Alternative Institutional Arrangements in Network Utilities: An Incomplete Contracting Approach[¤]

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Abstract

This paper presents a theoretical assessment of the e¢ciency implications of privatizing natural monopolies which are vertically related to potential competitive industries (network utilities). Based on the incomplete contracts and asymmetric information paradigm, I develop a model that analyzes the relative advantages of di¤erent institutional arrangements – alternative ownership and market structures in the industry – in terms of their allocative (static) and productive (dynamic) e¢ciencies. The main policy conclusion of this paper is that both ownership and the existence of conglomerates in network industries matter. Among other conclusions, this paper provides an economic rationale for mixed economies when the network is public and both vertical separation and full concentration of the industry when the natural monopoly is regulated under private ownership.

Keywords: Network utilities, Natural monopolies, Privatization, Public ownership, Regulation by incentives, Vertical integration / separation, Mixed economies, Incomplete contracts, Asymmetric Information.

1. Introduction

A large number of public enterprises were privatized in developed and developing countries in the 80's and 90's. From both the empirical and theoretical points of view, it is clear that privatizing public …rms in competitive sectors may result in welfare improvements. This outcome is not clear, however, when public …rms have monopolistic power. While some studies found empirical support for privatizing public enterprises with monopolistic power (e.g., Galal, et. al, 1994; Levy and Spiller, 1996; and Newbery, 1997), from a theoretical point of view, however, the best choice in terms of ownership and control is still ambiguous; in particular, when considering network utilities.

This paper compares the welfare implications of six di¤erent institutional arrangements which arise from the analysis of di¤erent market structures – liberalization, vertical separation, and full concentration – and two forms of ownership – privatization and nationalization – in an industry with naturally monopolistic characteristics. It may be useful to begin with some de…nitions.

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Liberalization is the market structure in which any …rm is free to enter the competitive market

Vertical separation is the market structure characterized by the legal impossibility for the monopoly to produce in any related market. I use in this paper divestiture as equivalent of vertical separation.

Full concentration is the market structure in which an integrated monopoly obtains the legal right to be the only …rm in the industry

Nationalization corresponds to a situation in which the monopoly is state owned

Privatization occurs when the monopoly is privately owned and regulated by the government

Institutional arrangement is the industry design resulting from one speci…c form of ownership of the monopoly and one of the speci…c market structures de…ned above.

In studying the welfare implications of alternatives institutional structures, I identify welfare with the net social surplus.

The model suggests that the two forms of ownership and the three forms of market structure markedly contrast in their implications on the allocatively and productively e¢ciency of the industry. Hence, it provides theoretical support to i) vertical separation of competitive and monopolistic activities under private property, ii) privatization of a legal monopoly in the industry, and iii) mixed economies in the competitive market under a state owned monopoly.

For example, under privatization – regulation under private ownership of the monopoly – a vertically separated industry is socially preferred to both a liberalized and a fully concentrated industry when information asymmetries between the government and the monopolist are large enough, so that they induce important distortionary rents to the monopolist in the competitive industry.

On the other hand, mixed economies – a state owned monopoly producing in competitive markets of the industry – is preferred to any other alternative when both information asymmetries are large enough, so that privatization becomes too costly in terms of distortionary rents to the monopolist, and there are adequate incentives for public …rms to produce e¢ciently.[1]

What is new in this paper is that it studies various institutional set-ups within the same common framework, and …nds an economic rationale for imposing constraints on competition in a network industry with naturally monopolistic activities. This result, nonetheless, does not rely on noncompetitive assumptions concerning the monopoly's behavior.

The literature on applied contract theory tells us that ownership is irrelevant and liberalization Pareto dominates any other market structure when fully complete contingent contracts can be written at the moment of choosing the best institutional arrangement for the network utility. Williamson (1985) argues that under no transaction costs a full contingent contract can be written by the government such that a public …rm can mimic a private one. Moreover, a public …rm may outperform private …rms when externalities are present. Then, under complete contracting a public …rm can be at least as good as a private …rm, from the social welfare point of view. On the other hand, Sappington and Stiglitz (1987) show the converse in the so-called Fundamental Theorem of Privatization. Whenever possible, the government may write down a full contingent contract specifying the whole life of a …rm after being privatized. Then, from the society's perspective a private …rm can be at least as good as a public …rm.[2]

However, when unforeseen contingencies prevent the government from writing complete contingent

[1] This paper considers a normative view of privatization. Its conclusions, regarding the relative advantages of public ownership, may not hold when corruption and rent seeking activities are non-negligible.

[2] See Proposition 1 in Shapiro and Willig (1990) or Bös (1994) for a formal proof of this Theorem. In our speci…c model, Proposition 3.1 also shows the irrelevance of ownership under full contracting. Moreover, under the same assumption, Lemmas 4.1 and 4.2 prove that liberalization Pareto dominates the other two institutional arrangements.

contracts, we no longer have conclusive results regarding whether private or public monopolies are more e¢cient.[3] For example, Shapiro and Willig (1990) suggest that privatization means a change in the structure of incentives of the …rm such that private ownership reduces the incentives of the government's o¢cials to pursue their own agenda but it is more allocatively ine¢cient than public ownership. La¤ont and Tirole (1991) show that a private monopoly is productively e¢cient but con‡icts in the agenda of the principals – a regulator and shareholders – induces lower powered incentive schemes. Schmidt (1990) and (1996) – whose framework I follow closely – shows a trade o¤ between a private monopoly which may produce at lower costs and a public monopoly which always produces Pareto optimal allocations. Finally, La¤ont (1995) suggests that there exists a trade o¤ between the lower costs of low powered incentive schemes under privatization and the expectations of rent appropriation under public ownership.

Many other issues need to be taken into account, however, when analyzing privatization in developing countries.[4] For example, an adequate regulation by incentives requires, minimally, well prepared regulators, unambiguous regulatory frameworks, and enforceability of the law. Indeed, none of those characteristics are adequately present in developing countries. Moreover, there are factors a¤ecting the allocative e¢ciency of private monopolies as long as they are allowed to carry out potential competitive activities. Even though the latter e¤ect is not only a characteristic in developing countries,[5] its adverse implications are exacerbated by the incompetence of regulators, ambiguities in the regulatory framework, and the lack of institutions able to enforce contracts. Such characteristics justify using the incomplete contracting approach in this paper.

The main contribution of this paper to the literature on privatization using optimal mechanism design is to introduce a network utility industry into the analysis. Most of the literature has assumed a monopoly without any relation to other potentially competitive markets. Such a setting is far from reality, because natural monopolies are tipically vertically related with competitive activities. For example, the telecommunications sector usually has a natural monopoly in local telephone services, which provide access facilities to wireless, long distance telephone carriers, TV Cable, and Internet providers; the electricity sector has natural monopolistic characteristics in transmission and distribution activities but generation and supply segments of the industry are potentially competitive; pipelines may be designed to be open carriers to distributors; track activity in railroads is a natural monopoly but passenger and freight markets are potentially competitive. Therefore, a consistent framework to that observed in practice provides an economic rationale for some commonly observed institutional arrangements, such as mixed economies when the monopoly is public or vertical separation when it is regulated under private ownership.

The paper is organized as follows. The basic model of two vertically related markets, one of which has natural monopoly characteristics and the other, which may be designed as a competitive market, is presented in the next section. I assume in section 3 that the government chooses to liberalize the industry,

[3] Shapiro and Willig (1990), Schmidt (1990), and La¤ont and Tirole (1991), certainly are the …rst papers in taking the incomplete contracting approach to theoretically justify that property matters. Schmidt (1996) provides a brief survey of such literature. La¤ont (1995), on the other hand, is the …rst paper in introducing a political economy theory of privatization using the incomplete contracting approach.

[4] La¤ont (1994 a) stresses the relationship between incentives and privatization in developing countries. Bhaskar (1993) and Bitran and Saavedra (1993) present an extended discussion on this regard using, respectively, the Indian and the Chilean experience. Basañes, Saavedra, and Soto (1999) provides a number of speci…c cases on post contractual con‡icts arising in the newly privatized Chilean electricity sector.

[5] Regarding the British experience in privatizing utilities and the problems associated to natural monopolies operating in competitive activities, see Vickers and Yarrow (1988) and Armstrong, Cowan and Vickers (1994).

either under nationalization or privatization of the monopoly, so that the pros and cons of privatizing a natural integrated monopoly under asymmetric information are extended to a network setup. I analyze the other feasible institutional arrangements in section 4. One such option arises from the possibility of designing a vertically separated monopoly, whose competitive market industry is operated by …rms unrelated to the monopoly. The other feasible institutional arrangement is to concentrate all the activities in a unique fully integrated monopoly. Comparisons among di¤erent institutional arrangements are presented in this section. A simple example that highlights our main …ndings is shown in section 5. Finally, section 6 concludes the analysis and discusses the scope for further research using the model.

2. The Model

There are two vertically related goods. A natural monopoly upstream produces y units of an intermediate good using a constant return to scale technology. This good is only used as input in the downstream industry. This monopoly may also produce x_m units of the downstream good using a decreasing return to scale technology. Let us assume, without lost of generality, that both y and x_m are produced by an integrated monopoly.

Technologies used by the monopoly are not common knowledge, however. The owner has better information, for example, about the e¢ciency of the technological processes inside the …rm. Accordingly, total costs of the monopoly, unknown to outsiders, are $k(\mu)¢y + C(x_m;\mu)$, where $\mu \in \{\underline{\mu};\overline{\mu}\}$ is an adverse selection parameter which summarizes the e¢ciency level of the …rm. Nonetheless, the support of μ is common knowledge.[6]

Let us assume the existence of important sunk costs that justify the assumption of there being one …rm (monopoly) producing the upstream good. These costs, however, are less than the social value of the …nal good, x, for any $x > 0$. They become irrelevant, however, when analyzing di¤erences on payo¤s of the alternative institutional arrangements. Thus, I take it out of the parties' payo¤s.

