reductions that accrue from scope economies and firm's profits are ultimately related to its informational advantage, as shown in Lemma 1.[11]

On the other hand, with dis-economies the firm faces a trade off since foreign diversification guarantees $\Pi \geq \Pi_f^0$,but also a lower "variable" profit since regulated output is lower. However, notice that the least efficient type obtains zero profit when staying at home (see (13) valued at $\theta = \bar{\theta}$), and it will certainly prefer to be active abroad. Furthermore, as the firm's profit decreases in θ faster with foreign expansion due to dis-economies, there is a cutoff type $\tilde{\theta}$ which is indifferent between the two choices and separates types as illustrated in the Proposition.[12]

These results together with what is shown in Proposition 2 illustrate that with economies of scope the firm, home consumers and national interests are aligned: optimal domestic output is larger, and this brings about larger profit as well as greater consumer surplus and national welfare. With dis-economies this instead depends on firm's efficiency.

4 Foreign production and asymmetric information

So far we have assumed that the sole source of asymmetric information is home production. However, foreign production may be an additional source of private information for the firm. Hence, we are now interested in verifying how our previous analysis may extend in this direction by considering cost functions where the adverse selection parameter θ also affects the production of y_f and possibly y_f^* as well.

[11] To see this consider for simplicity full information so that $\Pi(\theta) = \Pi_f^0$ and $T = y_h p_h - SAC + (\Pi_f - \Pi_f^0)$. The term in brackets is the profit saving of scope economies which clearly increases one-to-one the payment from the firm to the regulator.

[12] It may be $\tilde{\theta} < \underline{\theta}$ indicating that the firm never expands abroad.

This may well be the case, for example, when the activities in the foreign market belong to the same sector as domestic ones, so that productions y_h and y_f are homogenous goods issued by the same production line and both affected by firm's private information on θ (this may be an inverse measure of expertise obtained with learning-by-doing in the water or in the postal sector). The process of de-regulation is taking place at different paces in different countries, so that it may well be the case that the same segment is regulated in one country (here, at home) and de-regulated abroad, such as for example the European telecom or energy national markets currently characterized by different degrees of de-regulation. Alternatively, θ may affect the cost of production of a common intermediate input for the two outputs y_h and y_f that refer to unrelated sectors, such as water and energy production (see also Section 2 for a discussion on this possibility). In this case, costs for final outpulls y_h and y_f turn out to be related and, at the same time, they are both affected by firm's better knowledge on θ.

Together with demand functions as in (1) here we then employ the following functional forms

$$\begin{aligned} &C\left(y_h, y_f; \theta\right) = \theta y_h + \left(\delta\theta + \theta^*\right) y_f + \lambda y_h y_f \\ &C^*(y_f^*; \theta) = \left(\delta^*\theta + \theta^*\right) y_f^* \end{aligned} \tag{15}$$

where $\delta > 0$ and $\delta^* > 0$ imply that asymmetric information also affects the regulated firm's cost of production for the foreign market, and similarly for the rival firms.[13] This formulation, for different values of δ and δ^*, lends itself to different interpretations. For instance, when $\delta = \delta^* = 0$ we are back to the model explored in the previous sections. The other extreme case with $\delta = \delta^* = 1$ may correspond to a situation where the firm is active in the same sector in the two countries, but where the cost of production are larger abroad than at home. In general, δ and δ^* may well be different and we shall assume $\Delta\left(n\right) \equiv \delta + \left(\delta - \delta^*\right)n \geq 0$ so that a larger θ reduces the foreign production of the regulated firm and of its rivals.

When foreign production is itself a source of asymmetric information, two remarkable new facts emerge. First, the firm's reservation profit becomes type-dependent. This is because even if the firm decides not to produce for the home market, still it can produce for the foreign market with costs that are unknown to the regulator. Second, the firm obtains informational rents also from foreign production because Π_f now also depends on the true cost parameter θ.

These notable differences significantly affect optimal regulation requiring to separate the two cases of economies and dis-economies of scope, and for the latter case, we need to introduce a new (but standard) assumption that guarantees the hazard rate $\left(1 - F(\theta)\right)/f(\theta)$ is decreasing in θ.

[13] Foreign firms know the value of θ because it directly affects their production. Firms may also have private information on θ^*. Although, here we rule out multi-dimensional screening which is out of the scope of the present paper (see Rochet and Stole, 2003), as long as the correlation between θ and θ^* is positive and large (as we may expect for firms operating in similar domestic and foreign sectors), results should not significantly change.

Proposition 4 (Foreign activities worsening asymmetric information) *Consider the model defined by costs (15) and demands as in (1).*

- ***Scope Economies.*** *Optimal pricing is (10), the same as in the base model, where now* $\frac{\partial^2 \Pi}{\partial\theta\partial y_h} = -\frac{\partial^2 SAC}{\partial\theta\partial y_h} + \frac{\partial^2 \Pi_f}{\partial\theta\partial y_h}$*; equilibrium profits are* $\Pi^{AI}(\theta) = \int_\theta^{\bar\theta} \left\{ \frac{\partial SAC}{\partial\theta} - \frac{\partial \Pi_f}{\partial\theta} \right\} du + \Pi_f^0\left(\bar\theta\right)$ *with* $\frac{\partial \Pi_f}{\partial\theta} \leq 0$.
- ***Scope Dis-Economies.*** *For weak dis-economies (λ small), optimal regulation is the same as with scope economies. When dis-economies are large (λ large), the optimal pricing rule is*

$$p_h(y_h) - \frac{\partial SAC(y_h;\theta)}{\partial y_h} + (1-\alpha+\beta)\frac{\partial \Pi_f(y_h;\theta)}{\partial y_h} + (1-\alpha)\frac{1-F(\theta)}{f(\theta)}\frac{\partial^2 \Pi(y_h;\theta)}{\partial\theta\partial y_h} = 0.$$

  With intermediate dis-economies, the optimal regulated price may be independent of θ (bunching"). In both the last two cases, firm's profit is $\Pi^{AI}(\theta) = \int_{\underline\theta}^{\theta} \left\{ \frac{\partial SAC}{\partial\theta} - \frac{\partial \Pi_f}{\partial\theta} \right\} du + \Pi_f^0\left(\underline\theta\right)$.

