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Summary

In this paper, we study the impact of government's budget constraint on the optimal industrial policy in industries with increasing returns to scale. We show that privatization is preferred to regulation for intermediate values of the shadow cost of public funds (i.e., the Lagrange multiplier of the government's budget constraint). However, the advantage of privatization is likely to disappear once the product market allows the entry of more than one firm.

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1 Introduction

Between 1980 and 1996, state ownership in low income countries went from 16% to 8% of GDP (Megginson and Netter (2001)). In many cases, transfers of public ownership to private ownership has been grounded on the poor economic performance of public enterprises. Inefficiencies did not only emanate from the conflicts between governments' political objectives and the firm's economic objective (Shapiro-Willig (1990), Laffont-Tirole (1993)) but also from the existence of soft-budget constraints. Since less efficient firms were allowed to rely on the government for funding, they lacked the financial discipline required for efficient management (Dewatripont and Maskin (1995) and Schmidt (1996a, 1996b)). Hence after two decades of reforms, a new consensus emerged: in competitive industries privatization is the optimal industrial policy.

In practice privatization waves have coincided with growing public debts and large trade deficits.[1] This suggests that governments privatized public assets, not necessarily out of long run efficiency concerns, but to cope with critical budget situation. This is especially true in developing countries where privatization has been a major component of structural adjustment programs. International donors and creditors, like the World Bank or the IMF, made it a condition for economic assistance in reaction to the explosive debt crisis of the early 1980s. As a result about one third of the worldwide proceeds of privatization, which have now stabilized at $140 billion per year (Gibbon 1998, 2000), is to be accounted to the non-OECD countries

[1] For instance, the first Japanese privatization were initiated in 1982 when the Japanese public deficit reached 41.2% of GDP. Similarly in the U.S. Lopez-de-Silanes *et al.* (1997) show that, privatizations have been more likely in States where fiscal constraints were more binding.

(Mahboobi (2000)). The empirical evidences strongly suggest that the governments use these privatization's proceeds to relax their budget constraint. For instance using a panel of 18 developing countries, Davis *et al.* (2000) show that budgetary privatization proceeds are used to reduce domestic financing on a roughly one-for-one basis. Despite its empirical importance the link between a government's industrial policy and its budget constraint didn't receive much attention in the theoretical literature. This paper studies the role of the fiscal conditions in the privatization process of non competitive industries. It argues that in industries subject to weak competitive forces the fiscal interests of the government might conflict with efficiency concerns.

Market failures arise in markets with *natural monopolies* (i.e. firms with large economies of scale). According to Walras (1936), a legal monopoly should be set to prevent wasteful duplication of investments, and should be regulated to avoid the welfare loss associated to monopoly pricing. This has generally lead, notably in developing countries, to state control through public ownership. However, by imposing the output and prices the government must also assume responsibility for the firm's profits and losses. The possibility to transfer resources between the government and public firms generates a soft-budget constraint. Under incomplete information, the government can hardly discriminate between good and bad project and/or management. Ex-post, governments are likely to transfer too much resources to inefficient firms (through subsidies and taxation, or through soft bank credit and trade credit). Kornai (2001) provides evidence of the use of soft-budget constraints by state-owned enterprises.

Privatization eliminates the soft-budget constraint. Because managers and/or owners of privatized firms assume the full responsibility for the firm's cash flows, the government is not constrained to transfer resources to unlucky firms. However, the elimination of the soft-budget constraint has a cost. On the one hand, the government is not able to take advantage of the positive cash flows in the profitable firms. On the other hand, the removal of the control on the private firm's prices has a cost to consumers in terms of higher prices and lower output. Indeed empirical studies reveal that privatization results in lower prices and higher output in competitive industries only. With natural monopolies, changing the ownership structure does not solve for the lack of competitive pressure. Privatized natural monopolies should either be regulated, or their output prices will increase. The problem is that developing countries often lack the institutions to credibly enforce regulation and concession contracts. For instance, according to a World Bank database on Latin America, the concessions that were granted to private operators following the divestiture of public firms have been renegotiated after an average 2.1 years only (see Laffont 2001).

The question addressed in this paper is whether the elimination of soft-budget constraint together with the cash-flow generated by privatization compensate for the market inefficiencies associated with private monopolies and oligopolies. Here privatization is treated as the move from regulation to *laissez-faire*. It does not only involve a transfer of ownership but it also includes the deregulation of prices (market liberalization). This definition particularly fits to developing countries in which, as argued above, price control by governmental agencies can hardly be set up and/or trusted. We also consider the government budget constraint. As in Laffont & Tirole (1993), we assume that the shadow cost of public funds summarizes the tightness of this constraint, larger shadow costs of public funds stemming from tighter budget constraint. In developing countries, inefficient taxation systems and large public deficits lead to high shadow costs of public funds.

The paper shows that with profitable natural monopoly, the optimal industrial policy is non monotone in the shadow cost of public funds. When the shadow cost of public fund is high the government's option to tax the firm's profits is particularly appealing. In order to maximize the tax revenues prices are chosen close to the private monopoly prices. In contrast, when the shadow cost of public funds is low, the government puts more weight on the consumer surplus. It then sets prices close to marginal cost and subsidizes the firm to cover its fixed costs. Rises in the shadow cost of public funds increase the social cost of such transfers. The government prefers to let a private firm operate in the market for intermediate values of the shadow cost of public funds. For very low values of the shadow cost (i.e., when bailouts are cheap) or very large values (i.e. when 'holdup' on profitable industries are valuable) it prefers to set up a regulated monopoly. This result is interesting because it is not intuitive and has potential important policy implications. That is, divestiture of profitable public firms is not necessarily the best policy for the government of a developing country. As shown in this paper the privatization proceeds do not necessarily compensate for the tax revenue losses and for the prices distortion due to the monopoly power of the newly privatized firm.

In industries with low ex-ante profitability, the optimal industrial policy is monotone in the shadow cost of public funds. That is, it exists a threshold above which privatization is optimal; for lower value of the shadow cost, regulation is preferred. This implies that for infrastructures such as road, railroad, water or electricity distribution network, regulation is optimal for a wealthy nation while it is not necessarily optimal for a developing country. The intuition is simple. There is a public good aspect to these investments, which moreover generate externalities. As recommended by standard microeconomy in nations with wealthy public finance the government regulates these activities. Now in developing countries where the government faces tight budget constraint, it cannot finance these sunk costs. Privatization is the alternative to the absence of public financing. It is indeed better to have a privately owned and operated infrastructure, even with the monopoly distortion, than no infrastructure at all.

Finally when the ex-ante profitability rises, the market allows the entry of more than one firm. The paper shows that the advantage of private structures is then likely to disappear. In this case, the negative impacts of market power and excessive entry in private Cournot oligopolies are likely to be overcome by the positive effect of a regulated oligopoly (i.e., 'sampling gains'). Although this result contrasts with standard privatization theories in which larger markets favor privatization (see for instance Vickers and Yarrow (1991) and Segal (1998)), it is congruent with the theory of adverse selection in which a rise in the number of agents reduces the cost of information revelation (Auriol & Laffont (1993)).

The paper is organized as follows. Section 2 presents the model and the main assumptions. Section 3 compares the performance of private and regulated monopolies while Section 4 studies the duopoly case. Section 5 derives the optimal industrial policy. Section 6 summarizes our results and offers some concluding remarks.

2 The model

We consider a problem of industrial policy setting. The government has to decide whether an industry characterized by increasing returns to scale should be under public or private control. In line with Laffont and Tirole (1993), we call *regulation regime* the regime in which the government controls the production of a *regulated firm*. The government's control rights are associated with accountability on profits and losses. That is, it must subsidize the firm in case of losses whereas it can tax the regulated firm in case of profits. Concretely, in the context of a developing country, this corresponds to public ownership. In contrast, we call *private regime* the regime in which the government imposes no control on the operations of a *private firm*, and it takes no responsibility for the firm's profits or losses. No transfers are possible between the private firm and the government after production has taken place. Nevertheless the government might control the entry of the private firms through licence fees.

To keep the analysis simple we consider a linear product demand which can be seen as a linearization of a more general demand function. The inverse demand function for $Q \geq 0$ units of the commodity is given by

$$P(Q) = a - bQ \tag{1}$$

where $a > 0$ and $b > 0$ are common knowledge. The gross consumer surplus is therefore

$$S(Q) = \int_0^Q P(x)dx = aQ - \frac{b}{2}Q^2. \tag{2}$$

We focus on industries characterized by increasing returns to scale. There are N firms in the industry. Firm $i \in \{1, ..., N\}$ produces output q_i. The total production in the industry is $Q = \sum_{i=1}^{N} q_i$. Firm $i \in \{1, ..., N\}$ has the following cost function:

$$C(\beta_i, q_i, K) = K + \beta_i q_i, \tag{3}$$

As in Baron-Myerson (1982), the cost function includes a fixed cost $K > 0$, and an idiosyncratic marginal cost β_i. The fixed cost K is so large that the maximal number of firms N that survive in the market is small. We restrict our analysis to $N \in \{0, 1, 2\}$.