Assume that $C(x_m;\mu)$ is strictly increasing and convex in x_m, for all x_m. Convexity of $C(x_m;\mu)$ is consistent with a strictly increasing and concave production function when the monopoly produces the downstream good. This, in turn, implies that the derived demand for the input from the monopoly itself is a strictly increasing and convex function of x_m. That is, $y = '(x_m;\mu)$, such that $'^{0} > 0$ and $'^{"} > 0$. For simplicity, let us write it as $'(x_m)$. In addition, assume that $k(\underline{\mu}) < k(\overline{\mu})$, $C(x_m;\underline{\mu}) < C(x_m;\overline{\mu})$, and $C^{0}(x_m;\underline{\mu}) < C^{0}(x_m;\overline{\mu})$, for all x_m. The last condition is the Spence-Mirrlees condition (single crossing condition).[7]

An important assumption in the model is that only the owner of the monopoly observes the adverse selection parameter, μ. Hence, under privatization the government is unable to observe μ and must elicit the true information through solving a mechanism design problem. Assume that the government requires to hire a manager to run the upstream state owned …rm, but without further loss of generality, assume that the owner runs the monopoly by herself under privatization.[8]

[6] It is important to mention that we are using the common network assumption (both technologies, upstream and downstream, have the same adverse selection parameter). Despite being a strong assumption, it is absolutely necessary to apply optimal mechanism design in this paper, as noted by La¤ont and Tirole (1993) chapter 5. Otherwise, under network expansion (di¤erent adverse selection parameters), the regulator has less instruments than unknowns to elicit true-telling.

[7] Since μ is a discrete variable, derivative symbols represent partial derivatives with respect to the other argument of the function.

[8] It is without further loss of generality. Alternatively, we may assume that the asymmetric information between the private monopolist and her manager is less important than that between the government and the monopolist, then all our

Let us assume that before μ is realized by the owner of the monopoly, the manager of this …rm (a public employee or the private owner) may invest e¤orts e in cost reducing activities. The higher the value of e, the more likely the …rm will be an e¢cient type. Let q(e) be the probability of obtaining $\underline{\mu}$. In order to obtain interior solutions, assume that, for all $e \geq 0$, q(e) is strictly increasing and concave, $\lim_{e \to 0} q_e(e) = 1$, $\lim_{e \to 1} q_e(e) = 0$, and $0 < q(e) < 1$.

There is a potential competitive fringe downstream. If the fringe enters, it produces x_f units of the downstream good, using a linear-technology. The fringe's marginal cost is constant, c, and common knowledge.[9] The monopoly charges an access price a for each unit of its intermediate good sold to the fringe and this access price may be regulated under privatization. As usual in practice, in order to avoid market foreclosure, I assume that the monopoly cannot refuse to sell any required inputs by the fringe (serfdom).

Therefore, total production of the input is equal to its total derived demand, that is $y = '(x_m) + x_f$. Then, from now on I mention $['(x_m) + x_f]$ instead of y, so I denote $k(\mu)¢['(x_m) + x_f]$ as the upstream cost function of producing $['(x_m) + x_f]$ units of the intermediate good.

I assume that the downstream activity produces a social bene…t of $v(x_m + x_f)$. Let v(¢) be strictly increasing and concave, satisfying Inada Conditions, and v(0) = 0. Assume income e¤ects are negligible. Thus $v'(x_m + x_f) = P(x_m + x_f)$ corresponds to the inverse demand function for the …nal good. Moreover, market equilibrium condition implies zero pro…t to the fringe ($P(x_m + x_f) = c + a$).

The structure of these related markets allows us to analyze the e¢ciency advantages and pitfalls of six feasible institutional arrangements (three under nationalization and three under privatization). They are:

- Liberalization – integrated monopoly and competition downstream (nic & pic),
- Vertical separation – divestiture – and competition downstream (ndc & pdc),
- Full concentration – integrated monopoly with no competition at all – (nnc & pnc).[10]

In the case of regulation under private ownership, the government charges a price z to the winner of a competitive bidding process. In equilibrium, this price drives to the new owner of the monopoly to her expected reservation utility (by simplicity, assume this utility to be equal to zero). On the other hand, if the …rm is nationalized, the government pays to a manager a salary w. Similarly as before, in equilibrium w is such that the manager is driven to her reservation utility, which is equal to zero.

Let us considerer the case where the regulator determines cost reimbursement rules under privatization. The government gets the revenue of the monopoly activity and pays to the monopolist a transfer $T(\mu)$ in period 2. Transfers are determined by the government through a menu of contracts set in period 3/2, before production takes place and after the owner of the monopoly realizes μ. Since a direct mechanism requires the menu of contracts to be contingent on observable variables, transfers are …xed

qualitative results hold. My assumption is consistent, therefore, with normalizing the agency problem inside the private monopoly to be nonexistent.

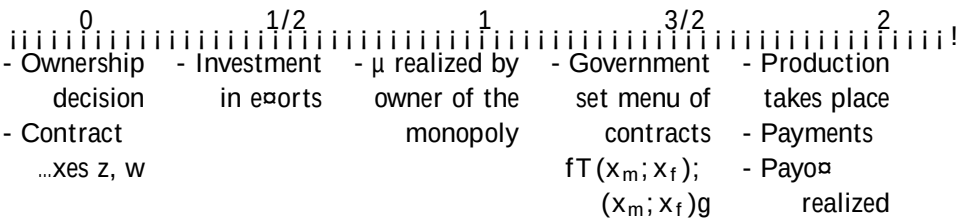
[9] This assumption is without further lost of generality. For our purpose, it is enough to assume that the fringe and the monopoly have di¤erent technologies when producing the downstream good.

[10] These acronyms work as follow: the …rst letter represents ownership (p: privatization and n: nationalization); second and third letters represent monopoly's activities and the nature of downstream competition (ic: integrated monopoly and competition downstream, i.e. liberalization; dc: divestiture of the monopoly and competition downstream, i.e. vertical separation; and nc: no competition in any market, i.e. full concentration).

contingent to the monopoly's production, y and x_m. Then, each contract is a pair transfer-production $\{T(x_m(\mu); x_f(\mu)); (x_m(\mu); x_f(\mu))\}$, for each $\mu \in \{\underline{\mu}; \overline{\mu}\}$, which induces truth-telling.

Figure 2.1, below, indicates the timing of actions in this model.

Figure 2.1



All players are risk neutral and there is no discounting. Table N± 1 presents player's payo¤s for each institutional arrangement (by de…nition, each competitive …rm in the fringe obtains zero pro…ts), which are realized in period 2.

Table N± 1

Privatization		
	Government (V)	Monopolist (U)
pic :	$v(x_m + x_f) + z - T(\mu) - c \cdot x_f$	$-z + T(\mu) - k(\mu) \cdot [\phi(x_m) + x_f] - C(x_m; \mu) - e$
pdc :	$v(x_f) + z - T(\mu) - c \cdot x_f$	$-z + T(\mu) - k(\mu) \cdot x_f - e$
pnc :	$v(x_m) + z - T(\mu)$	$-z + T(\mu) - k(\mu) \cdot \phi(x_m) - C(x_m; \mu) - e$

Nationalization		
	Government (V)	Manager (U)
nic :	$v(x_m + x_f) - w - k(\mu) \cdot [\phi(x_m) + x_f] - C(x_m; \mu) - c \cdot x_f$	$w - e$
ndc :	$v(x_f) - w - k(\mu) \cdot x_f - c \cdot x_f$	$w - e$
nnc :	$v(x_m) - w - k(\mu) \cdot \phi(x_m) - C(x_m; \mu)$	$w - e$

3. Liberalization of the Downstream Market

3.1. First Best Allocations

In this section I assume that the contract signed by the parties (government–manager or government–monopolist) is complete, in the sense that it speci…es relevant variables contingent to the states of nature.

Proposition 3.1 characterizes the …rst best production and allocations. As expected, it is irrelevant whether the monopoly is public or private. Under complete contracting the access price is not an issue either, because any deviation from the optimal price would be severely punished.

Proposition 3.1. Under full contracting there is a unique vector of allocations, access price, and a level of cost reducing activities $(x_m^{¤}(\mu); x_f^{¤}(\mu); a^{¤ic}(\mu); e^{¤ic})$, for each $\mu \in \{\underline{\mu}; \overline{\mu}\}$, which is optimal from the society's point of view. Furthermore, either the manager of the public monopoly or the owner of the private monopoly gets zero ex-post payments. Thus, the next …ve equations fully characterize the …rst best:

$$P(x_m^{¤ic}(\mu) + x_f^{¤ic}(\mu)) = k(\mu) \cdot '^{0}(x_m^{¤ic}(\mu)) + C^{0}(x_m^{¤ic}(\mu); \mu) \tag{3.1}$$

$$P(x_m^{¤ic}(\mu) + x_f^{¤ic}(\mu)) = k(\mu) + c \tag{3.2}$$

$$a^{¤ic}(\mu) = k(\mu) \tag{3.3}$$

$$q_e(e^{¤ic}) \cdot [W^{¤ic}(\underline{\mu}) - W^{¤ic}(\overline{\mu})] = 1 \tag{3.4}$$

$$U = 0 \tag{3.5}$$

where $W^{¤ic}(\mu)$ corresponds to the ex-post net social bene…t of producing $x_m^{¤ic}(\mu) + x_f^{¤ic}(\mu)$ units of the …nal good, for each $\mu \in \{\underline{\mu}; \overline{\mu}\}$; that is:

$$W^{¤ic}(\mu) \equiv v(x_m^{¤ic}(\mu) + x_f^{¤ic}(\mu)) - k(\mu) \cdot \left['(x_m^{¤ic}(\mu)) + x_f^{¤ic}(\mu) \right] - C(x_m^{¤ic}(\mu); \mu) - c \cdot x_f^{¤ic}(\mu)$$

Proof. See Appendix A.