Interestingly enough, with scope economies the analysis of optimal regulation developed in the previous sections is qualitatively unaffected by the generalization in the cost function we have introduced with (15). This is because with economies of scope the less firm is efficient the smaller the additional profit it obtains by expanding abroad (i.e. $\Pi(\theta) - \Pi_f^0(\theta)$ decreases in θ). The type-dependent outside option has no bite and, as in the base model of Section 2, the regulator must simply make sure that the least efficient firm (i.e. type $\overline\theta$) prefers to be active at home, as more efficient firms will also prefer so. Notice, however, that the equilibrium distortion $D^{AI}(\theta)$ is here larger because the pricing condition now accounts for the extra informational rent associated with foreign production i.e. $\partial^2 \Pi_f/(\partial\theta\partial y_h) \leq 0$. Hence, when foreign production is a source of asymmetric information, the regulated price is further distorted and the firm's profits are even larger. These results will have important effects on the desirability of foreign expansion of the regulated firm, as we will discuss next.

When dis-economies are weak (see the Appendix for a precise condition on λ), the analysis is similar, whilst with larger dis-economies countervailing incentives interestingly show-up. In particular, since with dis-economies the negative impact of domestic production on foreign profits is more important for an inefficient firm (i.e. $\partial^2 \Pi_f/(\partial\theta\partial y_h)$ is positive), if dis-economies are sufficiently large the overall effect on profits (i.e. $\partial^2 \Pi/(\partial\theta\partial y_h)$) may be positive. In this case, the firm's incentives to report its costs are reversed and the regulator is obliged to ask a more efficient firm to produce less.[14] Specularly, also the total profit net of the type-dependent outside option (i.e. $\Pi(\theta) - \Pi_f^0(\theta)$) may increase on θ so that the binding participation constraint becomes that of the most efficient type $\underline\theta$. Furthermore, the positive sign of $\partial^2 \Pi/(\partial\theta\partial y_h)$ also implies that the optimal regulated price with asymmetric information is larger and

[14] As an example, with a constant hazard rate and for intermediate values of λ, output is constant with "no-distortion at the top", i.e. $y_h^{AI}(\theta) = y_h^{FI}\left(\overline\theta\right)$ for any $\theta \in \Theta$ ("full-bunching"). Similar issues of countervailing incentives in regulation also appear for example in Lewis and Sappington (1989).

the quantity is smaller than the one with full information. These are all notable consequences of foreign expansion by the regulated firm.

All these new effects would clearly not appear if the regulator had full information on foreign firm's costs and/or the firm did not operate abroad, and are more important the larger is the level of scope (dis-)economies, i.e. $|\lambda|$. Furthermore, the model shows that the additional distortion in the regulated price induced by foreign activities decreases with the number of competitors in the foreign market since a larger n has a negative effect on the derivative $\partial y_f(y_h;\theta)/\partial y_h$ and also clearly on y_f. Hence, the regulator internalizes these effects and (being $\partial^2\Pi_f/(\partial\theta\partial y_h)$ smaller due to the larger n) she is then ready to expand y_h.

Concerning home output, consumer surplus and national welfare, we have now two opposing forces, and allowing the firm to operate abroad may harm domestic consumers even if there are scope economies. The point is that the diversification of activities now increases the informational rent by the term $-\partial\Pi_f/\partial\theta$ (see $\Pi^{AI}(\theta)$ in Proposition 4) which in turn distorts and increases regulated price.

Corollary 2 (Interests on foreign expansion) *When the regulator has limited information over foreign production costs as well: (i) The expansion of the regulated firm into a foreign market may harm domestic consumers and reduce welfare even if costs exhibit scope economies; (ii) The regulated firm may want to expand abroad even if its costs exhibit dis-economies of scope and independently of firm's efficiency.*

Result (i) with Proposition 2 show that the convergence of interests on foreign expansion between the firm, consumers (in terms of surplus) and the regulator (in terms of welfare) depends on the regulator's knowledge of costs of domestic and foreign production. In the same way, the decision to expand abroad (result (ii)) is affected by the regulator's lack of information on foreign production costs. In fact, we now know that if dis-economies are strong enough, inefficient firms find it interesting to mimic more efficient firms with lower values of θ. When this is the case the regulator may be obliged to abandon screening on firm's type so that the regulated equilibrium price is invariant over efficiency (i.e. constant for any or some subset of θ). Interestingly enough, this implies that the regulated output might increase when the firm expands its activity abroad, even if there are dis-economies of scale, thus increasing the firm's profits (for any level of θ) relative to those of a purely national monopolist.

5 Discussion and concluding remarks

The possibility to expand abroad induces the regulator to offer a menu of regulatory schemes, one for a purely domestic firm and another for a firm operating abroad. This reflects into real world policies with foreign active firms being treated and regulated differently than standard domestic firm. In this paper we have thus analyzed the intricate interplay between incentive regulation and foreign activities of a regulated firm. Expansion into foreign unregulated markets affects the firm's incentives, regulated prices and profits and, since the regulator lacks some relevant information, there are limits to a regulatory policy designed to boost foreign profitability. We have shown how these effects depend on cost spillovers, the nature of firm's private information vis à vis its domestic regulator, competition in the unregulated market, market size and on the weight the regulator attaches to profits earned at home and abroad. We have also illustrated when national interests and domestic consumers should oppose firm's expansion in unregulated markets. To this end the approach used in this paper based on optimal incentive regulatory schemes is particularly informative since it represents a benchmark for regulation under limited information.

National champions are currently at the center of a debate that so far has focussed mainly on the risk of manipulation of merger procedures by national competition authorities. While it emerges quite obviously that aggregate welfare requires competition laws to operate in a fair way, national interests are often aligned with those of domestic firms: what is good for a "national champion" is good for the country.[15] Hence, in the policy debate there seems to be a widespread presumption that the interests of national champions and those of the domestic country are aligned.[16] Our paper adds to this important debate in two ways. First, we show how regulatory policies can and should be affected when home producers are willing to expand abroad. This is important as it is widely recognized that this problem emerges with particular frequency in utility sectors, so that "merger policy should be complementary to sector specific regulations", as recently indicated by the European Commission (reported in Duso *et al.* 2007). Our analysis also indicates how regulatory policies could be used to favour national firms in foreign markets, by decreasing (increasing) regulated prices to help the firm exploit (dis-)economies of scope. Second, and more in contrast with the idea of interests alignment, our results highlight that – even when regulation is "optimal" – there may be a conflict between the firm's profits and consumer surplus. Depending on firm's private information, optimal regulation may be such that the decision to expand abroad – even in the presence of economies of scope – may harm domestic consumers. In such circumstances it may conceivable that any attempt by a "national champion" to expand its activities across borders should face severe scrutiny and political opposition.