Firm i must make the investment K before discovering β_i. Neither the government nor the competitors of firm i observe this firm-specific cost parameter. For each firm, the parameter β_i is independently drawn from the support $[\underline{\beta}, \bar{\beta}]$ according to the density and cumulative distribution functions $g(\cdot)$ and $G(\cdot)$. The expectation operator is denoted E such that $E[h(\beta)] = \int_{\underline{\beta}}^{\bar{\beta}} h(\beta)dG(\beta)$. We denote the average marginal cost by $E\beta$, the variance of marginal cost by $\sigma^2 = \text{var}(\beta)$.

The firms are profit maximizer. The profit of firm i is

$$\Pi_i = P(Q)q_i - C(\beta_i, q_i, K) + t_i \tag{4}$$

where t_i is the net transfer that the firm gets from the government (subsidy minus tax and franchise fee).

The government is utilitarian. It aims at maximizing the sum of consumer and producer surpluses minus the social cost of transferring public funds to the firm(s). The transfer to the firm(s) can either be positive (i.e., a subsidy), or negative (i.e., a tax). The government's objective function is

$$W = S(Q) - \sum_{i=1}^{N} C(\beta_i, q_i, K) - \lambda \sum_{i=1}^{N} t_i \tag{5}$$

where λ is the shadow cost of public funds.[2]

The shadow cost of public funds, λ, drives the results of the paper. This shadow cost, which can be interpreted as the Lagrange multiplier of the government budget constraint, measures the social cost of the government's

[2]The analysis and the results of the paper are consistent with a less optimistic view of government objectives. It is just a matter of interpretation of λ. With a non benevolent government, λ is the weight the government puts on the transfers it can get out of the firms (e.g., bribes).

economic intervention. For λ close to 0, the government maximizes the net consumers' surplus; for larger λ, the government puts some weight on the social cost of transfers. The shadow cost of public funds is positive because transfers to regulated firms imply either a decrease in the production of public goods, such as schooling and health care, or an increase in distortionary taxation. Each dollar that is transferred to the regulated firm costs $1 + \lambda$ dollars to society. In developed economies, λ is mainly equal to the deadweight loss accrued to imperfect income taxation. It is assessed to be around 0.3 (Snower & Warren, 1996). In developing countries, low income levels and difficulties in implementing effective taxation programs are strong constraints on the government's budget, which leads to higher values of λ. The World Bank (1998) suggests a shadow cost of 0.9. This number masks the diversity of developing countries fiscal situation. In particular, the value is much higher in countries close to financial bankruptcy.

3 Private versus regulated monopoly

When K is large, a natural monopoly emerges: $N \in \{0, 1\}$. Since there is at most one firm, the firm index i can be temporarily dropped. The production of the monopoly is equal to the total production Q. Regulation aims at correcting the distortion associated with monopoly pricing in the *laissez-faire* situation. Theory in regulation suggests that, at worse, a benevolent regulator should be able to mimic the choice of a private firm. Hence, welfare should never be smaller under regulation than under *laissez-faire*. Although regulation always dominates *laissez-faire* under complete information, we show that it is not always the best policy under asymmetric information.

3.1 Private monopoly

The production levels of *private monopolies* (henceforth PM) are not controlled by the government. The government can nevertheless control the entry of private monopolies by auctioning the right to operate. Let $F \geq 0$ be the franchise fee that the private firm pays to the government in order to operate in the product market. The private monopoly contemplates the following sequential choices. First, the monopoly chooses to enter the market by paying the franchise fee F and by making the investment K. If it enters, then nature chooses the marginal cost β according to the distribution $G(\cdot)$. The private firm learns β and chooses a production level Q. After the realization of β, the private firm never pays or receives a transfer from the government.

The profit of the private monopoly is therefore

$$\Pi^{PM} = \max_{Q} P(Q)Q - C(\beta, Q, K) - F, \tag{6}$$

and the optimal production is independent of K and F:

$$Q^{PM} = \frac{a - \beta}{2b}. \tag{7}$$

If a is smaller than the firm's marginal cost β, the production level falls to 0. In order to rule out corner solution in the sequel of the paper, we assume that a is not too small.

A1 $$a \geq \max\left\{2\overline{\beta}, \overline{\beta} + \frac{G(\overline{\beta})}{g(\overline{\beta})}\right\}$$

Substituting Q^{PM} in equations (4) and (5), we get the ex-ante profit and welfare of a private monopoly,

$$E\Pi^{PM} = \frac{1}{2}V - K - F, \tag{8}$$

$$EW^{PM}(\lambda) = \frac{3}{4}V - K + \lambda F \tag{9}$$

where

$$V = \frac{E(a-\beta)^2}{2b} = \frac{(a-E\beta)^2}{2b} + \frac{\sigma^2}{2b}. \qquad (10)$$

The value of operating the firm after the investment is made is measured by V which can be separated into two components: the value at the average cost, $(a-E\beta)^2/2b$, and the value of the cost spread, $\sigma^2/2b$. A more risky project increases the ex-ante profit and welfare of a private monopoly. This comes from the fact that the firm chooses its production level once it knows β. It can tailor production according to the realized value of β, rather than to its expected value $E\beta$. This production flexibility is more valuable as the spread around the mean rises.[3]

A monopoly is *privately feasible* if it is ex-ante profitable, i.e. if $E\Pi^{PM} \geq 0$. This requires $\frac{1}{2}V \geq K$ and $F \in [0, \frac{1}{2}V - K]$. Similarly a monopoly is *socially valuable* if it brings ex-ante positive welfare, i.e. if $EW^{PM} \geq 0$. It is easy to check that monopolies are socially valuable but privately infeasible if $\frac{3}{4}V > K > \frac{1}{2}V$. Because of the government need for cash, the ex-ante welfare $EW^{PM}(\lambda)$ increases linearly with F. The maximal entry fee that the government can collect is the maximum price a risk neutral entrepreneur would agree to pay for the monopoly concession:

$$F^* \equiv \max\{0, \frac{1}{2}V - K\}.$$

In practice private investors, especially foreign ones, will never agree to pay F^*. They are going to ask for a discount to compensate for the perceived risk of conducting business in a developing country. The privatization proceeds are lower in poor countries than in richer ones (despite sometimes a large

[3]Technically this property reflects the fact that profits and welfare are convex functions of the cost parameter β.

number of privatization).[4] Because of the instability, lack of transparency and predictability of political and judicial institutions, the government will generally collect $F < F^*$. To check the robustness of the privatization results we consider $F \in [0, F^*]$.

3.2 Regulated monopoly.

Under the regulation regime, the government monitors the production of any *regulated monopoly* (RM here after). In contrast to the *laissez-faire* situation, the government is accountable for the operating profits and losses of the firm. This creates a soft-budget constraint from which the firm benefits (i.e., the regulated monopoly is always ex-post profitable). Since it has private information about its cost parameter, it gets subsidized more often than necessary.

The timing is as follows: The government firstly decides to make the investment K. Secondly, nature chooses the marginal cost β according to the distribution function $G(\cdot)$. Thirdly, the regulated firm's manager learns β, but the government does not. The government proposes a production and transfer scheme $(Q(\cdot), t(\cdot))$. Finally the regulated firm reveals the information $\widehat{\beta}$ and production takes place according to the contract $(Q(\widehat{\beta}), t(\widehat{\beta}))$.

[4] According to the US National Center for Policy Analysis for the period 1988-1995: "Latin America and the Caribbean was the leading privatization region with total sales of about \$ 54 billion or 46 percent of the total amount of proceeds from privatization. East Asia was next with sales of \$28 billion or 25 percent, followed by Europe and Central Asia (which includes the formerly planned economies of Central and Eastern Europe and the former Soviet Union) with almost \$20 billion or 17 percent. The rest of the developing world combined [including Africa] was responsible for only about 12 percent of the value of sales." ('Privatization: Privatization Trends in Developing Countries' 1997, http://www.ncpa.org/pd/private/oct98ab.html)

We first study the benchmark case of regulation under symmetric information.