In period 0, the government's expected payo¤ under full contracting is equal to:

$$V^{¤ic} = q(e^{¤ic}) \cdot W^{¤ic}(\underline{\mu}) + \left[1 - q(e^{¤ic})\right] \cdot W^{¤ic}(\overline{\mu}) - e^{¤ic} \tag{3.6}$$

Long term contracts in general are not feasible, however. Since the technological parameter is only realized in period 1, the time zero contract cannot specify contingent e¤orts, production, wages, or transfers. In addition, the government is unable to commit not to expropriate rents from cost reducing activities. Therefore, optimal allocation of resources would not be achieved. Let us …rst analyze a state owned monopoly operating in both markets.

3.2. Nationalization

In practice, governments o¤er very low-powered incentives schemes to public employees, even to CEO's of public …rms. The literature has explained this regularity in two ways. First, governmental agencies have several less informed principals (such as unions, consumers, producers, ministries, politicians, etc.), all of them with their own agendas. It turns out that one of the actions taken for those principals is to limit the power of the government in designing payment schemes of public employees.[11]

[11] See, among others, Vickers and Yarrow (1987) and Martimort (1996) regarding the structure of incentives in government. Dixit, Grossmann, and Helpman (1997) show this result as an endogenous outcome of there being too many principals. Bernheim and Whinston (1986) and Gal-Or (1991) study this common agency problem in more general settings.

A second explanation comes from the fact that under some situations the government would be better o¤ choosing non contingent contracts. For example, Holmström and Milgrom (1991) argue that some high-powered incentives for some dimensions of performance may divert the attention of the agent from other more important, but less easily measured, aspects of performance.[12]

In order to capture this problem of low-powered incentive schemes in government's contracting and to avoid a more cumbersome model, let us assume that the government cannot o¤er an incentive scheme to the public manager; i.e., her salary w is …xed at the time zero contract.

The more important result under public monopoly is that allocative e¢ciency is attained; the government, as the owner of the …rm, realizes μ in period 1 and then production is optimal. That is, for each $\mu \in [\underline{\mu}, \overline{\mu}]$:

$$\begin{bmatrix} x_m^{nic}(\mu) \\ x_f^{nic}(\mu) \end{bmatrix} = \begin{bmatrix} x_m^{\text{¤}ic}(\mu) \\ x_f^{\text{¤}ic}(\mu) \end{bmatrix} \tag{3.7}$$

It turns out that the fringe pays for each unit of the intermediate good its marginal cost. Hence, for each $\mu \in [\underline{\mu}, \overline{\mu}]$:

$$a^{nic}(\mu) = a^{\text{¤}ic}(\mu) = k(\mu)$$

The disadvantage of the public ownership is that the manager does not invest in cost reducing activities at all. The reason is because her payo¤ function is strictly decreasing in those activities (w is …xed in the contract), then her best response is always to set:

$$e^{nic} = 0$$

Since the government is worse o¤ giving up rents to the manager, its dominating strategy is to set $w^{nic} = 0$ in order to drive the manager to her reservation utility.

The best interpretation of the previous proposition is to think $e^{nic} = 0$ as a normalized minimum level of e¤orts such that the manager will not be …red for bad performance. Such a feature is typical in public employees, but can this feature be generalized to a public monopoly's manager? Let say yes, at least compared to private …rms' managers, because public managers do not cope with discipline market mechanisms. For instance, the possibility of hostile take-over and bankruptcy are not an issue in public …rms. The former because the manager might be …red for political agreements rather than relative bad performance of her …rm; the latter because the government always goes in the rescue of its troubled …rms.[13]

Therefore, the government's expected payo¤ under public ownership at time 0 is:

$$V^{nic} = q(0) \cdot W^{\text{¤}ic}(\underline{\mu}) + [1 - q(0)] \cdot W^{\text{¤}ic}(\overline{\mu}) \tag{3.8}$$

3.3. Privatization

Under regulation of the private monopoly, the owner of this …rm realizes μ in period 1. This technological parameter is unknown to the government, however. Then the government must design a revelation

[12] Other explanations to incomplete contracting suitable to the model presented in this paper may be found in Spier (1992), Anderlini and Felli (1994), and Bernheim and Whinston (1998). It is important to mention that most of the papers in the literature consider private parties. They are not focused on a benevolent government as the principal of the relationship. See Dixit (1996) for an application of the transaction cost economics to political economy issues.

[13] Majumdar (1998) provides empirical support to the implications of soft budget constraint on slacks in state owned …rms.

mechanism to elicit the true value of μ. It is standard that the asymmetric information on μ allows e¢cient type …rms to obtain rents. It turns, therefore, that the monopolist has incentives to invest in cost reducing activities. Proposition 3.2, below, characterizes the second best production and transfers. The result is well known in the literature.[14] It is characterized by "no-distortion-and-informational-rents-on-the-top" and "underproduction-and-no-rents-at-the-bottom". Therefore, the private monopoly is allocative ine¢cient because it produces less than the …rst best level.[15]

Let β be the government's equilibrium belief regarding the action taken by the monopolist in cost reducing activities. Let us suppose, then, that the government believes the costs are low with probability $\phi \equiv q(\beta)$. Informational rents of the e¢cient monopolist are equal to $R^U(\beta)$ in the upstream market and $R^D(\beta)$ in the downstream market, where

$$R^U(\beta) \equiv \left[k(\bar{\mu}) - k(\underline{\mu})\right] \cdot \left[\psi'(x_m(\bar{\mu};\beta)) + x_f(\bar{\mu};\beta)\right]$$
$$R^D(\beta) \equiv C(x_m(\bar{\mu};\beta);\bar{\mu}) - C(x_m(\bar{\mu};\beta);\underline{\mu})$$

The government's problem in period 3/2 can be expressed as the problem of a central planner choosing $\{x_m(\underline{\mu};\beta); x_f(\underline{\mu};\beta); x_m(\bar{\mu};\beta); x_f(\bar{\mu};\beta)\}$.[16] That is,

$$\begin{aligned}\text{Max} \quad & \phi\{v(x_m(\underline{\mu};\beta) + x_f(\underline{\mu};\beta)) - k(\underline{\mu}) \cdot (\psi'(x_m(\underline{\mu};\beta)) + x_f(\underline{\mu};\beta)) \\ & - C(x_m(\underline{\mu};\beta);\underline{\mu}) - c \cdot x_f(\underline{\mu};\beta) - \underline{U}\} \\ & + (1-\phi)\cdot[v(x_m(\bar{\mu};\beta) + x_f(\bar{\mu};\beta)) - k(\bar{\mu}) \cdot (\psi'(x_m(\bar{\mu};\beta)) + x_f(\bar{\mu};\beta)) \\ & - C(x_m(\bar{\mu};\beta);\bar{\mu}) - c \cdot x_f(\bar{\mu};\beta) - \bar{U}] \\ & - \beta\end{aligned}$$

subject to (nomenclature is standard):

$$\begin{aligned} IR(\underline{\mu}): \quad & \underline{U} \geq 0 \\ IR(\bar{\mu}): \quad & \bar{U} \geq 0 \\ IC(\underline{\mu}): \quad & \underline{U} \geq U\big|_{\bar{\mu}=\underline{\mu}} \\ IC(\bar{\mu}): \quad & \bar{U} \geq U\big|_{\underline{\mu}=\bar{\mu}} \end{aligned}$$

Let $x_j^{pic}(\underline{\mu})$ and $x_j^{pic}(\bar{\mu})$, for $j = \{m; f\}$, be the solution to the government's problem.

Proposition 3.2. An interior solution to the government's problem is fully characterized by:

$$\begin{bmatrix} \bar{U} \\ \underline{U} \end{bmatrix} = \begin{bmatrix} 0 \\ R^U(\beta) + R^D(\beta) \end{bmatrix} \tag{3.9}$$

[14] My model is closer to Baron and Myerson's (1982) than La¤ont and Tirole's (1986; 1993, Chapter 1), in the sense that costs are not observed by the principal. Good surveys on optimal mechanism design applied to regulation of natural monopolies may be found in Caillaud, Guesnerie, Rey, and Tirole (1988) and La¤ont (1994 b). An interesting application to privatization issues is Pint (1992).

[15] The government dislikes giving up rents to the …rm. The model captures such a fact because it assumes, without loss of generality, that monopolist's pro…ts are not incorporated into the government's objective function.

[16] Roughly speaking, the government does not directly regulate the competitive market. It regulates production in the monopolistic upstream market and may regulate the access price charged by the monopoly to the fringe. Since the fringe is a residual supplier of x and I follow the convention that the government collects monopoly's revenue $(P(¢)x_m + ax_f)$, the solution to the planner's problem is equivalent to that resulting from a decentralized decision problem with …rms choosing x_m and x_f for each μ (see La¤ont and Tirole, 1993, Chapter 5).

$$\begin{pmatrix} x_m^{pic}(\underline{\mu}) \\ x_f^{pic}(\underline{\mu}) \end{pmatrix} = \begin{pmatrix} x_m^{\neq ic}(\underline{\mu}) \\ x_f^{\neq ic}(\underline{\mu}) \end{pmatrix} \tag{3.10}$$

$$\begin{pmatrix} x_m^{pic}(\bar{\mu}) \\ x_f^{pic}(\bar{\mu}) \end{pmatrix} < \begin{pmatrix} x_m^{\neq ic}(\bar{\mu}) \\ x_f^{\neq ic}(\bar{\mu}) \end{pmatrix} \tag{3.11}$$

Proof. See Appendix A.

Distortion when the monopoly is ine¢cient is the cost of private ownership in this model. Underproduction also a¤ects the access price that the monopolist charges to the fringe for using its intermediate good, usually a network facility. As expected, the optimal access price represents the shadow costs to the monopolist for providing its input to competitors.[17] The access price charged by the e¢cient monopoly is similar to that resulting under complete contracting. Otherwise, the competitive market would not be cleared.

$$a^{pic}(\underline{\mu}) = a^{\neq ic}(\underline{\mu}) = k(\underline{\mu})$$

However, when the monopoly is ine¢cient, this price is greater than the …rst best access price.

$$\begin{aligned} a^{pic}(\bar{\mu}) &= k(\bar{\mu}) + \frac{\phi}{1 - \phi} \left[R^U_{x_f}(\beta) \right] \\ &> a^{\neq ic}(\bar{\mu}) = k(\bar{\mu}) \end{aligned}$$

The latter inequality is because $R^U_{x_f}(\beta) > 0$ by the single crossing property and monotonicity on $C(x_m; \mu)$ and $\Psi(x_m; \mu)$. The …rst term in $a^{pic}(\bar{\mu})$ is the direct marginal cost to the monopoly of providing access to the fringe. The second term is the monopoly's opportunity cost in terms of lower informational rents.