[15] As noted by Neven and Roller (2000), the suspicion that conflicts in international merger control may well be associated with the pursuit of objectives such as the defense of national champions, is quite common. Duso et al. (2007) show that the size of the country in which the merging firms originate does play a role in the final outcome of a EC merger investigation, presumably because of the political pressure that countries exert onto European institutions.

[16] The recent report by Bruegel, a think tank funded and supported by 16 European governments, has recently stressed that "The perception of a convergence of interests between "national" companies and their respective nations is deeply ingrained in many senior policymakers' world view." (Veron, 2006). Something similar emerges form academic studies on merger policies; for instance Motta and Ruta (2007) show that a welfare maximizing government would endorse a merger increasing the market power of a national firm even if general efficiency considerations would suggest not to do so.

Several themes remain open for future research. For instance, by directly interacting with the firm, a regulator may learn more information on the firm's cost efficiency than the firm's competitors and may then be able to control the level of information that is available to them. This type of informational externality has been studied in abstract contract theory by Calzolari and Pavan (2006) and we explore the possibility that regulation also signals information to rival firms in Calzolari and Scarpa (2006) where we study a multi-utility firm operating in several national sectors.

Our paper has addressed the issue of a firm regulated at home and competing abroad, whilst Calzolari (2004) has studied a setting in which a firm is regulated in all countries where it operates. We plan to complete the picture, by studying whether national authorities should be interested in playing as first movers in deregulating, rather than waiting for other countries to make the first move.

Another interesting theme is the issue of incentives to invest. There is an extensive literature which –not without ambiguity– points out how competition might contribute to the internal efficiency of the firm. Analyzing how competitive pressure in "adjacent" markets drives the firms to exert greater effort, compensating the *under-investment* problem (see for example Laffont and Tirole, 1993) represents an immediate potential extension of this line of research that we plan to follow.

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6 Appendix

Proof of Proposition 1. The pricing rule is immediate from optimization with respect to y_h of

$$V_h(y_h) - SAC(y_h;\theta) - (1-\alpha)\Pi(y_h;\theta) + (1-\alpha+\beta)\Pi_f(y_f).$$

Being the term introduced by foreign activities $\frac{d\Pi_f}{dy_h} \propto -\frac{\partial^2 C}{\partial y_h \partial y_f}$, it follows that the equilibrium price distortion of foreign activities $D^{FI}(\theta)$ is such that $D^{FI}(\theta) \leq (\geq) 0$ if $\lambda \leq (\geq) 0$. The comparative statics of $D^{FI}(\theta)$ on α and β follow from the implicit function theorem (differentiating the pricing rule (9) with respect to y_h and either with respect to α or β).

As for comparative statics on other parameters, consider the model defined in (1). In the rest of this proof and in all other proofs that will make use this model we will consider admissible parameters such that prices, outputs and profits are non-negative in the foreign market. The distortion is

$$D^{FI}(\theta) = (1-\alpha+\beta)\lambda 2(n+1)s_f \frac{a-\theta^* - (n+1)\lambda s_h(a-\theta)}{S}$$

where $S \equiv (2+n)^2 - (1-\alpha+\beta)2\lambda^2(1+n)^2 s_h s_f \geq 0$ and $S \geq 0$ from second order conditions on y_f. Hence, $\frac{\partial D^{FI}(\theta)}{\partial \lambda} \geq 0$ for $\lambda \leq 0$ because the sign of $\frac{\partial D^{FI}(\theta)}{\partial \lambda}$ is proportional to

$$(1-\alpha+\beta)2\lambda^2(1+n)^2 s_h s_f(a-\theta^*) + (2+n)^2\left[a-\theta^* - 2\lambda(1+n)s_h(a-\theta)\right]$$

which is clearly positive when $\lambda \leq 0$. On the contrary, the sign of $\frac{\partial D^{FI}(\theta)}{\partial \lambda}$ is ambiguous when $\lambda \geq 0$ and there are admissible parameters configurations in which it can be positive or negative.

With analogous calculations we have $\frac{\partial D^{FI}(\theta)}{\partial s_h} \leq 0$ with the sign implied by the non-negativity condition of $y_h^{FI}(\theta)$ and $\frac{\partial D^{FI}(\theta)}{\partial s_f} \geq (\leq) 0$ when $\lambda \geq (\leq) 0$ with the signs implied by the non-negativity condition of $y_f^{FI}(\theta)$.

Finally, differentiating the pricing rule (9) with respect to y_h and n we obtain with the implicit function theorem

$$\frac{\partial y_h}{\partial n} = -\frac{2(1-\alpha+\beta)\lambda s_h s_f[n(a-\theta^*) + 2\lambda(1+n)y_h]}{S}$$

which is negative for $\lambda \geq 0$ or for $\lambda \leq 0$ together with small n and it is negative for large n. The parameter configuration $a = 10$, $s_h = 5$, $s_f = 1$, $\theta = 1$, $\theta^* = 0$, $\alpha = \beta = 1/2$, $\lambda = -1/10$, $n = 2$ satisfies all the non-negativity conditions for outputs, prices, profits, the second order condition and it documents a case where $\frac{\partial D^{FI}(\theta)}{\partial n} \leq 0$. On the other hand, the same parameters with $\lambda = -1/20$ satisfy all the above conditions but imply $\frac{\partial D^{FI}(\theta)}{\partial n} \geq 0$. ■

Proof of Lemma 1. With the Revelation Principle, we solve the regulatory game in which (i) the regulator sets a menu of contracts $\{(y_h(\theta), T(\theta))\}_{\theta\in\Theta}$, one for each possible value of θ; (ii) the firm makes an announcement $\hat{\theta}$ on its type, thus choosing a specific regulatory contract $(y_h(\hat{\theta}), T(\hat{\theta}))$; (iii) the regulatory policy effectively induces the firm to announce truthfully its type. The profit of type θ which announces $\hat{\theta}$ is $\Pi(\hat{\theta};\theta) = \Pi_h(\hat{\theta};\theta) + \Pi_f(\hat{\theta})$ with

$$\begin{aligned} &\Pi_h(\hat{\theta};\theta) \equiv y_h(\hat{\theta})\; p_h\left[y_h(\hat{\theta})\right] - SAC\left(y_h(\hat{\theta});\theta\right) - T(\hat{\theta}), \\ &\Pi_f(\hat{\theta}) \equiv \Pi_f(y_h(\hat{\theta})). \end{aligned} \tag{16}$$

We indicate as $\Pi_h(\theta)$, $\Pi_f(\theta)$, $\Pi(\theta)$ the profits when the firm truthfully announces its type, i.e. $\hat{\theta} = \theta$.