3.2.1 Symmetric information

When the realization of β is publicly observed the government solves

$$\max_{\{Q,t\}} W \text{ s.t. } \Pi \geq 0 \tag{11}$$

with W and Π defined in (5) and (4). Since λ is positive, transfers to the regulated firm are costly and must be reduced down to the break-even point $\Pi = 0$. That is, $t^{RM} = -P(Q)Q + K + \beta Q$. Substituting this expression in W and maximizing W with respect to Q yields

$$Q^{RM}(\beta) = \frac{1+\lambda}{1+2\lambda}\frac{a-\beta}{b}. \tag{12}$$

Inserting Q^{RM} in (5) gives the ex-ante welfare under symmetric information

$$EW^{RM}(\lambda) = (1+\lambda)\left(\frac{1+\lambda}{1+2\lambda}V - K\right) \tag{13}$$

where V is defined in equation (10). The government invests K in a regulated firm only if (13) is positive. The ex-ante welfare increases in V. It is non-monotonic in λ if $\frac{1}{2}V > K$. That is, it decreases for small λ and increases for large λ. This deserves a comment.

For small λ, the government incurs small social costs of transferring money to the regulated firm. It then chooses quantities that are close to the first best level which means a price that is close to marginal cost. Indeed, $lim_{\lambda \to 0} Q^{RM} = (a-\beta)/b$ and therefore $P[(a-\beta)/b] = \beta$. At this price, the regulated monopoly cannot recover its fixed cost. The loss is compensated by a transfer to the firm $t = K > 0$. By continuity, the government will subsidize the regulated firm as long as λ remains small enough. In contrast, for large λ, the government is more interested in receiving transfers from the firm than in consumers surplus. Since Q^{RM} is a decreasing function of λ, the government sets production such that a positive profit is made and then confiscated through taxes. As λ becomes very large, the government seeks the maximal revenue from the from state-owned firm. It chooses the production level of a private monopoly (i.e., $lim_{\lambda\to\infty}Q^{RM} = Q^{PM} = (a-\beta)/2b$). Regulation is then used to collect public funds. "Taxation by regulation" occurs both in rich and poor countries.[5] However "On the whole this non-tax revenue is more important for developing than opposed to industrial countries, comprising about 21 percent compared to 10 percent of total revenue (IMF 1989)." (Burgess and Stern (1993) page 782). Despite the privatizations waves recent evidences of significant use of public firms as sources of revenues in less developed countries has been offered by the World Bank. Over the period 1990-95, tax collected from public firms amounted to 8% of GDP in Bolivia, 2.2% in Brazil, 5% in Chile, 1% in India, 3% in Mexico, 3% in Peru (World Bank 1998).

3.2.2 Asymmetric information

Under asymmetric information, β is not observed by the government. The government must design the contracts such that the regulated firm (henceforth RMI) reveals its private information. Incentive compatibility constraints are added to the previous problem. By virtue of the revelation principle, the analysis is restricted to direct truthful revelation mechanism

[5] For instance, the US Telecommunication Act of 1996 directed the FCC to subsidize internet services to schools and libraries. The discount, estimated to cost \$2.25 billion per year by Hausman (1997), has been funded by an increase in price on interstate telephone services. This form of indirect taxation took place in the U.S. because Congress wanted to implement social programs but was unwilling (or unable) to increase general taxes.

($\widehat{\beta} = \beta$). To avoid the technicalities of 'bunching' we make the classical monotone hazard rate assumption:

A2 $\quad G(\beta)/g(\beta)$ is non decreasing

We define the *virtual cost* as

$$v(\beta, \lambda) = \beta + \frac{\lambda}{1+\lambda} \frac{G(\beta)}{g(\beta)}. \tag{14}$$

The virtual cost includes the marginal cost of production, β, and the marginal cost of information acquisition, $\frac{\lambda}{1+\lambda}\frac{G(\beta)}{g(\beta)}$. We deduce that $v(\beta, \lambda) \geq \beta$, and by A2, that $v(\beta, \lambda)$ increases in β and λ. Let

$$V^{RMI}(\lambda) = \frac{E(a - v(\beta, \lambda))^2}{2b} \tag{15}$$

This implies that $V^{RMI}(\lambda)$ decreases in λ. Following the Baron-Myerson's (1982) approach, we deduce the following lemma.

Lemma 1 *Under asymmetric information, the optimal production and the ex-ante welfare of a regulated monopoly are those of the symmetric information case evaluated at the* virtual cost $v(\beta, \lambda)$. *That is,*

$$Q^{RMI}(\beta) = Q^{RM}(v(\beta, \lambda)) \tag{16}$$

$$EW^{RMI}(\lambda) = (1+\lambda)\left(\frac{1+\lambda}{1+2\lambda} V^{RMI}(\lambda) - K\right) \tag{17}$$

The quantity produced by a regulated monopoly under asymmetric information is the quantity of a regulated monopoly under symmetric information valued at the *virtual cost.* Since $v(\beta, \lambda) \geq \beta$, we deduce that $Q^{RMI}(\beta) \leq Q^{RM}(\beta)$ for any β. Moreover, since $v(\beta, \lambda)$ increases in β, the distortion is higher at larger marginal costs. Indeed by lowering the production of inefficient firms, the government reduces the overall incentive to inflate cost report.

Comparing (10) and (15) it is easy to verify that $V^{RMI}(\lambda) \leq V$ for all $\lambda \geq 0$. Hence, the ex-ante welfare of a regulated monopoly is lower under asymmetric information than under symmetric information:

$$EW^{RMI}(\lambda) \leq W^{RM}(\lambda). \tag{18}$$

In the next section we compare the welfare levels generated by a private monopoly with those of a regulated monopoly.

3.3 Regulation versus privatization

As a benchmark case we first consider the symmetric information case.

Proposition 1 *Under symmetric information, regulated monopoly dominates privately feasible monopoly, whether the latter is franchised or not.*

Proof: See Appendix 1.

Proposition 1 is very intuitive. Under symmetric information a benevolent government cannot do worse than a private monopoly because, for any realization of β, it can always replicate the outcome of the private firm.

However, it is easy to show that, for large shadow costs of public funds, a regulated monopoly under symmetric information does not bring much more welfare than a private monopoly when the latter pays the maximal franchise fee, $F = F^*$. The welfare function under regulated monopoly then is equal to $EW^{RM}(\lambda) = ((1+\lambda)/(1+2\lambda))V/2 + (1+\lambda)(V/2-K)$, whereas the welfare function under private monopoly is equal to $EW^{PM}(\lambda) = V/4 + (1+\lambda)(V/2-K)$. One can check that the two welfare functions have a common asymptote with slope $V/2-K$. The welfare of a regulated monopoly coincides with the welfare of a private monopoly for large λ. From this argument, we can infer that the additional cost introduced by the asymmetry of information in the regulated monopoly gives a welfare advantage to the private monopoly for large λ. That is, under asymmetric information, the welfare function of the regulated monopoly has an asymptote with (negative or positive) slope $\lim_{\lambda\to+\infty} EW^{RMI}(\lambda)/\lambda < V/2 - K$. We deduce that privately feasible monopolies can dominate regulated monopolies. The next proposition formalises this result.

Proposition 2 *Suppose that a monopoly is privately feasible,* $V/2 - K \geq 0$*. Let the franchise fee be* $F \in [0, F^*]$ *and let* $F^\infty \equiv \lim_{\lambda\to\infty} EW^{RMI}(\lambda)/\lambda$*. Then,*

(i) *For* $F^\infty < F \leq F^*$*, there exists a threshold,* $\hat{\lambda}_F$*, such that privatization dominates regulation if and only if* $\lambda > \widehat{\lambda}_F$*.*

(ii) *For* $0 \leq F \leq F^\infty$ *there may exist two thresholds* $(\hat{\lambda}_F, \widetilde{\lambda}_F)$ *such that privatization dominates regulation if and only if* $\widehat{\lambda}_F < \lambda < \widetilde{\lambda}_F$*.*

(iii) *Larger* F *increases the preference for private feasible monopolies:* $\widehat{\lambda}_F$ *decreases with* F *and* $\tilde{\lambda}_F$ *increases with* F*.*

Proof: See Appendix 2.