Since I have assumed cost reimbursement rules, the government makes a transfer to the owner of the monopoly that covers opportunity costs. Let $T^{pic}(\mu)$ be such transfers, for $\mu \in \{\underline{\mu}; \bar{\mu}\}$. Notice that the government is using a truth-telling mechanism, thus it is …ne to use $T^{pic}(\mu)$ instead of $T^{pic}(x_m^{pic}(\mu); x_f^{pic}(\mu))$. Therefore,

$$T^{pic}(\underline{\mu}) = k(\underline{\mu}) - \left[\Psi(x_m^{pic}(\underline{\mu})) + x_f^{pic}(\underline{\mu}) \right] + \left[C(x_m^{pic}(\underline{\mu}); \underline{\mu}) + R^U(\beta) + R^D(\beta) \right]$$

$$T^{pic}(\bar{\mu}) = k(\bar{\mu}) - \left[\Psi(x_m^{pic}(\bar{\mu})) + x_f^{pic}(\bar{\mu}) \right] + \left[C(x_m^{pic}(\bar{\mu}); \bar{\mu}) \right]$$

The above discussion tells us that the …rm is granted total freedom in choosing the access price. However, the revelation principle ensures the …rm will choose the second best level, $a^{pic}(\mu)$, for $\mu \in \{\underline{\mu}; \bar{\mu}\}$. Such a result is a direct consequence of the common network assumption in the model, as noted by La¤ont and Tirole (1993), chapter 5. Under this assumption, the monopoly cannot charge an excessive access price to the fringe in order to deter entry in the downstream market. Doing so, the monopoly would increase its market share in the downstream industry with a higher x_m, but it would indicate to

[17] This is a well known result – E¢cient Component-Pricing Rule (ECPR) – due to Baumol (1983) and Willig (1979). Such a formula becomes much more complicated when allowing for imperfect substitutes, variable coe¢cient technology, and bypass possibilities in the downstream market, as noted by Armstrong, Doyle, and Vickers (1996), La¤ont and Tirole (1993), chapters 5 and 6, and La¤ont and Tirole (1994).

the government a predatory practice. The government knows that a higher access price means higher marginal costs for x_m too, which is inconsistent with raising x_m.[18]

Both, the monopolist and the regulator know what will happen after the …rm undertakes investments in cost reducing activities. The next proposition tells us that the monopolist invests more than the public manager, but less than the optimal $e^{\alpha ic}$. Then, the private monopoly is more productively e¢cient than the public monopoly, because production in the former is more likely to be at the lowest cost.

Proposition 3.3. The monopolist invests $e^{pic}(\beta)$, which is her best response to the government's belief that she invests β, and $0 < e^{pic}(\beta) < e^{\alpha ic}$. Furthermore, there exists a unique rational expectations equilibrium $e^{pic}(\beta) = \beta$ determined by:

$$q_e(e^{pic}(\beta)) \cdot \left[R^U(e^{pic}(\beta)) + R^D(e^{pic}(\beta)) \right] = 1 \tag{3.12}$$

Proof. See Appendix A.

Let $e^{pic} \equiv e^{pic}(\beta)$, the unique rational expectation equilibrium solving the monopolist's problem above. In period zero, the government drives the monopolist to her expected reservation utility, that we have assumed equal to zero. Therefore,

$$z^{pic} = q(e^{pic}) \cdot \left[R^U(e^{pic}) + R^D(e^{pic}) \right] - e^{pic}$$

It turns out that the government's expected payo¤ is equal to:

$$V^{pic} = q(e^{pic}) \cdot W^{\alpha ic}(\underline{\mu}) + \left[1 - q(e^{pic}) \right] \cdot W^{pic}(\bar{\mu}) - e^{pic} \tag{3.13}$$

where the ex-post social surplus at $\bar{\mu}$ is below $W^{\alpha ic}(\bar{\mu})$ and de…ned by:

$$W^{pic}(\bar{\mu}) \equiv v(x_m^{pic}(\bar{\mu}) + x_f^{pic}(\bar{\mu})) - k(\bar{\mu}) \cdot \varphi'(x_m^{pic}(\bar{\mu})) + x_f^{pic}(\bar{\mu})$$
$$- C(x_m^{pic}(\bar{\mu}) + x_f^{pic}(\bar{\mu}); \bar{\mu}) - c \cdot x_f^{pic}(\bar{\mu})$$

3.4. Analysis

In this model, public monopolies are allocatively e¢cient but productively ine¢cient, i.e. they don't optimally invest in cost reducing activities. The latter is so because the government, as the principal, is unable to credibly commit not to expropriate all rents generated by investments in cost reducing activities. Hence, the manager does not invest at all. On the contrary, a private monopoly is allocative ine¢cient in the high cost type but more productive e¢cient than a public monopoly (not yet fully e¢cient because the private owner under invests as compared to the …rst best level). Again, government's lack of commitment plays a crucial role in both inducing the agent (either private monopolist or public manager) to under invest and, consequently, distorting production in period 2.

[18] Discriminatory practices using the access price are ruled out in the model, which seems to be contrary to what we observe in practice. That may be the result of two non exclusionary explanations. Common network assumption may lack reality and network expansion would be better suitable to analyze the access price problem. Secondly, the model does not fully capture the fact that contracts enforceability in developing countries may be so poor that, even with a common network, the dominant …rm may discriminate and predate the market (see Saavedra, 1999).

Another interesting point highlighted by this model is that a benevolent government does not necessarily imply public monopolies are socially preferred to private monopolies. Hence, we do not need to assume private agendas at the top of the government (other than the social welfare maximization) to say that depending upon structural parameters of the economy, privatization may be preferred to nationalization, as the next result establishes.

Result 1 Privatization is socially preferred to nationalization if and only if:

$$\left[q(e^{pic}) - q(0)\right]\cdot W^{pic}(\underline{\mu}) \geq \left[1 - q(e^{pic})\right]\cdot\left[W^{pic}(\bar{\mu}) - W^{pic}(\bar{\mu})\right] + e^{pic} \qquad (3.14)$$

Remark 1. The left-hand side on (3.14) represents the pros of privatization. It corresponds to the net expected bene…t of producing at low costs. The cons of privatization are shown in the right-hand side of (3.14). Its …rst component corresponds to the expected loss caused by the allocative ine¢ciency of the private monopoly. Its second component measures the direct loss to the society in terms of costs reducing activities.

Inequality (3.14) is useful as policy advice because it tells the policy maker how speci…c industry and country characteristics a¤ect relative advantages of the privatization process. For example, the lower powered the incentive schemes and more bureaucratized and politically based the making of decisions in public …rms, the deeper the dynamic ine¢ciency of state-owned monopolies. On the contrary, the more informational, transactional, and institutional constraints in the country, the more ine¢cient allocation of resources under regulation of the private monopoly. Therefore, before initiating privatization processes, policy makers have to create conditions in order to reduce informational constraints, improve enforceability, and reduce ambiguities of the law, and so on.

4. The Two Extreme Cases

Most of the discussion when the private sector is allowed to participate in natural integrated monopolies is whether or not to vertically separate the monopolistic activity from those potential competitive industries. If divested, the monopolist would be impeded to expand its market power to those other markets. I provide a rational scope for this position. Another alternative is to fully integrate all the activities into the monopoly. This alternative is widely attacked because of its allocative and distributive e¤ects. I show in this section, however, that full concentration may provide the highest incentives to reduce costs in the long run.[19]

4.1. Vertical Separation of the Monopoly and Competition Downstream

Let us now consider the case where the monopoly is vertically separated and cannot produce the downstream good. This institutional arrangement was chosen in the USA telecommunication sector when AT&T was separated from its local network operators in 1984. Following the experience of the British privatization process, several developing countries, such as Argentina, have organized the electricity sector in this fashion too.

[19] Notice that the institutional arrangements which consider the two extreme institutional arrangements are special cases of those in section 3. Then, proofs are in general omitted.

In most developing countries people think that this is the only way to accept privatization of network utilities, otherwise the monopoly will use its market power against competitors in potential competitive markets in order to deter entry, discriminate, or predate, among other noncompetitive practices. In this regard, our objective in this section is to provide a rational justi…cation for a vertical separation of a network utility, as was the AT&T case.

² First Best Allocations For each $\mu \in \{\underline{\mu}; \overline{\mu}\}$, the …rst best allocations are fully characterized by equations (4.1) to (4.4).

$$P(x_f^{ndc}(\mu)) = k(\mu) + c \tag{4.1}$$

$$a^{ndc}(\mu) = k(\mu) = a^{nic}(\mu) \tag{4.2}$$

$$q_e(e^{ndc}) \cdot \left[W^{ndc}(\underline{\mu}) - W^{ndc}(\overline{\mu}) \right] = 1 \tag{4.3}$$

$$U = 0 \tag{4.4}$$

where

$$W^{ndc}(\mu) \equiv v(x_f^{ndc}(\mu)) - k(\mu) \cdot x_f^{ndc}(\mu) - c \cdot x_f^{ndc}(\mu)$$

First of all, notice that equations (4.1) implies $x_f^{ndc}(\mu) = \phi(x_m^{nic}(\mu)) + x_f^{nic}(\mu)$ – equivalently $y^{ndc}(\mu) = y^{nic}(\mu)$ – for each $\mu \in \{\underline{\mu}; \overline{\mu}\}$. This result is not general, however. It comes from the fringe's constant marginal cost assumption in the downstream industry.

Let V^{ndc} be the expected value of the fully informed planner's problem in this case. Lemma 4.1 tells us that in a world where contingent contracts are feasible, not only ownership does not matter but also the common belief against integrated monopolies is incorrect. There are no economic reasons, from the e¢ciency perspective, to blame against natural monopolies operating in competitive related industries.