The regulatory problem then consists in maximizing expected welfare

$$\underset{\{(y_h(\theta),T(\theta))\}_{\theta\in\Theta}}{Max} \int_\Theta W(y_h(\theta);\theta)\; dF(\theta)$$

subject to the following set of constraints

$$\Pi(\theta) \geq \Pi\left(\hat{\theta};\theta\right) \quad \forall\left(\hat{\theta},\theta\right) \in \Theta\times\Theta \quad (IC(\theta))$$
$$\Pi_h(\theta) + \Pi_f(\theta) \geq \Pi_f^0 \quad \forall\theta\in\Theta \qquad (IR(\theta))$$

As usual constraint (IC) is equivalent to

$$\frac{d\Pi}{d\theta} = \frac{\partial\Pi}{\partial\theta} \tag{17}$$

and

$$\frac{\partial^2\Pi}{\partial y_h\partial\theta}\dot{y}_h(\theta) \geq 0 \tag{18}$$

where $\dot{y}_h(\theta) \equiv \frac{dy_h}{d\partial\theta}$. Following the first order approach (Guesnerie and Laffont, 1984), instead of analyzing the original program we study a relaxed program $(\mathcal{P}_r)$ in which we momentarily neglect constraint (18) (and we will verify ex-post if the solution of $(\mathcal{P}_r)$ verifies (18)),

$$(\mathcal{P}_r)\left\{\begin{array}{ll} \underset{\{y_h(.),T(.)\}}{Max} \int_\Theta W\ dF(\theta) & \\ \text{s.t.} & \\ \frac{d\Pi}{d\theta} = \frac{\partial\Pi}{\partial\theta} & (IC_r) \\ \Pi(\theta) \geq \Pi_f^0 \quad \forall\theta\in\Theta & (IR) \end{array}\right.$$

Being $\frac{\partial\Pi}{\partial\theta} = -\frac{\partial SAC}{\partial\theta} \leq 0$ it suffices to consider constraint (IR) for type $\overline{\theta}$. Furthermore, substituting for $T(.)$ the objective functions becomes as in (8) with $y_f = y_f(y_h(\theta))$ and $y_f^* = y_f^*(y_h(\theta))$ and we will maximize with respect to $\{y_h(.),\Pi(.)\}$. Integrating by parts $\int_\Theta \{-(1-\alpha)\Pi\}\,dF(\theta)$ the objective further specifies as

$$\int_\Theta \left\{V(y_h(\theta)) - SAC(y_h(\theta);\theta) - (1-\alpha)\frac{\partial\Pi(y_h(\theta),y_f(y_h(\theta));\theta)}{\partial\theta}\frac{F(\theta)}{f(\theta)} + (1-\alpha+\beta)\Pi_f(y_h(\theta), y_f(y_h(\theta)))\right\} dF(\theta) + \\ -(1-\alpha)\Pi\left(\bar{\theta}\right)$$

Maximizing with respect to $\Pi\left(\bar{\theta}\right)$ requires $\Pi\left(\bar{\theta}\right) = \Pi_f^0$ and optimizing for $y_h(\theta)$ we obtain (10) for any $\theta\in\Theta$. Integrating $\frac{d\Pi}{d\theta} = \frac{\partial\Pi}{\partial\theta} = -\frac{\partial SAC(y_h(\theta);\theta)}{\partial\theta}$ we have the following firm's profit,

$$\Pi(\theta) = \int_\theta^{\bar{\theta}} \frac{\partial SAC(y_h(u);u)}{\partial\theta}du + \Pi\left(\bar{\theta}\right).$$

Solving (10) for $y_h(\theta)$ we obtain equilibrium output $y_h^{AI}(\theta)$ and then expressing the domestic price from (10) we obtain the equilibrium regulated price which can be written as $p_h^{AI}(\theta) = p_h^{FI}(\theta) + D^{AI}(\theta)$.

Finally, we need to check the second order condition (18) which is equivalent to $\dot{y}_h(\theta) \leq 0$ since

$\frac{\partial^2 \Pi}{\partial y_h \partial \theta} = -\frac{\partial^2 SAC}{\partial y_h \partial \theta} \leq 0$. This requires determining under what conditions the equilibrium price $\frac{\partial p_h^{AI}(\theta)}{\partial \theta} \geq 0$ where, from the optimal pricing condition (10),

$$\frac{\partial p(y_h)}{\partial \theta} = \frac{\partial^2 SAC}{\partial \theta \partial y_h} + (1-\alpha) \frac{\partial \frac{F(\theta)}{f(\theta)}}{\partial \theta} \frac{\partial^2 SAC}{\partial \theta \partial y_h} + (1-\alpha) \frac{F(\theta)}{f(\theta)} \frac{\partial^3 SAC}{\partial \theta^2 \partial y_h}. \tag{19}$$

As usual $\frac{\partial p_h^{AI}(\theta)}{\partial \theta} \geq 0$ as long as the standard monotone hazard rate assumption $\partial \left(\frac{F(\theta)}{f(\theta)} \right) / \partial \theta \geq 0$ and $dp_h^{FI}(\theta)/d\theta \geq 0$ are met. ■

Proof of Proposition 2. Consider first the effect of foreign expansion on prices. In the case of dis-economies of scope the two effects illustrated in the text go in the same direction increasing the domestic price: i.e. $D^{FI}(\theta) \geq 0$ and $D^{AI}(\theta) \geq D^{BM}(\theta)$, so that we unambiguously have $p_h^{AI}(\theta) \geq \tilde{p}_h^{BM}(\theta)$.

For the case of scope economies, comparing the pricing rule in Lemma 1 with the pricing rule when the firm operates only at home and the regulator is not informed, i.e. (12), we have that the difference is in the term introduced by foreign activities $(1-\alpha+\beta)\frac{d\Pi_f}{dy_h} \propto -\frac{\partial^2 C}{\partial y_h \partial y_f} \leq 0$ where the inequality is true for any output y_h. Since this is also true for equilibrium output $y_h^{AI}(\theta)$ it follows $p_h^{AI}(\theta) \leq \tilde{p}_h^{BM}(\theta)$.