Figure 1 illustrates Proposition 2. It is drawn for $V > 2K$. The bold solid curve represents the ex-ante welfare of regulated monopoly under symmetric information (RM) and the bold dashed curve displays ex-ante welfare under asymmetric information (RMI). The ex-ante welfare of regulated monopoly is non-monotone in λ. It is higher for low or high values of λ than for intermediate values. The thin solid lines represent the two bound of ex-ante welfare of a private monopoly (PM). When $F = F^*$, the shadow costs supporting privatization belong to the interval $[\widehat{\lambda}_{F^*}, +\infty)$ (i). When $F = 0$, the shadow costs supporting privatization belong to the closed interval $[\widehat{\lambda}_0, \widetilde{\lambda}_0]$ where $\widehat{\lambda}_{F^*} < \widehat{\lambda}_0 < \widetilde{\lambda}_0$ (ii). The use of franchise fee, $F \in [0, F^*]$, increases the

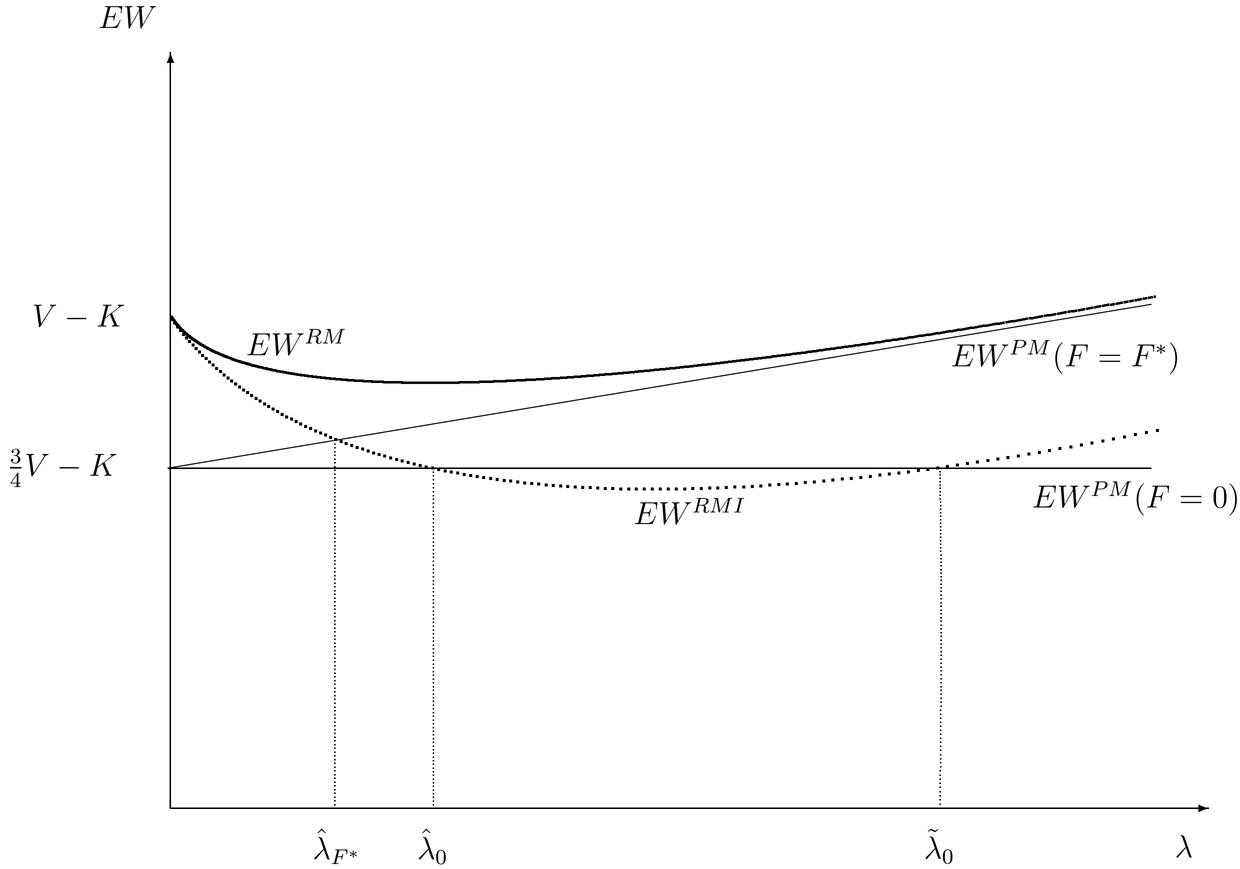

Figure 1: Welfare for Private and Regulated Monopoly

benefits from privatization (iii). That is, $[\widehat{\lambda}_0, \widetilde{\lambda}_0] \subset [\widehat{\lambda}_F, \widetilde{\lambda}_F] \subset [\widehat{\lambda}_{F^*}, +\infty)$

Figure 1: Welfare for Private and Regulated Monopoly.

A private entrepreneur enters the business if his/her firm is ex-ante profitable. After the investment, the private firm makes a large or a low operating profit depending on the realization of technical/demand uncertainties. A private entrepreneur, who bets her own assets (or the shareholders' ones) in the firm, is accountable for these profits and losses. In contrast, under regulation, accountability lies on the government side; the business risk is borne by the government that may have to grant subsidies to unlucky regulated firms. Under symmetric information, the soft-budget constraint plays no role because the government is able to perfectly monitor the cost and the profit of the firm. This is illustrated in figure 1 by the fact that, even for $F = F^*$, $EW^{RM}(\lambda)$ is always above $EW^{PM}(\lambda)$. However, under asymmetric information, the regulated firm uses the soft-budget constraint to acquire a positive informational rent. The government prefers that the private sector takes over when the social cost associated with the soft-budget constraint outweighs the social benefit of controlling the firm's operation. The use of a franchise fee accentuates the preference for private feasible monopolies.

Proposition 2 highlights the unconventional role of the shadow cost of public funds in the government's choice of industrial policy. Under optimal franchising, privatization dominates regulation once the cost of public funds reaches the threshold $\hat{\lambda}_{F^*}$. Since in wealthy nations governments are able to sell their public assets efficiently, the privatization waves of the eighties and nineties are consistent with higher pressures on the government budget constraint. Indeed an increase of the shadow cost of public funds corresponds in figure 1 to a horizontal shift to the right. That is, for F close enough to F^*, a move towards privatization. The practical relevance of this conclusion depends on the critical value $\hat{\lambda}_{F^*}$. Estimating $\hat{\lambda}_{F^*}$ is an empirical issue. Nevertheless in the next section we are able to compute admissible minimal bounds, denoted $\hat{\lambda}$, under which, in the context of our theoretical model, privatization is never optimal. It is conforting to check that these critical values are in the range of the shadow cost of public fund of the rich countries at the time of the reforms.

In developing economies the shadow cost of public fund is higher than in rich countries. Simultaneously the franchise fees that private entrepreneurs are ready to pay for a monopoly concession are, every thing else being equal, lower because of the additional risk of doing business in a poor country. With imperfect franchising, privatization dominates regulation when the cost of public funds belongs to the interval $[\hat{\lambda}_F, \tilde{\lambda}_F]$; for lower and larger value of λ regulation dominates privatization (see proposition 2 and figure 1). We conclude that for similar markets, the optimal industrial policy might differ widely depending on whether a country is wealthy or not. Rich countries are able to sell public assets efficiently, to regulate the newly privatized firms when it is necessary, and to compensate the potential decrease in government revenue by an increase in taxes. Developing countries are not able to do the same. Privatization of profitable public firms is not necessarily optimal for them. The telecommunication industry provides a good illustration of this problem: "*A PTT[Post and Telecommunication Company]'s yearly revenues (especially charges from international call) were used by governments to subsidize mail service, or to ease yearly budget deficits. Given this* *public convenience and necessity, the interests of third world governments are often diametrically opposed to telecom policies of privatization and network deregulation favored by wealthy nations.*" (Anania 1992). Privatizations in many developing countries, especially in Africa, then remain controversial. They have been qualified of "economic recolonization". To avoid being accused of selling "national assets", governments resist the privatization of the profitable state owned enterprises.[6] For instance Namibia is one of the few country with no plans to privatize, mainly because its publics enterprises are operating at a profit (Harsch 2002). Governments also resist privatization of their public utilities. "*At the end of 1995, not only were the larger enterprises in Africa, predominantly utilities, not included in privatization programs, in many cases they were specifically excluded. In the power sector, only two utilities -in Côte d'Ivoire and Guniea- had been privatized, although there were two cases (Gambia and Sao Tomé & Principe) where management contracts had been entered into. There is a long way to go from those four utilities to privatizing the remaining 53 power utilities across Africa.*" (Sarbib 1997).