Lemma 4.1. Under full contracting and competition in the downstream market society is better o¤ with an integrated monopoly than with a vertically separated monopoly.

The proof is simple. The planner's problem under vertical separation at time zero has an additional constraint as compared with the planner's problem under liberalization. Since this constraint binds (notice our assumption about interior solutions), then $V^{nic}(\mu) > V^{ndc}(\mu)$. Otherwise, a contradiction to the government's revealed preferences arises. This completes the proof ■

Figure 4.1 provides an explanation to Lemma 4.1, and to the previous discussion.

This result doesn't necessarily hold, however, when unforeseen contingencies impede to write fully complete contracts.

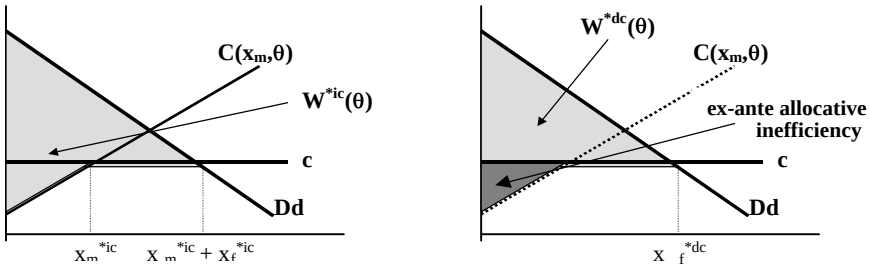
² Nationalization Consider a vertically separated state owned monopoly. As before, production is optimal, there is no investment in cost reducing activities, and the government establishes transfers equal to the marginal cost of producing y (which is equal to x_f) units of the upstream good. Since I have assumed the manager's opportunity cost is zero, she receives no salary ($w^{ndc} = 0$) in equilibrium, as already shown.

Government's expected payo¤ at date zero is:

$$V^{ndc} = q(0) \cdot W^{ndc}(\underline{\mu}) + [1 - q(0)] \cdot W^{ndc}(\overline{\mu}) \tag{4.5}$$

Comparing (3.7) and (4.5) – that is V^{nic} and V^{ndc} – yields the next result.

Figure 4.1: Welfare Costs of Vertical Separation under Complete Contracting



First best allocations requieres all firms producing at the same marginal costs

Liberalization

The first best x_m^{*ic} units are inefficiently produced

Vertical Separation

Result 2 An integrated public monopoly with a mixed competitive market downstream – liberalization – is socially preferred to a separated monopoly with a private fringe of …rms operating in the downstream industry.

Remark 2. This result is important for the optimal timing of the deregulatory process. That is, it is never optimal to forbid public monopolies to participate in potential competitive markets, even when the government is planning to privatize the monopolistic activity.[20]

This model provides a rationale scope for mixed markets. This result, in a context of a network utility with a downstream competitive market, is new in this literature. Most of the papers have justi…ed mixed oligopolies, i.e. private and public …rms operating in an oligopolistic competition.[21] Result 2 of this paper, however, tells us that mixed markets are socially desirable in competitive markets vertically connected to a state-owned natural monopoly, so that we do not need to abandon the pro-competition paradigm in order to justify this institutional design.

² Privatization Under privatization, the owner of the private monopoly realizes μ in period 1. The government designs a mechanism to elicit truth-telling, but it may give up some rents to the e¢cient type …rm. This informational rent, however, is smaller than the rent captured by the e¢cient …rm under liberalization. Since those rents induce ine¢cient allocation of resources, the society would be better o¤ under vertical separation than under integration and competition downstream.

[20] The experience shows that, before initiating privatization processes, public …rms are impeded to operate in emerging markets. This policy is used by governments in order to credibly signal its commitment to not revise privatizations. Such a consideration is not an issue in this paper, however, because revision of privatizations are ruled-out from the model.

[21] Some traditional papers in this emerging literature are Beato and Mas-Colell (1982), Cremer, Pestieau, and Thisse (1987), De Fraja and Delbono (1989), and De Fraja (1991). About partial privatization in mixed oligopolies, see Bös (1994) and Matsumura (1998).

Let de…ne the informational rents under vertical separation as:

$$B(\beta) \equiv \left[k(\bar{\mu}) - k(\underline{\mu})\right] \cdot x_f(\bar{\mu};\beta)$$

Similarly as before, the second best allocations are fully characterized by equations (4.6) to (4.8).

$$\overline{U} = 0 \text{ and } \underline{U} = B(\beta) \tag{4.6}$$

$$x_f^{pdc}(\underline{\mu}) = x_f^{*dc}(\underline{\mu}) \tag{4.7}$$

$$x_f^{pdc}(\bar{\mu}) < x_f^{*dc}(\bar{\mu}) \tag{4.8}$$

because $x_f^{pdc}(\bar{\mu})$ satis…es:

$$P(x_f^{pdc}(\bar{\mu})) = k(\bar{\mu}) + c + \frac{\phi}{1-\phi} \cdot [B'(\beta)]$$

and the last term of the right hand side is strictly positive because of $B'(\beta) \equiv \frac{\partial B(\beta)}{\partial x_f} > 0$.

The second-best access prices in equilibrium are equal to marginal costs of providing access to the network (input). Therefore, when the monopoly is e¢cient:

$$a^{pdc}(\underline{\mu}) = a^{*dc}(\underline{\mu})$$

Since (4.1) implies $y^{*dc}(\mu) = y^{*ic}(\mu)$, then

$$a^{pdc}(\underline{\mu}) = a^{pic}(\underline{\mu})$$

too. That is, the access price charged by an e¢cient monopoly to potential competitors is the same, whatever the institutional arrangements chosen by the government.

On the other hand, the access prices charged by an ine¢cient monopoly is greater than the …rst best access price:

$$\begin{aligned} a^{pdc}(\bar{\mu}) &= k(\bar{\mu}) + \frac{\phi}{1-\phi} \cdot [B'(\beta)] \\ &> a^{*dc}(\bar{\mu}) = k(\bar{\mu}) \end{aligned}$$

Moreover, the access price under vertical separation of the private monopoly is smaller than that of the ine¢cient type integrated monopoly operating in the competitive industry, $a^{pdc}(\bar{\mu}) < a^{pic}(\bar{\mu})$. The reason is that vertical separation induces smaller informational rents to the monopolist, which in turn shrinks the opportunity cost of providing access to the input.

Since the monopoly is not participating in the competitive industry, the government has to …x contingent (truth-telling) access prices in order to avoid abuse of monopoly power against competitors, i.e. the government cannot grant the monopoly with any freedom in choosing those prices under vertical separation. Accordingly, the government collects those charges (we are using cost reimbursement rules), so that transfers are:

$$T^{pdc}(\underline{\mu}) = k(\underline{\mu}) \cdot x_f^{pdc}(\underline{\mu}) + [B(\beta)]$$

$$T^{pdc}(\bar{\mu}) = k(\bar{\mu}) \cdot x_f^{pdc}(\bar{\mu})$$

As under liberalization, (second-best) optimal cost reducing activities are in the interior of the interval $[0; e^{¤dc}]$. Since expected informational rents under vertical separation are smaller than under liberalization, it is immediate that cost reducing activities under vertical separation are also smaller.[22]

$$e^{pdc} < e^{pic}$$

Hence, the adverse e¤ect of vertical separation on the society's welfare is that divestiture reduces the probability to the …rm to be e¢cient.

Continuing backward, the government sells the upstream monopoly at:

$$z^{pdc} = q(e^{pdc}) ¢ \pounds B(e^{pdc}) ¤ ¡ e^{pdc}$$

Therefore, the government's expected payo¤ at time zero is equal to:

$$V^{pdc} = q(e^{pdc}) ¢ W^{¤dc}(\underline{\mu}) + \pounds 1 ¡ q(e^{pdc}) ¤ ¢ W^{pdc}(\bar{\mu}) ¡ e^{pdc} \tag{4.9}$$

where,

$$W^{pdc}(\bar{\mu}) ´ v(x_f^{pic}(\bar{\mu})) ¡ k(\bar{\mu}) ¢ x_f^{pdc}(\bar{\mu}) ¡ c ¢ x_f^{pdc}(\bar{\mu})$$

² Analysis We are interested in the trade o¤ resulting when the decision is whether or not to allow integrated monopolies to participate in competitive industries. In other words, the question is whether to design a liberalized or a vertically separated industry.[23]

When a monopoly is e¢cient in producing, it obtains more rents if operating in both markets than if it is impeded to produce the …nal good. Then, it has more incentives to invest in cost reducing activities under integration than under vertical separation. On the contrary, a vertically separated natural monopoly is more allocative e¢cient than an integrated monopoly because its expected rents are smaller in the former case, what implies the monopoly reduces underproduction on the ine¢cient type state of nature.

As analyzed before, ine¢ciencies come from the fact that the government cannot credible commit to not expropriate some of the monopolist's rents caused by cost reducing activities.

I summarize this discussion on the next result:

Result 3 Vertical separation of the private natural monopoly is socially preferred to grant it total freedom to operate vertically related markets – liberalization – if and only if:

$$\begin{aligned} &\left[q(e^{pic}) ¢ W^{¤ic}(\underline{\mu}) ¡ q(e^{pdc}) ¢ W^{¤dc}(\underline{\mu}) \right] \cdot \\ &\qquad \left[\pounds 1 ¡ q(e^{pdc}) ¤ ¢ W^{pdc}(\bar{\mu}) ¡ \pounds 1 ¡ q(e^{pic}) ¤ ¢ W^{pic}(\bar{\mu}) \right] \\ &\qquad + \pounds e^{pic} ¡ e^{pdc} ¤ \end{aligned} \tag{4.10}$$

This result comes from equations (3.12) and (4.9), after imposing $V^{pic} \cdot V^{pdc}$.