We now turn to the comparison of total welfare. For a given level of output y_h, the difference of the two objective functions in the reduced programs is

$$W^{AI} - W^{BM} = (1-\alpha+\beta) \int_\Theta \Pi_f(y_h, y_f(y_h)) \, dF(\theta) - (1-\alpha)\Pi_f^0.$$

Now, with economies of scope $\Pi_f(y_h, y_f(y_h)) \geq \Pi_f^0$ and the above difference is positive. Furthermore, since social value of home regulated output is larger when the firm also operates abroad, i.e.

$$V_h\left(y_h^{AI}(\theta)\right) - SAC\left(y_h^{AI}(\theta); \theta\right) \geq V_h\left(\tilde{y}_h^{BM}(\theta)\right) - SAC\left(\tilde{y}_h^{BM}(\theta); \theta\right),$$

it then follows that total welfare increases when the firm expands abroad.

With dis-economies, on the contrary, $\Pi_f(y_h, y_f(y_h)) < \Pi_f^0$ and, since $y_h^{AI}(\theta)$ is even further distorted with respect to $\tilde{y}_h^{BM}(\theta)$, the previous condition over social value of domestic output is reversed. However since the weight to foreign profits is larger due to β, foreign expansion can be still desirable from the welfare view point if β is sufficiently high and diseconomies are not too strong. ■

Proof of Corollary 1. First the non-negativity conditions for $y_h^{AI}(\theta)$ and $y_f(y_h^{AI}(\theta))$ respectively require

$$(2+n)^2(a-\theta) - (a-\theta^*)2\lambda(1+n)s_h(1-\alpha+\beta) - \lambda(2+n)^2\frac{F(\theta)}{f(\theta)} \geq 0,$$
$$a - \theta^* - 2\lambda(1+n)s_h(a-\theta) + (1-\alpha)\lambda(1+n)s_h\frac{F(\theta)}{f(\theta)} \geq 0.$$

These conditions will be used to derive the signs in the comparative statics analysis. With the model defined in (1) we have

$$D^{AI}(\theta) = (1-\alpha)\tfrac{F(\theta)}{f(\theta)}\tfrac{(2+n)^2}{S}$$
$$D^{AI}(\theta) - D^{BM}(\theta) = (1-\alpha+\beta)\lambda^2 2(n+1)^2 \tfrac{s_f s_h}{S}(1-\alpha)\tfrac{F(\theta)}{f(\theta)} \geq 0$$
$$p_h^{AI}(\theta) - \tilde{p}_h^{BM}(\theta) = (1-\alpha+\beta)\lambda 2(n+1)s_f\left[\tfrac{a-\theta^*-(n+1)\lambda s_h(a-\theta)}{S} + \lambda(n+1)\tfrac{s_h}{S}(1-\alpha)\tfrac{F(\theta)}{f(\theta)}\right]$$

With these expressions we have that $\frac{\partial D^{AI}(\theta)}{\partial \alpha} = -\frac{S+2s_f s_h(1-\alpha)\lambda^2(1+n)^2\frac{F(\theta)}{f(\theta)}}{S} \geq 0$ and all the other comparative statics for $D^{AI}(\theta)$ is immediate from simple calculations. Similarly, the comparative statics of $D^{AI}(\theta) - D^{BM}(\theta)$ is immediate except for $\frac{\partial[D^{AI}(\theta)-D^{BM}(\theta)]}{\partial \alpha} = -\frac{2s_f s_h \lambda^2[(1-\alpha+\beta)S+(1-\alpha)(2+n)^2]}{S^2}\frac{F(\theta)}{f(\theta)} \geq 0$.

The comparative statics on $p_h^{AI}(\theta)$ is in general more complicate. If $\lambda \leq (\geq) 0$, then $\frac{\partial p_h^{AI}(\theta)}{\partial \beta} \leq (\geq) 0$ and $\frac{\partial p_h^{AI}(\theta)}{\partial s_f} \leq (\geq) 0$ where the sign follows from $y_f\left(y_h^{AI}(\theta)\right) \geq 0$. $\frac{\partial p_h^{AI}(\theta)}{\partial s_h} \leq 0$ where the sign follows from $y_h^{AI}(\theta) \geq 0$. As in the case of full information $\frac{\partial p_h^{AI}(\theta)}{\partial n}$ is ambiguous with the same qualitative properties of the full information price. Similarly, $\frac{\partial p_h^{AI}(\theta)}{\partial \alpha}$ is ambiguous because we know that $\frac{\partial D^{FI}(\theta)}{\partial \alpha} \leq (\geq) 0$ if $\lambda \geq (\leq) 0$ but $D^{AI}(\theta)$ is decreasing in α. Finally, $\frac{\partial p_h^{AI}(\theta)}{\partial \lambda} \geq 0$ with $\lambda \leq 0$ for the same parameters that imply $y_h^{AI}(\theta) \geq 0$. ■

Proof of Proposition 3. The firm decides whether to expand abroad and take the appropriate regulatory policy by comparing the profit it can obtain in the two cases. We know from the previous analysis that the profits when the firm is and is not active abroad are respectively,

$$\Pi^{AI}(\theta) = \int_\theta^{\bar{\theta}} \frac{\partial SAC\left(y_h^{AI}(u); u\right)}{\partial \theta} du + \Pi_f^0, \quad \Pi^{BM}(\theta) = \int_\theta^{\bar{\theta}} \frac{\partial SAC\left(y_h^{BM}(u); u\right)}{\partial \theta} du,$$

and both $\Pi^{AI}(\theta)$ and $\Pi^{BM}(\theta)$ are increasing in the regulated output y_h. The results in Proposition 2 show that with scope economies $y_h^{AI}(\theta) \geq y_h^{BM}(\theta)$, so that we immediately have $\Pi^{AI}(\theta) \geq \Pi^{BM}(\theta)$ and the firm prefers to be active (also) in the foreign market.