Proposition 2 contrasts with the results obtained in the main strand of the literature on soft-budget constraint (see for instance Schmidt (1996b), Maskin (1999) and Segal (1998)). In this literature, privatization is socially efficient because it avoids the time-inconsistency problem raised by regulation. That is, under regulation the firm anticipates that subsidies to unprofitable firms will be granted since such subsidies are *ex-post* efficient. Hence, a firm with low profitability prospects will *ex-ante* deflate its investment level, which is inefficient. Here, the investment K is fixed and common knowledge. The choice between the regulated and the private regime is made *before* the

[6] One third of the privatizations to end 1996 in Africa were liquidations or asset sales of unprofitable firms (Sarbib 1997).

investment is realized. Therefore, the government is not allowed to take advantage of any investment sunk by the private sector. Still, privatization is socially desirable due to macro-economic considerations.

4 Private and regulated duopoly

We next explore industry structure when the fixed cost K becomes smaller or equivalently, when the value of operating the firm after investment, V, becomes larger. This is important because in the last two decades some industries (e.g., telecommunication) have experienced dramatic technological and/or demand changes resulting both in a decrease in fixed costs and an increase in demand. Moreover, for a given industry the demand is generally weaker in developing countries than in industrialized countries, resulting in lower V (i.e., for the same population size, both the number of consumers and their propensity to pay are lower). This difference might imply again a different industrial policy depending on whether the country is wealthy or not. From figure 1, it is easy to see that a private monopoly is less likely to be preferred to a regulated monopoly as K/V diminishes. However this result is not complete. For lower K/V, more than one private firm may enter the market and the government can improve welfare by setting up more than one regulated firm. In the next section we study the case of a private duopoly.

4.1 Private duopoly

To simplify the exposition we rule out in this section franchising: $F = 0$. This is done without loss of generality.[7] Private duopoly (PD here after)

[7] Considering $F > 0$ would only reinforce the results of the paper because franchise fees are higher with a monopoly than with a duopoly. Allowing for them would favors further

is modeled as Cournot duopoly with asymmetric information between firms. Each firm gets private information on its own marginal cost but it is not informed about the competitor's marginal cost. As in any Cournot game, each firm maximizes its profit taking the other firm's output as given. The timing of the game is as follows: First both firms $i \in \{1,2\}$ simultaneously make the investments K. Second, each firm i learns the realization of its own marginal cost β_i and chooses its production level q_i.

The equilibrium concept is Bayesian Nash equilibrium:

$$q_i^* \in arg\max_{q_i} E_{\beta_j}\left[(a - b(q_i + q_j^*))q_i - \beta_i q_i\right] \quad \forall i = 1, 2, j \neq i. \tag{19}$$

Due to the linear shapes of the demand and cost functions, firm i's best response strategy is equal to $q_i^*(\beta_i) = (2a + E\beta - 3\beta_i)/6b$.[8] The existence of a duopoly with both firms producing at the equilibrium requires that $a \geq \left(3\bar{\beta} - E\beta\right)/2$, which is true under assumption A1. Substituting $(q_1^*(\beta_1), q_2^*(\beta_2))$ in (4) and (5), we compute the ex-ante firm profit and the industry welfare of the Cournot duopoly

$$E\Pi^{PD} = \frac{2}{9}V + \frac{5}{18}\frac{\sigma^2}{2b} - K, \tag{20}$$

$$EW^{PD} = \frac{8}{9}V + \frac{11}{18}\frac{\sigma^2}{2b} - 2K. \tag{21}$$

A duopoly is *privately feasible* if the two firms are ex-ante profitable. It means that expression (20) should be positive. A private duopoly is *socially desirable* if it brings more welfare than a private monopoly. That is, if $EW^{PD} \geq EW^{PM}$. Let $K^{PD/PM}$ be the level of fixed cost such that the government is indifferent between a private duopoly and a private monopoly,

the private monopoly structure.

[8] For more on Cournot competition under asymmetric information see Sakai (1985), Shapiro (1986) and Raith (1996).

i.e. $EW^{PD} = EW^{PM}$. From (9) and (21), we compute

$$K^{PD/PM} = \frac{5}{36}V + \frac{11}{18}\frac{\sigma^2}{2b}. \qquad (22)$$

Walras (1936) and Spence (1976) have shown in a context of symmetric information that industries with increasing returns to scale were characterized by excess entry. Proposition 3 shows that the presence of asymmetric information does not alter this result of wasteful competition.

Proposition 3 *Under asymmetric information there is excessive entry. Privately feasible duopolies are socially undesirable whenever* $\frac{5}{36}V + \frac{11}{18}\frac{\sigma^2}{2b} \leq K \leq \frac{2}{9}V + \frac{5}{18}\frac{\sigma^2}{2b}$.

Under the condition in Proposition 3, which is not empty since $\frac{5}{36}V + \frac{11}{18}\frac{\sigma^2}{2b} < \frac{2}{9}V + \frac{5}{18}\frac{\sigma^2}{2b}$ is equivalent to $a > E\beta + \sqrt{3}\sigma$ which is true under A1, ex-ante welfare is higher if a private monopoly is legally set and if entry is prevented. Indeed, firms do not internalize the social cost of the investment duplication in their entry decision. As a result they enter too often in the industry.

4.2 Regulated duopoly

Many contributions in procurement and regulation theory emphasize that despite sub-additive cost functions, it can be optimal to have several producers in a regulatory setting. A regulated duopoly can be better than a regulated monopoly because it increases the variety of products, lowers transportation costs, or because it reduces prices through (yardstick) competition. In the present model, the firms' marginal cost are independent and identically distributed. The benefit of choosing a regulated duopoly originates from the *sampling gain* as first analyzed by Auriol-Laffont (1993).

4.2.1 The sampling effect under symmetric information

The timing is the same as for a regulated monopoly with the following differences: the investment K is made in the two regulated firms (henceforth RD) and the marginal cost parameters β_i with $i \in \{1,2\}$ are independently drawn.

Under symmetric information the transfers t_i to the regulated firms $i \in \{1,2\}$ which are socially costly, are reduced until firms break even: $t_i = -(a - bQ)q_i + \beta_i q_i + K$. Substituting this expression into W yields the objective function

$$\max_{q_i} W^{RD} = S(Q) + \lambda P(Q)Q - (1+\lambda)(\beta_1 q_1 + \beta_2 q_2 + 2K). \tag{23}$$

This welfare function is linear in q_1 and q_2. We deduce that $q_i = Q^{RD} > 0$ if $\beta_i = min\{\beta_1, \beta_2\}$ and $q_i = 0$ otherwise. The optimal production level coincides with the level of the regulated monopoly defined in equation (12): $Q^{RD}(\beta_1, \beta_2) = Q^{RM}(min\{\beta_1, \beta_2\})$. Monitoring a regulated duopoly is equivalent to monitoring a regulated monopoly for which the investment level is $2K$ and the marginal cost is distributed as $\beta^{min} = min\{\beta_1, \beta_2\}$, that is, with the law:

$$g^{min}(\beta) = 2(1 - G(\beta))g(\beta). \tag{24}$$

The ex-ante welfare of the regulated duopoly under symmetric information is

$$EW^{RD}(\lambda) = (1+\lambda)\left(\frac{1+\lambda}{1+2\lambda}V^{min} - 2K\right) \tag{25}$$

where

$$V^{min} = \int_{\underline{\beta}}^{\bar{\beta}} \frac{(a-\beta)^2}{2b} g^{min}(\beta) d\beta. \tag{26}$$

The facts that $g^{min}(\cdot)$ stochastically dominates $g(\cdot)$ and that $(a-\beta)^2/2b$ decreases in β imply that $V^{min} > V$. Then comparing (13) and (25), the ex-ante welfare is larger under a regulated duopoly than under a regulated monopoly if the *sampling gain*, measured by $(V^{min} - V)\,(1+\lambda)\,/\,(1+2\lambda)$, is larger than K, the duplicated investment.[9]

4.2.2 Asymmetric information

Under asymmetric information, the regulated duopoly (henceforth RDI) must be enticed to reveal their private information to the government. By the revelation principle, the analysis is restricted to direct revelation mechanisms. The equilibrium is defined as truthful Bayesian Nash equilibrium. Each firm $i \in \{1,2\}$ sets its revelation strategy $\widehat{\beta}_i$ such that it maximizes the expected profit given the cost distribution of the competitor $j \neq i$. Let

$$V^{RDI}(\lambda) = \int_{\underline{\beta}}^{\bar{\beta}} \frac{(a - v(\beta,\lambda))^2}{2b} g^{min}(\beta) d\beta. \tag{27}$$

The following lemma presents the structure of production and the welfare level of the duopoly under asymmetric information.