[22] That is because $\pounds B^0(\theta) ¤ = \pounds k(\bar{\mu}) ¡ k(\underline{\mu}) ¤ = \pounds R^U_{x_f}(\theta) ¤$ and $q(e^{pdc}) < q(e^{pic})$, which comes from the fact that $\pounds B(\theta) ¤ < \pounds R^U(\theta) + R^D(\theta) ¤$ induces $e^{pdc} < e^{pic}$.

[23] Under vertical separation, state owned monopolies are allocatively e¢cient but productively ine¢cient; the contrary happens to private monopolies. Since we have already assessed this trade o¤ under more general assumptions (Result 1), it is omitted here.

Remark 3. The left-hand side on (4.10) represents the pros of liberalizing the competitive market. It corresponds to the net expected bene…t of producing at lower costs by the integrated monopoly. The bene…ts of the vertical separation are represented by the right-hand side of (4.10). The …rst component corresponds to the expected gains caused by reducing the allocative ine¢ciency of the private monopoly. The second component on the right hind side of (4.10) measures the direct bene…t to the society in terms of fewer resources spent in cost reducing activities.

Whether or not inequality (4.10) holds depends in speci…c calibrations of the structure of the industry (demand and cost functions) and on the intensity in which incentives push cost reducing activities. The left-hand side and the last term of the right-hand side of this inequality are strictly positive because $e^{pic} > e^{pdc}$ (see footnote 23) and $W^{¤ic}(\underline{\mu}) > W^{¤dc}(\underline{\mu})$, whereas the …rst term of the right-hand side of (4.10) could be positive if welfare distortions at the ine¢cient type of …rms are not too high under vertical separation that under liberalization (see section 5 for a speci…c parametric example).

4.2. Monopoly Concentrates All the Activities

State-owned monopolies concentrating all the activities of an industry were the characteristic around the world until a few years ago. After privatization, this situation has remained somewhere. Governments in these countries have granted private monopolies with legal entry barriers to competitors in non-natural monopoly segments of the industry. These legal rigidities have been imposed in industries experiencing fast technological advances in the last time, making competition feasible in markets controlled by a "legal" monopoly. Since the government's response to new market conditions is slow and the monopoly may use its pro…ts to maintain the status quo, this situation may remain longer than expected.

Economists typically blame "legal" monopolies. We ought to say that competition is socially preferred to monopoly whenever possible. The model presented in this paper, however, establishes that this conclusion depends on country and/or industry speci…c characteristics. The fact that the cost parameter (μ) is common to any production of the monopoly might imply that full concentration of vertically related activities were desirable to the society, as we would see in a world with unforeseen contingencies. It is perfectly feasible, therefore, to observe the situation in which a rational and benevolent government with no long-term commitments decides about the ownership of a monopoly before introducing competition in potentially competitive segments of the industry. That is, for instance, when privatization precedes liberalization of the industry.

² First Best Allocations Full concentration in the industry is also a particular case of liberalization, in which there does not exist a fringe of competitive …rms that operate in the downstream market. For each $\mu \in \{\underline{\mu}, \overline{\mu}\}$, …rst-best allocations are fully characterized by equations (4.11) to (4.13).

$$P(x_m^{¤nc}(\mu)) = k(\mu) ¢ '^{0}(x_m^{¤nc}(\mu)) + C^{0}(x_m^{¤nc}(\mu); \mu) \tag{4.11}$$

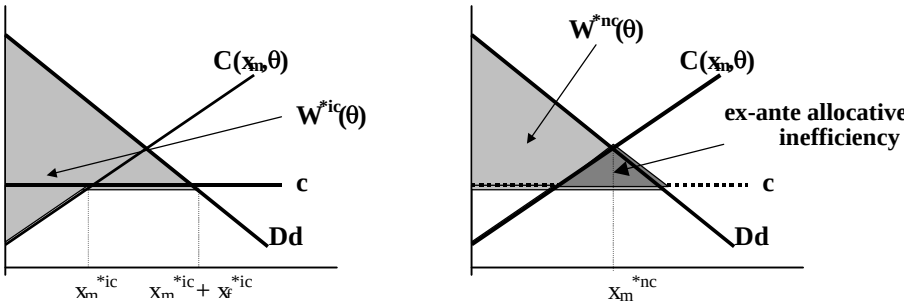
$$q_e(e^{¤nc}) ¢ \left[W^{¤nc}(\underline{\mu}) - W^{¤nc}(\overline{\mu}) \right] = 1 \tag{4.12}$$

$$U = 0 \tag{4.13}$$

where,

$$W^{¤nc}(\mu) \equiv v(x_m^{¤nc}(\mu)) - k(\mu) ¢ '(x_m^{¤nc}(\mu)) - C(x_m^{¤nc}(\mu); \mu)$$

Figure 4.2: Welfare Costs of Full Concentration under Complete Contracting



First best allocations requieres all firms producing at the same marginal costs

Liberalization

The last [$x_m^{*nc} - x_m^{*ic}$] units are inefficiently produced

Full Concentration

Let V^{nc} be the expected value of the fully informed planner's problem in this case. Likewise vertical separation, in a world where contingent contracts are feasible the best market design requires to allow both an integrated monopoly and competitors participating in those potentially competitive markets.

Lemma 4.2. Under full contracting, the society is better o¤ if the government deregulates competitive markets and does not impose any barrier to enter.

The proof is similar to Lemma 4.1. By government's revealed preferences, $V^{ic}(\mu) > V^{nc}(\mu)$. This completes the proof ■

Regarding the comparison between vertical separation and full concentration, it is interesting to mention that none of these institutional arrangements dominates the other. Both present ex-ante ine¢cient allocation of resources because the mix of technologies to produce the …nal good is not optimal, as compared to that under liberalization.[24] The nature of the ex-ante allocative ine¢ciency is di¤erent in both alternatives, however. Thus, we cannot ensure what institutional arrangement makes the society better o¤.

Figure 4.2 provides an explanation to Lemma 4.2, and to the previous discussion.

Conclusions under incomplete contracts hold in the case of a state owned monopoly, but not in the case of regulation under a private fully concentrated monopoly.

[24] Notice that ex-ante ine¢ciencies concern comparison among alternative institutional arrangements and not within them. Within each institutional arrangement, there is not (ex-post) allocative nor (ex-post) productive ine¢ciency because we are comparing complete contracting situations.

² Nationalization In this subsection I show that there is no rationale behind the policy of maintaining legal entry barriers in state owned industries.

Remember that the government does not have a credible commitment to not expropriate ex-post rents resulting from cost reducing activities undertaken by the manager. This intertemporal inconsistency in the government's behavior is anticipated by the manager, who underinvests as compared to the full contracting case ($e^{nnc} = 0$). The government, then, drives the manager to her reservation utility in period zero, that is $w^{nnc} = 0$. Then, the government's expected payo¤ is therefore:

$$V^{nnc} = q(0) \cdot W^{\neg nc}(\underline{\mu}) + [1 - q(0)] \cdot W^{\neg nc}(\overline{\mu}) \tag{4.14}$$

Comparing (3.7), (4.5), and (4.14) – that is V^{nic}, V^{ndc}, and V^{nnc} – yields the next result.

Result 4 An integrated public monopoly with competition downstream is socially preferred to an integrated state owned …rm operating as a monopoly in all markets.

Results 2 and 4 are conclusive. If nationalization is preferred to privatization, then it is always better to allow the public monopoly to operate in all related markets. Similarly, private competitors should also be allowed to operate in potentially competitive segments of the industry. Therefore, contrary to the current literature, liberalization is always welcome in potentially competitive markets when maintaining a state owned monopoly.

² Privatization Assume for a while that the monopoly is very e¢ cient to produce the …nal good – its cost's structure is close to that of the fringe – but rents of the e¢ cient type push cost reducing activities in such way that productive e¢ ciency out weights allocative ine¢ ciencies of the full concentration. Under this context, then, liberalization is not socially desirable. This subsection attempts to show how feasible is this situation.

Let the informational rents be $\pounds M^U(\theta) + M^D(\theta)\¤$, in which:

$$M^U(\theta) \equiv \pounds k(\overline{\mu}) - k(\underline{\mu})\¤ \cdot \varphi(x_m(\overline{\mu};\theta)$$

$$M^D(\theta) \equiv C(x_m(\overline{\mu};\theta);\overline{\mu}) - C(x_m(\overline{\mu};\theta);\underline{\mu})$$

The second best allocations are fully characterized by equations (4.15) to (4.17)

$$\begin{bmatrix} \overline{U} \\ \underline{U} \end{bmatrix} = \begin{bmatrix} 0 \\ M^U(\theta) + M^D(\theta) \end{bmatrix} \tag{4.15}$$

$$x_m^{pnc}(\underline{\mu}) = x_m^{\neg nc}(\underline{\mu}) \tag{4.16}$$

$$x_m^{pnc}(\overline{\mu}) < x_m^{\neg nc}(\overline{\mu}) \tag{4.17}$$

because $x_m^{pnc}(\overline{\mu})$ satis…es:

$$P(x_m^{pnc}(\overline{\mu})) = k(\overline{\mu}) \cdot \varphi'(x_m^{pnc}(\overline{\mu})) + C'(x_m^{pnc}(\overline{\mu});\overline{\mu}) + \frac{\phi}{1-\phi} \cdot \pounds M_{x_m}^U(\theta) + M_{x_m}^D(\theta)\¤$$

and the last term of the right-hand side is strictly positive.

Truth-telling transfers to the monopolist are:

$$T^{pnc}(\underline{\mu}) = k(\underline{\mu}) \cdot \tau'(x_m^{pnc}(\underline{\mu})) + C(x_m^{pnc}(\underline{\mu}); \underline{\mu}) + \left[M^U(\beta) + M^D(\beta) \right]$$

$$T^{pnc}(\bar{\mu}) = k(\bar{\mu}) \cdot \tau'(x_m^{pnc}(\bar{\mu})) + C(x_m^{pnc}(\bar{\mu}); \bar{\mu})$$

Higher expected rents provides incentives to the owner of the monopoly to undertake cost reducing activities, $e^{pnc} \in [0; e^{anc}]$. Unfortunately, without further information on demand and cost functions, and in the informational incentives in cost reducing activities, we cannot say anything regarding the relative size of e^{pnc}, e^{pic}, and e^{pdc}.