When instead costs are characterized by dis-economies we have two countervailing effects. On one side dis-economies reduce regulated output when the firm is active abroad, thus depressing profits, on the other side being active abroad increases firm's outside option by the term Π_f^0. We then study how the difference between the profits in the two cases varies with θ :

$$\frac{d[\Pi^{AI}(\theta) - \Pi^{BM}(\theta)]}{d\theta} = \frac{\partial SAC\left(y_h^{BM}(\theta); \theta\right)}{\partial \theta} - \frac{\partial SAC\left(y_h^{AI}(\theta); \theta\right)}{\partial \theta} = -\int_{y_h^{BM}(\theta)}^{y_h^{AI}(\theta)} \frac{\partial^2 SAC(z; \theta)}{\partial \theta \partial y_h} dz \leq 0.$$

where the sign follows from $y_h^{AI}(\theta) \leq y_h^{BM}(\theta)$ with dis-economies. Since $\Pi^{AI}\left(\bar{\theta}\right) = \Pi_f^0 > \Pi^{BM}\left(\bar{\theta}\right) = 0$, there exists a $\tilde{\theta} < \bar{\theta}$ defined by $\Pi^{AI}\left(\tilde{\theta}\right) - \Pi^{BM}\left(\tilde{\theta}\right) = \Pi_f^0$ such that for all $\bar{\theta} \geq \theta \geq \tilde{\theta}$ the firm prefers to expand abroad and, conversely, for all $\theta \leq \tilde{\theta}$ the firm prefers to remain domestic. ■

Proof of Proposition 4. Here we study optimal regulation when the firm operates also abroad. Regulation of a firm acting only in the domestic market is unchanged.

Scope Economies. Proceeding as in the proof of Lemma 1 the reduced program is

$$(\mathcal{P}_r)\quad \begin{cases} \underset{\{y_h(.),T(.)\}}{Max} \int_\Theta W\ dF(\theta) \\ \text{s.t.} \\ \frac{d\Pi}{d\theta} = \frac{\partial \Pi}{\partial \theta} = -\frac{\partial C}{\partial \theta} + \frac{\partial \Pi_f}{\partial y_f^*}\frac{\partial y_f^*}{\partial \theta} \qquad (IC_r) \\ G(\theta) \geq 0 \quad (IR) \end{cases}$$

where $G(\theta) \equiv \Pi_h(\theta) + \Pi_f(\theta) - \Pi_f^0(\theta)$ is the extra-gain the firm obtains operating in both markets instead of being active only abroad. Note that $\partial \Pi/\partial \theta \leq 0$ and since $\frac{\partial C}{\partial \theta} = y_h + \delta\ y_f(y_h(\theta);\theta)$, $\frac{\partial \Pi_f}{\partial y_f^*} = -\frac{n}{s_f} y_f(y_h(\theta);\theta)$, $\frac{\partial y_f^*}{\partial \theta} = \frac{(\delta - 2\delta^*)s_f}{2+n}$, we obtain

$$\frac{\partial \Pi}{\partial \theta} = -y_h - 2\Delta(n)s_f \frac{a - \Delta(n)\theta - \theta^*}{(2+n)^2} + \lambda \frac{2(1+n)\Delta(n)s_f}{(2+n)^2} y_h.$$

The second order condition for incentive compatibility equivalent to (18) is $\partial^2 \Pi/(\partial y_h \partial \theta)\ \dot{y}_h(\theta) \geq 0$ where now

$$\frac{\partial^2 \Pi}{\partial \theta \partial y_h} = \frac{\partial^2 \Pi_h}{\partial y_h \partial \theta} + \frac{\partial^2 \Pi_f}{\partial y_h \partial \theta} = -1 + \lambda \frac{2(1+n)\Delta(n)s_f}{(2+n)^2} \leq 0, \tag{20}$$

so that, again, the second order condition simply requires domestic output to be non-increasing in θ, i.e. $\dot{y}_h(\theta) \leq 0$.

To deal with the participation constraint, we now show that $dG(\theta)/d\theta \leq 0$, so that the only individual rationality constraint one need to consider is $G\left(\bar{\theta}\right) \geq 0$. In fact,

$$\frac{dG(\theta)}{d\theta} = \frac{\partial \Pi\left(\hat{\theta} = \theta; \theta\right)}{\partial \hat{\theta}}\frac{\partial \hat{\theta}}{\partial \theta} + \frac{\partial \Pi\left(\hat{\theta} = \theta; \theta\right)}{\partial \theta} - \frac{\partial \Pi_f^0\left(\hat{\theta} = \theta; \theta\right)}{\partial \hat{\theta}}\frac{\partial \hat{\theta}}{\partial \theta} - \frac{\partial \Pi_f^0\left(\hat{\theta} = \theta; \theta\right)}{\partial \theta}$$

and then

$$\begin{aligned} \frac{dG(\theta)}{d\theta} &= -\left[\frac{\partial C}{\partial \theta}\left(y_h(\theta), y_f(\theta); \theta\right) - \frac{\partial C}{\partial \theta}\left(0, y_f^0(\theta); \theta\right)\right] + \left[\frac{\partial \Pi}{\partial y_f^*}\frac{\partial y_f^*}{\partial \theta} - \frac{\partial \Pi_f^0}{\partial y_f^*}\frac{\partial y_f^*(0;\theta)}{\partial \theta}\right] \\ &= -y_h + \lambda \frac{2(1+n)\Delta(n)s_f}{(2+n)^2} y_h. \end{aligned}$$

With economies of scope the first square bracket is positive and the second is negative so that $G(\theta)$ is decreasing.

Now, substituting $T(.)$ into the objective function we obtain welfare as in (8) where the profits appear decomposed in Π_h and Π_f whilst constraints are written in terms of total profits. Using $d\Pi_h/d\theta = d\Pi/d\theta - d\Pi_f/d\theta$, the expression for $d\Pi/d\theta$ in (IC_r) and the following expression for $d\Pi_f/d\theta$

$$\begin{aligned}&\tfrac{d\Pi_f(\theta,\theta)}{d\theta} = \tfrac{\partial\Pi_f}{\partial y_f}\left(\tfrac{\partial y_f}{\partial y_h}\dot{y}_h(\theta) + \tfrac{\partial y_f}{\partial\theta}\right) + \tfrac{\partial\Pi_f}{\partial y_f^*}\tfrac{\partial y_f^*}{\partial\theta} + \tfrac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) + \tfrac{\partial\Pi_f}{\partial\theta}\\ &= \tfrac{\partial\Pi_f}{\partial y_f^*}\tfrac{\partial y_f^*}{\partial\theta} + \tfrac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) - \tfrac{\partial IC}{\partial\theta},\end{aligned}$$

we obtain that $d\Pi/d\theta = \partial\Pi/\partial\theta$ is equivalent to $\frac{d\Pi_h}{d\theta} = -\frac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) - \frac{\partial SAC}{\partial\theta}$. Hence $(\mathcal{P}_r)$ can be conveniently rewritten,

$$(\mathcal{P}_r)\quad\left\{\begin{array}{l}\underset{\{y_h(.),\Pi_h(.)\}}{Max}\int_\Theta\{V(y_h) - SAC(y_h,\theta) - (1-\alpha)\Pi_h + \beta\Pi_f\}\ dF(\theta)\\ \text{s.t.}\\ \frac{d\Pi_h}{d\theta} = -\frac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) - \frac{\partial SAC}{\partial\theta}\quad(IC_r)\\ \Pi_h\left(\bar{\theta}\right) \geq \Pi_f^0\left(\bar{\theta}\right) - \Pi_f\left(\bar{\theta}\right)\quad(IR)\end{array}\right.$$