Lemma 2 *Under asymmetric information, only the firm with the lowest marginal cost produces. Output and welfare levels are the levels obtained*

[9] Only one firm produces at the equilibrium. This is an artifact of the assumption of constant marginal costs which is used to isolate the sampling effect. Models with non-constant marginal costs yield an optimal split of production between the two firms, with the larger share going to the most efficient. These models, which are less tractable, yield qualitatively similar results (see Auriol-Laffont 1993). Finally we assume that the government shuts down the least efficient regulated firm for the sake of readability. It could instead transfer the best technology to all regulated firms and share the optimal production Q^{RD} among them. The analysis would be unaltered.

under symmetric information evaluated at the virtual cost:

$$Q^{RDI}(\beta_1, \beta_2) = Q^{RM}\left(v(\beta^{min}, \lambda)\right), \tag{28}$$

$$EW^{RDI}(\lambda) = (1+\lambda)\Big(\frac{1+\lambda}{1+2\lambda}V^{RDI}(\lambda) - 2K\Big). \tag{29}$$

Proof: The proof is similar as in Auriol-Laffont (1993) Proposition 2.

Monitoring a regulated duopoly is equivalent to monitoring a regulated monopoly for which the investment level is $2K$, the marginal cost is $v(\beta^{min}, \lambda)$ and β^{min} is distributed according to $g^{min}(\cdot)$. Under asymmetric information, the sampling gain is measured by $\left(V^{RDI}(\lambda) - V^{RMI}(\lambda)\right)\ (1+\lambda)\,/\,(1+2\lambda)$, which has positive values. The distribution function $g^{min}(\beta)$ stochastically dominates $g(\beta)$ and $(a - v(\beta, \lambda))^2/2b$ decreases in β. This implies that $V^{RDI}(\lambda) \geq V^{RMI}(\lambda)$. However the larger λ is, the lower is the impact of the sampling gain and the smaller is the government's preference for regulated duopoly.

5 Optimal industrial policy

Under complete information, the government can always replicate the production decisions of private firms so that privatization is never optimal. The optimal industrial policy varies from no production, regulated monopoly to regulated duopoly according to whether the investment cost K is large, medium or small. Under asymmetric information the soft-budget constraint alters this result. In particular we have seen in Section 3 that private monopoly can be preferred. By extension, private duopoly could also be preferred to monopoly or regulated duopoly. However, excess entry and weak competition intensity in private duopoly will generally preclude this structure from being socially desirable. We present a sufficient condition to rule out private duopolies in the optimal industry structure.

Let $K^{RDI/PD}(\lambda)$ be the value of the fixed cost such that regulated duopolies are equivalent to private duopolies: $EW^{RDI}(\lambda) = EW^{PD}$. The government prefers a regulated duopoly to a private duopoly if $K \leq K^{RDI/PD}(\lambda)$. On the other hand, if $K \geq K^{PD/PM}$ defined in equation (22), the government prefers a private monopoly to a private duopoly. The following condition C1 guarantees that a private duopoly is never preferred by the government:

C1 $$K^{RDI/PD}(\lambda) \geq K^{PD/PM}$$

Under condition C1 regulated duopolies are always preferred to private duopolies when the latter are preferred to private monopolies. The following lemma summarizes this argument and provides sufficient conditions for C1 to hold.

Lemma 3 *Under the condition C1, the optimal industrial policy never involves private duopolies. Moreover, the condition C1 holds (i) if the demand parameter a is not too small, and more particularly (ii) if parameter a satisfies the assumption A1 and if cost parameter* β_i $(i = 1, 2)$ *is uniformly distributed over [0,*$\overline{\beta}$*] .*

Proof: See Appendix 3.

The condition C1 implies that only private monopoly, regulated monopoly and regulated duopoly can become optimal structures. Let $K^{RMI}(\lambda)$ be the value of the fixed cost such that the government is indifferent between a regulated monopoly and no production, i.e. $EW^{RMI}(\lambda) = 0$.

$$K^{RMI}(\lambda) = \frac{1+\lambda}{1+2\lambda} V^{RMI}(\lambda). \tag{30}$$

Also, let $K^{RMI/PM}(\lambda)$ be the value of the fixed cost such that the government is indifferent between a regulated monopoly and a private monopoly, i.e. $EW^{RMI}(\lambda) = EW^{PM}(\lambda)$.

$$K^{RMI/PM}(\lambda) = \frac{(1+\lambda)^2}{\lambda(1+2\lambda)} V^{RMI}(\lambda) - \frac{3V}{4\lambda}. \quad (31)$$

One can check that $K^{RMI}(\lambda) > K^{RMI/PM}(\lambda)$. Let finally $K^{RMI/RDI}(\lambda)$ be the value of the fixed cost such that the government is indifferent between a regulated monopoly and a regulated duopoly, i.e. $EW^{RMI}(\lambda) = EW^{RDI}(\lambda)$.

$$K^{RMI/RDI}(\lambda) = \frac{1+\lambda}{1+2\lambda} \left(V^{RDI}(\lambda) - V^{RMI}(\lambda) \right) \quad (32)$$

Using the fact that $g^{min}(\beta) \leq 2g(\beta)$, it is straightforward to check that $V^{RDI}(\lambda) < 2V^{RMI}(\lambda)$, and thus that $K^{RMI}(\lambda) > K^{RMI/RDI}(\lambda)$.

Putting all the pieces together, we deduce the next proposition.

Proposition 4 *Under condition C1, the optimal industrial policy under asymmetric information is to set:*

- *no production if* $K \geq \max\left\{\frac{V}{2}, K^{RMI}(\lambda)\right\}$;
- *a private monopoly if* $K^{RMI/PM}(\lambda) < K \leq \frac{V}{2}$;
- *a regulated monopoly if* $K^{RMI/RDI}(\lambda) < K \leq \min\left\{K^{RMI/PM}(\lambda), \frac{V}{2}\right\}$ *or if* $\frac{V}{2} \leq K < K^{RMI}(\lambda)$;
- *a regulated duopoly if* $K \leq K^{RMI/RDI}(\lambda)$.

Figure 2: Optimal Industrial Policy under Asymmetric Information.