In period zero, the government sells the whole integrated monopoly at:

$$z^{pnc} = q(e^{pnc}) \cdot \left[M^U(\beta) + M^D(\beta) \right] - e^{pnc}$$

Therefore, the government's expected payoff at the moment of the privatization is equal to:

$$V^{pnc} = q(e^{pnc}) \cdot W^{anc}(\underline{\mu}) + [1 - q(e^{pnc})] \cdot W^{pnc}(\bar{\mu}) - e^{pnc} \tag{4.18}$$

where,

$$W^{pnc}(\bar{\mu}) \equiv v(x_m^{pnc}(\bar{\mu})) - k(\bar{\mu}) \cdot \tau'(x_m^{pnc}(\bar{\mu})) - C(x_m^{pnc}(\bar{\mu}); \bar{\mu})$$

² Analysis Once it is recognized that incomplete contracting matters, it is clear that liberalize (deregulate) potential competitive industries is a dominant strategy of the government only if the monopoly remains public and operates in both markets (Result 4).

Suppose for a while that for some reason mixed markets (private and public operators) are not feasible, then a state-owned monopoly concentrating all the activities may be socially preferred to a vertically separated public monopoly. This is the case in which the ex-ante allocative inefficiency in the former is smaller than that in the latter (see shaded areas in Figure 4.1 above).[25] Anyway, Result 2 strongly recommends liberalizing competitive markets when the monopolistic upstream firm is state owned.

A stronger conclusion may be driven when considering a private monopoly. The economic literature has discussed the advantages of deregulating potentially competitive activities at length. Examples are airlines, trucking, banking, agriculture, some segments in telecommunications, gas, water and electricity, etc.[26] Vickers (1995) assumes that "all clear benefits of deregulation may be summarized in a parameter $\bar{\alpha} > 0$, which out weights any feasible advantage of concentrating in competitive markets". Such assumption hides what those deregulatory advantages exactly are. In terms of the model in the present paper, however, such procedure would impede to see that concentration might be socially preferred because it would facilitate production at the lowest costs, and all the expected monopoly profits can be captured by the government when auctioning the firm.

[25] Remember that under nationalization both alternatives have the same productive inefficiency (none investment in cost reduction activities at all) and both are (ex-post) equally allocative efficient. Then, the only difference between them is their ex-ante allocative inefficiency.

[26] See Bailey (1995) and Beesley (1997) for further references. The analysis of all the reasons argued by this literature is out of the scope of this paper, however.

There is an increasing literature questioning the advantages of deregulation in practice but, to the best of my knowledge, none argument goes in the direction assessed in this article.[27] This conclusion is summarized in the next result:

Result 5 To concentrate all the activities in a private monopoly is socially preferred to liberalizing the competitive market if and only if:

$$\left[q(e^{pnc})\cdot W^{nc}(\underline{\mu}) - q(e^{pic})\cdot W^{ic}(\underline{\mu})\right]^{a} + \left[1 - q(e^{pnc})\right]\cdot W^{pnc}(\bar{\mu}) - \left[1 - q(e^{pic})\right]\cdot W^{pic}(\bar{\mu})\right]^{a} \geq \left[e^{pnc} - e^{pic}\right] \tag{4.19}$$

and

$$\left[q(e^{pnc})\cdot W^{nc}(\underline{\mu}) - q(e^{pdc})\cdot W^{dc}(\underline{\mu})\right]^{a} + \left[1 - q(e^{pnc})\right]\cdot W^{pnc}(\bar{\mu}) - \left[1 - q(e^{pdc})\right]\cdot W^{pdc}(\bar{\mu})\right]^{a} \geq \left[e^{pnc} - e^{pdc}\right] \tag{4.20}$$

Remark 4. The importance of this result is that it provides us with an economic rationale for maintaining monopolies in potentially competitive markets. Obviously, the outcome depends on speci…c country and industry characteristics. To see what is the best outcome in practice requires to estimate not only demands and costs of production, but also the e¤ects of the incentives and informational rents achieved by the e¢cient type monopolist.

Whether or not inequalities (4.19) and (4.20) hold in practice is an open question. As already mentioned in the beginning of this subsection, these two inequalities are more likely to occur when technology of the …nal good between the monopoly and the fringe are more or less similar and cost reducing activities are very sensitive to expected rents (see a speci…c example in section 5).

5. A Simple Example: Linear Demand and Cost Functions

This section attempts to illustrate the following trade o¤s:

- whether to privatize or not the upstream industry
- after privatization, whether to liberalize the downstream market, vertically separate the industry, or fully integrate all activities into the monopoly.

First of all, consider a gross consumer surplus as follows:

$$v(x_m + x_f) = A\cdot(x_m + x_f) - \frac{1}{2}\cdot(x_m + x_f)^2$$

which yields an inverse linear demand function for the downstream good:

$$P = A - (x_m + x_f)$$

[27] Further references may be found in MacAvoy (1995). As a di¤erence from this model, such literature is calling into question the capacity of regulators representing the interest of the society, i.e. it abandons the normative view of the government.

Let the monopolist's cost function be:

$$\begin{aligned} \text{Upstream} &: \mu \cdot \left[\pm \cdot (x_m)^2 + x_f \right] \\ \text{Downstream} &: \circledR \cdot \mu \cdot (x_m)^2 \end{aligned}$$

where $\mu \in \{\underline{\mu}; \overline{\mu}\}$ is the asymmetric information parameter and $\circledR; \pm$ are positive, constant numbers.

Then, its total costs are:

$$\mu \cdot (\pm + \circledR) \left[(x_m)^2 \right] + \mu \cdot x_f$$

and marginal cost are:

$$\begin{aligned} \text{respect to } x_m &: 2 \cdot \mu \cdot (\circledR + \pm) \cdot x_m \\ \text{respect to } x_f &: \mu \end{aligned}$$

On the other hand, the competitive fringe presents constant marginal costs, c.

Assume that $q(e)$ takes the following form:

$$q(e) = \gamma + (1 - \gamma) \left[\frac{e}{\circ + e} \right]^{\neg}$$

where γ is the probability of being an e¢cient monopolist when no investments in cost reducing activities are undertaken, $\circ$ is a positive parameter, and $\neg > 0$ such that $q(e)$ is strictly concave on e.

Despite linear demand and cost functions, the solution – …rst and second-best optimal allocations, net consumer surpluses, rents, and e¤orts – for each institutional arrangement in general cannot be characterized because of the non-linearity of $q(e)$. Moreover, the system of equations becomes simultaneous under the three institutional arrangements in both complete contracting and privatization cases. The system is recursive only under nationalization. Therefore, I use numerical analysis in these simulations.

² Base Simulation and the Privatization-Nationalization Trade o¤ Let us assume that the Table N± 2 below contains the basic parameters of the industry.

Table N± 2

Parameter :	A	c	$\circledR$	$\pm$	$\overline{\mu}$	$\underline{\mu}$	γ	$\circ$	$\neg$
Value :	50	1:0	0:20	0:20	0:25	0:10	0:60	60	0:90

This structure implies that a mixed market in the downstream sector yields a better outcome to society than a private, liberalized industry, as shown in the table below.[28]

[28] Table B.1 in Appendix B summarizes the solution of the model using these parameters under liberalization, vertical integration, and full concentration.

Table N± 3

	First Best (¤ic)		Nationalization (nic)		Privatization (pic)	
	μ	$\bar{\mu}$	μ	$\bar{\mu}$	μ	$\bar{\mu}$
V	1198:78		1198:78		1198:76	
e	0.073		0		0.006	
q(e)	0.608		0.600		0.601	
W	1203.2	1192.2	1203.2	1192.2	1203.2	1192.1
x_m	13.8	6.25	13.8	6.25	13.8	5.8
x_f	35.2	42.5	35.2	42.5	35.2	42.73

What should happen if the asymmetry of information between the private monopoly and the regulator increases? There are two implications of varying ¢μ in this model. Unfortunately, both run in opposite directions. First, the greater di¤erences between μ^0s, the more "distortion-at-the-bottom" (the allocative ine¢ciency of a private monopoly increases). Secondly, the greater di¤erences between μ^0s, the more "rents-on-the top", which induces higher cost reducing activities (private monopoly becomes more productively e¢cient).

The model with linear demands considered in this section shows that the …rst e¤ect domains for small di¤erences between the unknown parameters, making a publicly owned monopoly preferred to a private owned; whereas the second e¤ect becomes much more important for high di¤erences in the unknown parameters, so that privatization becomes preferred when $\bar{\mu}$ is three or more times higher than μ under the parameterization showed in Table N± 2 above. Figure 5.1 below illustrates this result.[29]

² A Case for Vertical Separation One of the main …ndings of this paper is that there exists an economic rationale for vertical separation under regulation and private ownership of the monopoly. I illustrate its feasibility by considering a more radical parameterization of the industry. Assume that parameters of the industry are those in Table N± 4 below:

Table N± 4

Parameter :	A	c	®	±	$\bar{\mu}$	μ	¸	°	¯
Value :	200	1:0	0:20	0:20	0:50	0:10	0	100	0:90

that is, the competitive fringe of …rms is very e¢cient in producing the …nal good (A increases from 50 to 200), $\bar{\mu}$ is now 400 percent higher than μ, and the probability q(e) is not very responsive to changes in cost reducing activities (¸ = 0 and ° = 100).

Under this parameterization, vertical separation becomes preferred to liberalization (integration and competition downstream), as shown in Table N± 5 below ($V^{pdc} > V^{pic}$).

[29] Table B.2 in Appendix B contains the outcome of simulations required to construct this …gure.