Integrating by parts the term $\int_\Theta\{-(1-\alpha)\Pi_h\}\,dF(\theta)$ and using (IC_r) the objective function becomes

$$\begin{aligned}&\int_\Theta\left\{V(y_h(\theta)) - SAC(y_h(\theta),\theta) - (1-\alpha)\left[\tfrac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) + \tfrac{\partial SAC}{\partial\theta}\right]\tfrac{F(\theta)}{f(\theta)} + \beta\Pi_f\right\}\ dF(\theta) +\\ &-(1-\alpha)\Pi_h\left(\bar{\theta}\right)\end{aligned}$$

Hence, it is optimal to make constraint (IR) binding so that $\Pi\left(\bar{\theta}\right) = \Pi_f^0\left(\bar{\theta}\right)$. Since the derivative of the control y_h appears in the objective function, to maximize the objective w.r.t. y_h one needs to employ calculus of variations. Let

$$\begin{aligned}&a \equiv \left[V(y_h(\theta)) - SAC(y_h(\theta),\theta) + \beta\Pi_f\right]f(\theta) - (1-\alpha)\tfrac{\partial SAC}{\partial\theta}F(\theta),\\ &b \equiv -(1-\alpha)\tfrac{\partial\Pi_f}{\partial y_h}F(\theta),\end{aligned}$$

so that the Euler's equation is $\partial a/\partial y_h = \partial b/\partial\theta$. Rearranging, it finally becomes (10) where $\partial^2\Pi/(\partial y_h\partial\theta)$ is the expression illustrated above. Integrating $\frac{d\Pi}{d\theta} = \frac{\partial\Pi}{\partial\theta}$, we also have the firm's equilibrium profit,

$$\Pi(\theta) = \int_\theta^{\bar{\theta}}\left\{\frac{\partial SAC\left(y_h(u), y_f(u); u\right)}{\partial\theta} - \frac{\partial\Pi_f\left(y_h(u), y_f(u), y_f^*(u); u\right)}{\partial y_f^*}\frac{\partial y_f^*}{\partial\theta}\right\}du + \Pi_f^0\left(\bar{\theta}\right).$$

Finally, we need to check the second order condition $\dot{y}_h(\theta) \leq 0$. Proceeding as in the proof of Lemma 1 we have that

$$\frac{\partial p(y_h)}{\partial\theta} = \frac{\partial^2 SAC}{\partial\theta\partial y_h} + (1-\alpha)\frac{\partial\frac{F(\theta)}{f(\theta)}}{\partial\theta}\left[\frac{\partial^2 SAC}{\partial\theta\partial y_h} - \frac{\partial^2\Pi_f}{\partial\theta\partial y_h}\right] + \\ + (1-\alpha)\frac{F(\theta)}{f(\theta)}\left[\frac{\partial^3 SAC}{\partial\theta\partial y_h\partial\theta} - \frac{\partial^3\Pi_f}{\partial\theta\partial y_h\partial\theta}\right] - (1-\alpha+\beta)\frac{\partial^2\Pi_f}{\partial\theta\partial y_h} \geq 0.$$

Dis-economies of scope . We cannot proceed directly with the proof for scope economies because here $\partial^2\Pi/(\partial y_h\partial\theta)$ has ambiguous sign since now $\partial^2\Pi_f/(\partial y_h\partial\theta) \geq 0$. However, if

$$\lambda \leq \frac{(2+n)^2}{2(1+n)\Delta(n)s_f} \tag{21}$$

so that dis-economies are not too large, then (20) is verified and the proof follows unchanged.

On the contrary, if dis-economies are strong so that the previous inequality is reversed, the second order condition for implementability requires $\dot{y}_h(\theta) \geq 0$ and we also have $dG/d\theta > 0$ so that it is optimal for the regulator to set the participation constraint binding for type $\underline{\theta}$ and have all other (IR) constraints verified. With standard substitutions we obtain the following reduced program

$$(\mathcal{P}_r)\quad \begin{cases} Max \int_\Theta \{V(y_h(\theta)) - SAC(y_h(\theta),\theta) - (1-\alpha)\Pi_h + \beta\Pi_f\}\ dF(\theta) \\ \text{s.t.} \\ \frac{d\Pi_h}{d\theta} = -\frac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) - \frac{\partial SAC}{\partial\theta} \\ \Pi_h(\underline{\theta};\underline{\theta}) = \Pi_f^0(\underline{\theta};\underline{\theta}) - \Pi_f(\underline{\theta};\underline{\theta}) \quad (IR) \end{cases}$$

Integrating by parts

$$\int_\Theta \Pi_h dF(\theta) = -\left[\Pi_h(\theta)(1-F(\theta))\right]_{\underline{\theta}}^{\overline{\theta}} + \int_\Theta \frac{d\Pi_h}{d\theta}(1-F(\theta))\,d\theta \\ = \Pi_h(\underline{\theta}) - \int_\Theta \left[\frac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) + \frac{\partial SAC}{\partial\theta}\right](1-F(\theta))\,d\theta$$

and, substituting, the objective function becomes

$$\int_\Theta \left\{V(y_h) - SAC(y_h,\theta) + (1-\alpha)\left[\frac{\partial\Pi_f}{\partial y_h}\dot{y}_h(\theta) + \frac{\partial SAC}{\partial\theta}\right]\frac{1-F(\theta)}{f(\theta)} + \beta\Pi_f\right\} dF(\theta) + \\ -(1-\alpha)\Pi_h(\underline{\theta}).$$