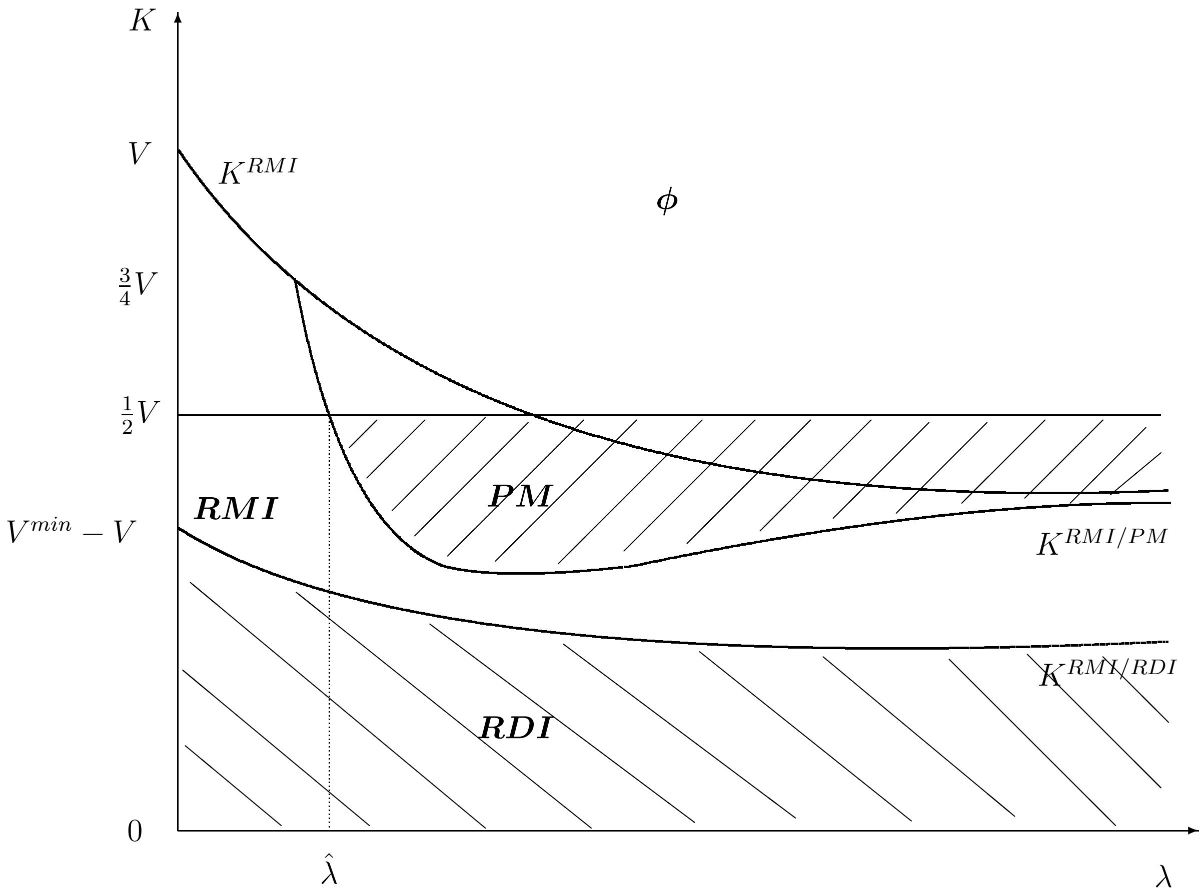

Figure 2: Optimal Industrial Policy

Figure 2 illustrates Proposition 4 in (λ, K) space. First, there is the case of no production (depicted by the area $\emptyset$) when a regulated monopoly is not desirable because of informational costs while a private monopoly is not feasible because of the profitability constraint. Second, there are cases where private monopoly is preferred simply because it is feasible whereas regulated monopoly is not (this correspond to the area above the curve K^{RMI}). By continuity private monopoly dominates regulated monopoly for lower values of the fixed cost. This situation is denoted PM and is represented by the hatched area above the curve $K^{RMI/PM}$. Third, for lower values of the fixed cost, regulated monopoly is preferred to private monopoly. Regulated monopoly is also preferred to no production for $K > V/2$. Regulated monopolies that are desirable under asymmetric information are depicted by the white area denoted RMI. Finally, for the lowest values of K, regulated duopolies are preferred to regulated monopolies. This case is depicted by the hatched area below the curve $K^{RMI/RDI}$ denoted RDI.

Proposition 4 implies that if the shadow cost of public fund is low (i.e., lower than $\hat{\lambda}$ in figure 2), privatization of non competitive industry is never optimal. Depending on the ratio V/K, the optimal industrial policy is either a regulated monopoly or a regulated duopoly. Privatization of natural monopolies becomes optimal when the shadow cost of public fund increases and reaches the critical level $\hat{\lambda}$. If in practice $\hat{\lambda}$ is very high, privatization is never optimal. It is important to evaluate the minimal value $\hat{\lambda}$ for which *laissez-faire* becomes attractive. In general this will require empirical studies. Yet under our theoretical framework it happens to be feasible without any.[10]

[10] However the validity of the simulations relies on the assumptions (1) and (3) of the paper. Testing these assumptions is an empirical issue.

To compute the critical values of $\hat{\lambda}$ we assume that β is uniformly distributed over $[\underline{\beta}, \overline{\beta}]$. However the conclusions of the simulation are robust to other statistical specifications of the model (e.g. normal distributions). Under the uniform specification the demand intercept a satisfies A1 if $a \geq 2\overline{\beta}$. By definition the lowest value of the shadow cost, $\widehat{\lambda}$, for which *laissez-faire* becomes attractive is such that $K^{RMI/PM}(\lambda) = \frac{V}{2}$ (see figure 2). One can easily check that $\widehat{\lambda}$ depends on $\underline{\beta}/a$ and $\bar{\beta}/a$ only. Table 1 displays $\widehat{\lambda}$ for the various admissible values of $\underline{\beta}/a$ and $\bar{\beta}/a$ (A1 imposes $0 \leq \underline{\beta}/a < \overline{\beta}/a \leq 0.5$).

$\widehat{\lambda}$	$\underline{\beta}/a = 0.0$	0.1	0.2	0.3	0.4
$\bar{\beta}/a = 0.1$	1.10	-	-	-	-
0.2	0.71	1.10	-	-	-
0.3	0.52	0.66	0.99	-	-
0.4	0.42	0.48	0.6	0.90	-
0.5	0.35	0.38	0.44	0.54	0.81

Table 1: Minimal shadow costs $\widehat{\lambda}$ for which privatization becomes preferred.

The results of Table 1 illuminate the relationship between privatization and shadow costs of public funds. According to our theoretical exercice, the critical levels are in the range of those of industrial countries at the time of the privatization reforms. Moreover, we see that privatization is more likely as technological uncertainty (i.e., $(\overline{\beta} - \underline{\beta})/a$) increases. Larger business uncertainty implies stronger information asymmetry between firms and government and hence larger information cost in the regulated structures. As explained above the validity of this result relies on the assumptions of linear demand and cost functions and uniform distribution of marginal costs.[11]

[11] The choice of uniform cost distribution, that is made here for the sake of simplicity, is

This is an empirical question that has to be tested econometrically. Policy implications of the paper need to be qualified by this proviso.

The present model allows to consider three types of market structures for natural monopolies. First, when $V/2$ is close to K, market offers low ex-ante prospects to firms. As presented in the proposition 2 and as shown in figure 2, the optimal industrial policy is monotone in the shadow cost of public funds. It is regulation if $\lambda \leq \hat{\lambda}$ and privatization otherwise. Because developing countries have larger shadow costs of public funds, these countries may implement industrial policies that strongly differ from the policies in developed countries. In fact, privatization can be welfare improving in developing countries while it is welfare reducing in developed countries. For instance many developing countries plagued by financial problems have started build-operate-and-transfer (BOT) programs. In such programs, a private firm finances the sunk cost of some infrastructure, for instance a highway, in exchange for a 10-30 years licence to exploit it in a monopoly position. Clearly, a privately owned and operated infrastructure is a better solution than no infrastructure at all, which in the absence of a public financing, is the alternative to privatization. Water supply, which typically is provided worldwide through public ownership, could be a good candidate for the privatization alternative. This is at least what is advocated by Brook-Cowen and Cowen (1998). In developing countries tariffs are so low that on average they do not cover more than 30 percent of the total cost (World Bank 1994). This precludes public investment, and large fraction of the population in cities (up to 75 percent in Jakarta in 1991) has no formal water hook-up. In this context some countries have chosen to implement BOT contracts.

not crucial. Simulations with other cost distributions lead to similar results. Linearization of cost and demand functions is more important.

China, Malaysia, Thailand implemented it in water, and Chile, Mexico, in sanitation (World Bank 1997). Indeed, privatization is a good alternative to the absence of basic public service. It is not a good alternative to efficient regulation, though.

The second case occurs when, $V/2$ being larger than K, markets offer good ex-ante prospects to one firm. As argued in the previous section, privatization is optimal for intermediate values of shadow cost of public funds, regulation is preferred otherwise. Based on the simulation of the model we conclude that the optimal industrial policy depends non-trivially on the public finance of a country. Privatization can be optimal in developed countries with intermediate values of shadow cost of public funds. However, in developing countries with very high values of shadow cost of public funds, privatization is dominated by regulation.

Finally, when $V/2$ is much larger than K, markets offer good ex-ante prospects to more than one firm. Proposition 4 then shows that privatization is never an optimal policy. The negative impacts of market power and excessive entry in private Cournot oligopolies is overcome by the positive effects (here the 'sampling gains') of a regulated duopoly. The advantage of private structures disappears once the market allows the entry of more than one firm. We conclude that the optimal industrial policy is non monotone in N, the number of firms active in the market. This result may look at odds with theories where private structures perform better when the market allows for a larger number of entry (see for instance Vickers and Yarrow (1991) and Segal (1998)). A basic difference in our model lies in the intensity of competition that exists within private and regulated structures. Under *laissez-faire*, the private firms face a Cournot competition. In contrast, under the regulation regime, the government is able to implement a second price auction between the firms (where the cost announcements are the firms' strategies). As a result of this competition, the information cost drops when a second firm is added in the regulated market.[12] The cost of information and soft-budget constraints under regulation is smaller than the cost of excessive prices and entry under private duopoly structure.

Proposition 4 sheds some light on the link between market liberalization, on the one hand, and technological and/or product demand changes, on the other hand. Market liberalization, often referred to as 'deregulation', corresponds to the divestiture of the historical monopoly, which is often privatized when it was public, and the introduction of new entrants. However this liberalization is not equivalent to laissez-faire. In practice prices and entry remain generally regulated (through price caps and licences for instance) to avoid collusion or predatory behavior. According to our analysis, such a market liberalization with price regulation must be motivated by a drop of ratio K/V. That is, by smaller fixed costs and by larger product demand. In figure 2 this corresponds to a downward shift, where industry structures move from regulated monopolies to regulated duopolies. The telecommunication industry may provide an example of such market liberalization. In this industry, the introduction of new technologies has significantly reduced the fixed costs to operate networks whereas the demand for communication has steadily increased. Consistently with our model, many developed and developing countries have deregulated their domestic telecommunication monopoly. Nevertheless more than 70 percent of all countries still maintain a monopoly in basic services, while more than half allow competition in mo-

[12] If we had considered that firms operating in the same industry have correlated costs, we would have used this correlation to implement yardstick competition, reducing further the cost of information revelation (see Auriol-Laffont 1993).

bile service (ITU 1999). Wallsten (2000), who studied telecom reforms in Africa and Latin America, found that regulated competition (measured as the number of mobile operators not owned by the incumbent) yields network improvements and that while privatization by itself does not yield improvements, privatization combined with an independent regulator does. The lesson to be drawn here is that privatization, being defined as a move to *laissez-faire,* is not optimal when the ratio K/V is low. Regulation should then be a key component of structural reforms.