Defining

$$A \equiv [V(y_h(\theta)) - SAC(y_h(\theta),\theta) + \beta\Pi_f]\,f(\theta) + (1-\alpha)\frac{\partial SAC}{\partial\theta}[1-F(\theta)], \\ B \equiv (1-\alpha)\frac{\partial\Pi_f}{\partial y_h}[1-F(\theta)],$$

the Euler's equation $\partial A/\partial y_h = \partial B/\partial\theta$ becomes

$$p_h^{AI}(y_h(\theta)) = \frac{\partial SAC}{\partial y_h} - (1-\alpha+\beta)\frac{\partial\Pi_f}{\partial y_h} - (1-\alpha)\frac{1-F(\theta)}{f(\theta)}\left[\frac{\partial^2 SAC}{\partial\theta\partial y_h} - \frac{\partial^2\Pi_f}{\partial\theta\partial y_h}\right]$$

where

$$\frac{\partial^2 SAC}{\partial\theta\partial y_h} - \frac{\partial^2 \Pi_f}{\partial\theta\partial y_h} = \frac{(2+n)^2 - \lambda 2(1+n)\Delta(n)s_f}{(2+n)^2}.$$

We are then left to check the second order condition $\dot{y}_h(\theta) \geq 0$ that in this case requires

$$\frac{\partial p(y_h)}{\partial\theta} = \frac{\partial^2 SAC}{\partial\theta\partial y_h} - (1-\alpha+\beta)\frac{\partial^2\Pi_f}{\partial\theta\partial y_h} + \\ -(1-\alpha)\frac{\partial\frac{1-F(\theta)}{f(\theta)}}{\partial\theta}\left[\frac{\partial^2 SAC}{\partial\theta\partial y_h} - \frac{\partial^2\Pi_f}{\partial\theta\partial y_h}\right] - (1-\alpha)\frac{1-F(\theta)}{f(\theta)}\left[\frac{\partial^3 SAC}{\partial\theta\partial y_h\partial\theta} - \frac{\partial^3\Pi_f}{\partial\theta\partial y_h\partial\theta}\right] \leq 0$$

Substituting the expressions for costs and profits this is equivalent

$$1-(1-\alpha+\beta)\frac{\lambda 2(1+n)\Delta(n)s_f}{(2+n)^2} - (1-\alpha)\frac{\partial\frac{1-F(\theta)}{f(\theta)}}{\partial\theta}\frac{(2+n)^2 - \lambda 2(1+n)\Delta(n)s_f}{(2+n)^2} \leq 0. \tag{22}$$

With the standard assumption $[1-F(\theta)]/f(\theta)$ decreasing in θ, the last term in the previous expression is positive. Hence it follows that if λ is sufficiently large the previous condition (22) is met. On the contrary, for intermediate values of λ we have that (21) is satisfied while (22) is not, so that the second order condition is violated. In this case, optimal pricing requires bunching in a sub interval $\tilde{\Theta} \subseteq \Theta$ so that for any $\theta \in \tilde{\Theta}$ and $\theta' \in \tilde{\Theta}$ then $p_h^{AI}(\theta) = p_h^{AI}(\theta')$.[17] Finally, note that the condition for $\frac{\partial p_h^{FI}}{\partial\theta} \geq 0$ is $(2+n)^2 \leq (1-\alpha+\beta)\lambda 2(1+n)\Delta(n)s_f$ which shows that even if $\partial p_h^{FI}/\partial\theta \geq 0$, we may have that asymmetric information obliges the regulator to have $p_h^{AI}(\theta)$ (weakly) increasing over θ. ■

Proof of Corollaries 2. Note first that, as compared with profits of the model in the previous sections, $\Pi^{AI}(\theta)$ is here augmented by the term

$$-\int_\theta^{\bar{\theta}} \frac{\partial\Pi_f}{\partial\theta} du = \int_\theta^{\bar{\theta}} \left[\frac{\partial IC}{\partial\theta} - \frac{\partial\Pi_f}{\partial y_f^*}\frac{\partial y_f^*}{\partial\theta}\right] d\theta \geq 0.$$

Consider now the "standard" cases (economies of scope and weak dis-economies). Proceeding as in the proof of Proposition 3 we have

$$\Pi^{AI}(\theta) - \Pi^{BM}(\theta) = \int_\theta^{\bar{\theta}} \left\{\frac{\partial SAC\left(y_h^{AI}(u);u\right)}{\partial\theta} - \frac{\partial\Pi_f(u,u)}{\partial\theta}\right\} du + \Pi_f^0(\bar{\theta}) - \int_\theta^{\bar{\theta}} \frac{\partial SAC\left(y_h^{BM}(u);u\right)}{\partial\theta} du.$$

Furthermore, comparing the pricing conditions we now have

$$p_h^{AI} - p_h^{BM} = -(1-\alpha+\beta)\frac{d\Pi_f(y_h)}{dy_h} - (1-\alpha)\frac{F(\theta)}{f(\theta)}\frac{\partial^2\Pi_f}{\partial\theta\partial y_h}.$$

[17] The extremes of the interval $\tilde{\Theta}$ could be explicitly derived using the techniques illustrated in Guesnerie and Laffont (1984) and Fudenberg and Tirole (1991) chapter 7.

With economies of scope we immediately have $\Pi^{AI}(\theta) \geq \Pi^{BM}(\theta)$ so that the firm will always expand abroad. However, the effect on domestic consumers' surplus can be negative since comparing the pricing conditions we now have

$$p_h^{AI} - p_h^{BM} = -(1-\alpha+\beta)\frac{d\Pi_f(y_h)}{dy_h} - (1-\alpha)\frac{F(\theta)}{f(\theta)}\frac{\partial^2\Pi_f}{\partial\theta\partial y_h}$$

which has ambiguous sign. This also shows that, contrary to what stated in the proof of Proposition 2, also domestic welfare may reduce when the firm expands abroad and there are economies of scope.

With weak dis-economies the analysis is similar to the one in the proof of Propositions 2 and 3 with the only difference that since $\Pi^{AI}(\theta)$ is now increased by the term $-\int_{\theta}^{\bar{\theta}} \frac{\partial \Pi_f}{\partial \theta} du$ so that more efficient types will expand abroad, i.e. $\tilde{\theta}$ is lower than in the base model of Section 2. For the sake of completeness and although not explicitly discussed in the text of the Proposition, also notice that foreign expansion with diseconomies again tend to hurt domestic welfare (and not only domestic consumers) unless β is sufficiently large.

Consider now the non-standard case with dis-economies. From the firm's profit we have that the most efficient type now obtains profit $\Pi^{AI}(\underline{\theta}) = \Pi_f^0(\underline{\theta})$ which can be larger than what this firm obtains when remaining domestic. This also true for intermediate types so that, independently of firm's efficiency, the firm may want to expand abroad. ■