6 Conclusion

This paper discusses the optimal industries policy in markets characterized by increasing returns to scale. Considering the government budget constraint, the paper compares utilitarian welfare levels under *regulation* and *laissez-faire*. Under the regulation policy, the government controls the prices and the entry of regulated firms. As a consequence, it also assumes the responsibility for profits and losses of these firms. This creates a soft-budget constraint from which the regulated firms may benefit. By contrast, under *laissez-faire*, the government takes no responsibility for the financial results of the private firms, which rules out the problem associated with the soft-budget constraint.

We show that rising values of the shadow cost of public funds can be considered as a motivation for privatization. This argument is consistent with empirical studies and is particularly critical to many developing economies in which governments' budget constraints are increasingly tightened by worsening macro-economic conditions and poorly efficient tax systems. We also show that the advantage of private structures is likely to disappear once the market allows the entry of more than one firm. Indeed, when a second firm is introduced, the cost of information and soft-budget constraints in regulated firms are likely to diminish more than the cost of excessive prices and entry under *laissez-faire*. We ultimately show how technical or demand changes might explain the destitution of former regulated monopolies. Smaller fixed costs and larger product demands indeed favor the liberalization of markets while holding some form of price regulation.

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Appendix 1: Proof of Proposition 1

We have to show that

$$(1+\lambda)\left(\frac{1+\lambda}{1+2\lambda}V-K\right)\geq\frac{1}{2}V-K+\lambda F \quad \forall\lambda\geq 0 \tag{33}$$

The maximal franchise fee F is equal to the firm's ex-ante profit, i.e. $F = \frac{1}{2}V-K$. Therefore the above inequality is satisfied if

$$\begin{aligned}(1+\lambda)\left(\frac{1+\lambda}{1+2\lambda}V-K\right) &\geq \frac{3}{4}V-K+\lambda\left(\frac{1}{2}V-K\right) \quad \forall\lambda\geq 0,\ \text{or}\\ 4(1+\lambda)^2 &\geq (3+2\lambda)(1+2\lambda)\ \ \forall\lambda\geq 0,\end{aligned}$$

which is always true.

Appendix 2: Proof of Proposition 2

(i) The function $EW^{RMI}(\lambda)$ has an asymptote at $\lambda\to\infty$ with slope $F^{\infty} = \lim_{\lambda\to\infty} EW^{RMI}(\lambda)/\lambda < V/2-K$ whereas the function $EW^{PM}(\lambda)$ has an asymptote at $\lambda\to\infty$ with slope $F^{*} = V/2-K > F^{\infty}$. When $F^{*}\geq F > F^{\infty}$, it is obvious that there exists a threshold, $\hat{\lambda}_F$, such that $EW^{PM}(\lambda) > EW^{RMI}(\lambda)$ if and only if $\lambda > \widehat{\lambda}_F$.

(ii) We now prove that, for $F < F^{\infty}$, there may exist two thresholds $(\hat{\lambda}_F, \widetilde{\lambda}_F)$ such that privatization dominates regulation if and only if $\widehat{\lambda}_F < \lambda < \widetilde{\lambda}_F$. We need to show an example where $EW^{PM}(\lambda) > EW^{RMI}(\lambda)$ if $\lambda\in[\hat{\lambda}_F, \tilde{\lambda}_F]$. Consider the least favorable franchise fee for private monopolies: $F=0$ and assume that β is uniformly distributed over the interval $[0, 0.5a]$ where a is the demand intercept (assumption A1 implies that $a\geq 2\overline{\beta}$). With this uniform distribution, we have that $V = 0.875\frac{a^2}{3b}$ and that $V^{RMI}(\lambda) = \frac{0.875+1.25\lambda+0.5\lambda^2}{(1+\lambda)^2}V$. The critical values $\hat{\lambda}_0$ and $\tilde{\lambda}_0$ are then solutions of the equality

$$(1+\lambda)\Big(\frac{1+\lambda}{1+2\lambda}V^{RMI}(\lambda) - K\Big) = \frac{3}{4}V - K. \tag{34}$$

or after simplification,

$$4\,(V/K-4)\,\lambda^2 - 2\,(V/K+4)\,\lambda + V/K = 0.$$

This quadratic expression accepts two roots $(\hat{\lambda}_0,\ \tilde{\lambda}_0)$ if and only if its discriminant is positive. That is, if $-3\,(V/K)^2 + 24\,(V/K) + 16 > 0$, which is satisfied whenever $V/K < 8.61$.

(iv) Increase in the franchise fee F rises the ex-ante welfare $EW^{PM}(\lambda)$ in private monopolies; $EW^{RMI}(\lambda)$ is not affected by the franchise fee, we deduce easily the result.

Appendix 3: (Condition C1)

Lemma 3 is true as soon as $K^{RDI/PD}(\lambda) \geq K^{PD/PM}$. This is equivalent to

$$\frac{18(1+\lambda)^2}{(1+2\lambda)(16+5\lambda)}V^{RDI}(\lambda) \geq V + \frac{1+2\lambda}{16+5\lambda}\frac{11\sigma^2}{2b}. \tag{35}$$

Let $v(\beta,\lambda)$ be the virtual cost $\beta + \frac{\lambda}{1+\lambda}\frac{G(\beta)}{g(\beta)}$. Simplifying by $2b$, C1 is equivalent to:

$$\frac{18(1+\lambda)^2}{(1+2\lambda)(16+5\lambda)}E_{\beta^{min}}\left[(a-v(\beta,\lambda))^2\right] \geq E_\beta\left[(a-\beta)^2\right] + \frac{(1+2\lambda)11\sigma^2}{16+5\lambda}. \tag{36}$$

Let $h(\lambda) = \frac{18(1+\lambda)^2}{(1+2\lambda)(16+5\lambda)} - 1 = \frac{2-\lambda+8\lambda^2}{(1+2\lambda)(16+5\lambda)} > 0\ \forall\lambda \geq 0$. Let also $\Phi(\lambda) = E_{\beta^{min}}\left[v(\beta,\lambda)^2\right] + \frac{E_{\beta^{min}}\left[(v(\beta,\lambda)^2\right] - E_\beta\left[\beta^2\right]}{h(\lambda)} - \frac{(1+2\lambda)11\sigma^2}{(16+5\lambda)h(\lambda)}$. The condition C1 is equivalent to:

$$a^2 - 2a\left[E_{\beta min}\left[v(\beta,\lambda)\right] + \frac{E_{\beta min}\left[v(\beta,\lambda)\right] - E\beta}{h(\lambda)}\right] + \Phi(\lambda) \geq 0. \tag{37}$$

This condition, which requires that a is large enough, is not very strong. For instance, one can check that with an uniform distribution over $[0,\overline{\beta}]$, and with the convention that $a = A\overline{\beta}$, condition C1 is equivalent to: $H(A) = 12A^2(8\lambda^2-\lambda+2)+12A(4-7\lambda)(1+2\lambda)+(1+2\lambda)(44\lambda-59) \geq 0$. Under the assumption A1 (i.e., $A \geq 2$), it is easy to check that $H(A)$ is increasing in A for all $\lambda \geq 0$. We deduce that $H(A) \geq H(2) = 136\lambda^2 - 98\lambda + 133 > 0\ \forall \lambda \geq 0$. So, for a uniform distribution, assumption A1 is a sufficient condition to get C1. More generally, let

$$\begin{aligned} a^l \;\equiv\; & E_{\beta min}\left[v(\beta,\lambda)\right] + \frac{E_{\beta min}\left[v(\beta,\lambda)\right] - E\beta}{h(\lambda)} \\ & + \left\{\left[E_{\beta min}\left[v(\beta,\lambda)\right] + \frac{E_{\beta min}\left[v(\beta,\lambda)\right] - E\beta}{h(\lambda)}\right]^2 - K(\lambda)\right\}^{1/2}. \end{aligned}$$

If a is larger than a^l, the Condition C1 is satisfied.

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