Figure 5.1: Trade-o¤ Privatization vs. Nationalization

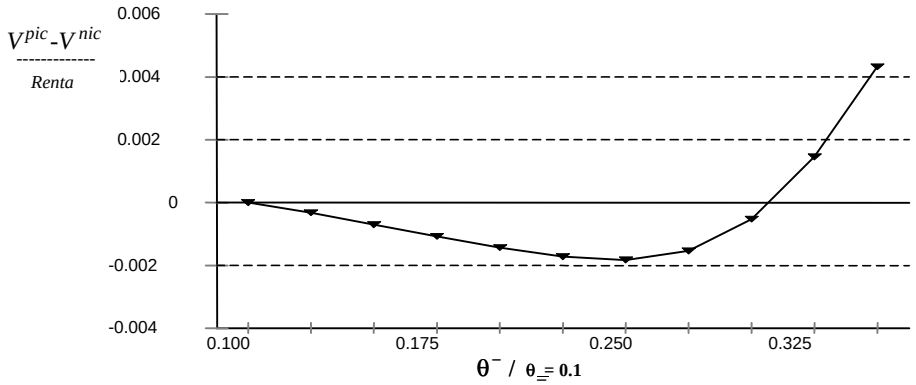


Table N± 5

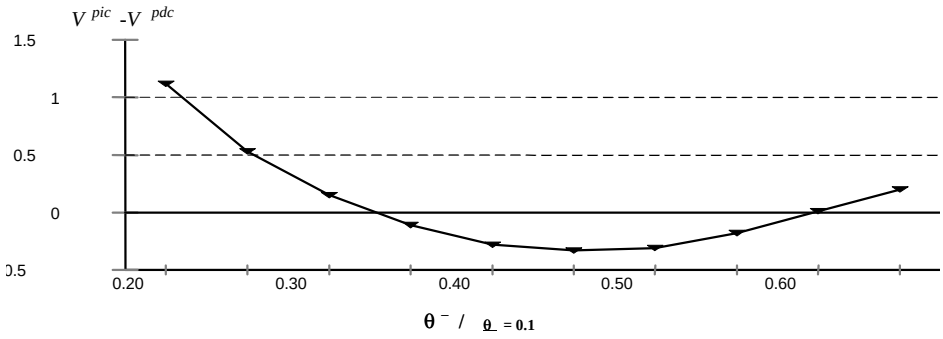
		Vertical Separation (pdc)		Liberalization (pic)	
		$\underline{\mu}$	$\overline{\mu}$	$\underline{\mu}$	$\overline{\mu}$
…rst best	V	19701.44		19704.43	
second best	V	19700:33		19700:02	
	e	2.27		2.42	
	q(e)	.032		.034	
	W	19780.61	19699.98	19788.17	19699.98
	Rents	78.8	0	78.9	0
	x_m	——	——	13.75	3.74
	x_f	198.90	196.99	185.15	191.75

Is it in society's advantage to divest the monopoly as the information between the regulator and the monopoly becomes more asymmetric (everything else constant)? The answer is ambiguous, as illustrated in Figure 5.2 below. As the di¤erence between $\underline{\mu}$ and $\overline{\mu}$ becomes higher, the relative advantage of the liberalization decreases for small ¢μ's. This trend is, however, reverted for values of $\overline{\mu}$ above 0.5.[30]

In summary, $V^{pdc} > V^{pic}$ is only true for values of $\overline{\mu}$ between 0.33 and 0.60 (or ¢μ 2 [0:33; 0:5]). Then, for small amounts of asymmetric of information, society is better o¤ liberalizing the industry. Fur-

[30] Details about …rst-best, nationalization, and full concentration outcomes using this parameterization are in Table B.3, Appendix B. Table B.4 contains the outcome of simulations required to construct Figure 5.2.

Figure 5.2: Trade-o¤ Liberalization vs. Vertical Separation



thermore, this result was found assuming an extremely radical parameterization of the industry. Under "normal" assumptions on the parameters, vertical separation is not the best institutional arrangement.[31]

² Changing the Timing of Privatization – Liberalization The literature is not conclusive regarding the optimal timing of the liberalization-privatization process. One example is De Fraja (1994), whose model characterizes the optimallity of this process using a complete-contract, incomplete-information model. Since the present paper does not attempt to model the timing of this process, I want to illustrate this (second best) optimal timing in an incomplete-contract, incomplete-information model. It is easy to show that for most structural parameters of the industry, society is better o¤ when liberalization precedes privatization. However, it is more interesting to show that for some speci…c parameterization of the industry, society is better o¤ under a fully concentrated and privatized industry.

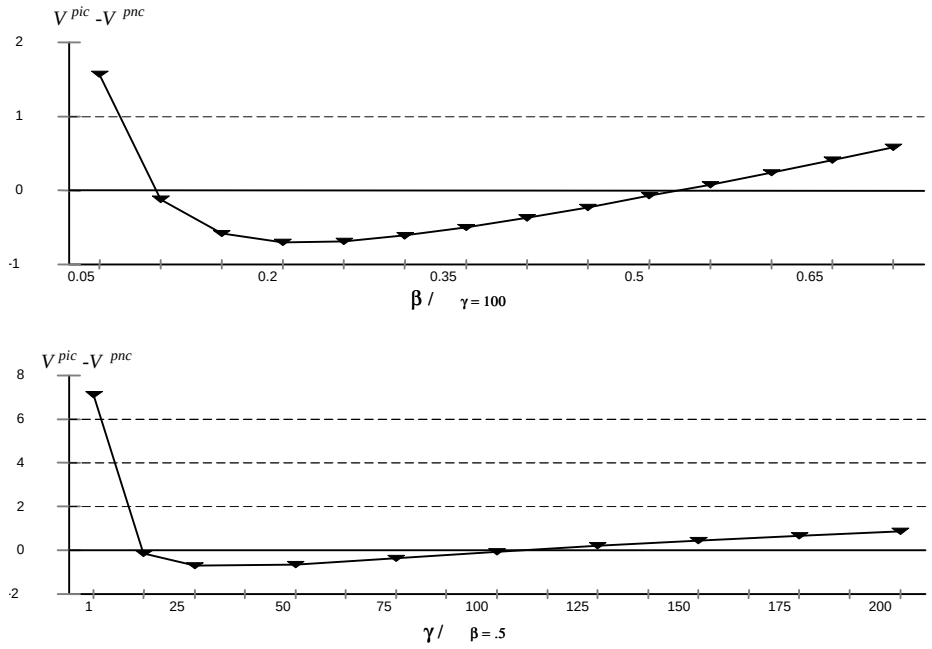
Let us assume that the structure of the industry is adequately summarized by parameters in Table N± 4. Notice, in particular, that ¢µ = 0:4. However, let us assume now that the competitive fringe of …rms is poorly e¢cient (c = 14:7) and q(e) is more sensitive to investment in cost reducing activities (¯ = 0:5) than the case in Table N± 4. Table N± 6, below, shows the results of the new simulation.

This table shows that monopolization of the whole industry is more socially desirable than liberalization under regulation of a private owned monopoly when unforeseen contingencies impede to write fully contingent contracts.[32] This result holds in a wide range of ¯ and °, as showed in Figure 5.3 below. See Table B.6 for details. Notice, however, that this result was found assuming an extremely radical parameterization of the industry. Therefore, under "normal" assumptions on the parameters,

[31] Remember that this model does not consider anticompetitive practices of the incumbent.

[32] See the Table B.5 in Appendix B for further details about …rst-best, public ownership, and vertical separation outcomes in this context.

Figure 5.3: Trade-o¤ Liberalization vs. Full Concentration



liberalization of the industry seems to be the best institutional arrangement.

Table N± 6

		Full Concentration (pnc)		Liberalization (pic)	
		μ	$\bar{\mu}$	μ	$\bar{\mu}$
…rst best	V	18423.91		18424.82	
	V	18422:06		18421:99	
second	e	23.63		19.06	
best	q(e)	.44		.40	
	W	18518.52	18389.12	18518.52	18389.38
	Rents	138.1	0	113.4	0
	x_m	2500.00	185.78	185.00	168.27
	x_f	——	——	0.20	13.92

6. Conclusions and Further Research

The main purpose of this paper is to shed some light on the e¢ciency implications of privatization processes recently carried out in developing countries, in particular Chile. It may be argued that, in some limited measure, the model is suitable for developed countries too. The point is that some underlying assumptions in the model better apply to developing countries, such as incomplete contracts and enforceability problems.[33]

The experience of recent privatizations in developing countries shows that these processes are not always successful. Their main shortcomings are basically three. The …rst problem is the existence of conglomerates in each privatized market – operating in di¤erent segments of the industry – that use their informational advantages to hamper competition and extract rents from the society. This produces an ine¢cient allocation of resources. The second shortcoming is the existence of regulatory frameworks that are both ambiguous and incomplete. Finally, developing countries lack institutions (e.g. regulators and a judiciary system) able to enforce contracts, improve the law (contracts), and encourage competition in potentially competitive industries.[34]

The model used in this article took as given the last two shortcomings, emphasizing the fact that the monopoly is part of a network utility which provides services to potentially competitive markets. In this regard, six institutional arrangements were studied and their relative productive and allocative e¢ciency compared. The main results, in terms of the social welfare perspective, are:

- Result 1 shows that there exists a trade o¤ between privatization and nationalization. A state owned monopoly is more allocative e¢cient than a private one but – as expected – the latter is more productively e¢cient.
- If the monopoly remains public, Results 2 and 4 tell us that the society is better o¤ when the downstream market is liberalized, so that private-run …rms (fringe in the model) may compete with the public monopoly in this market. Nonetheless, if liberalization is for some reason forbidden the third-best is not clear, i.e. whether a vertically separated or a fully concentrated public monopoly makes the society better o¤.
- If the monopoly is regulated under private ownership, then there is no institutional arrangement that strictly dominates the other two, as shown in Results 3 and 5. This conclusion provides a rational scope for:
  - vertical separation of the naturally monopolistic activities from those potentially competitive. That is, the greater the asymmetric information, ambiguities in the regulatory framework, and the less reliable institutions to enforce contracts, the better it is to vertically separate the monopoly.
  - full concentration of the industry. That is, the fewer di¤erences on technologies between the monopoly and the competitive fringe and the more sensitive cost reducing activities to

[33] Some economists argue that when assessing issues pertinent to developing countries, it is essential to include corruption, regulatory capture, and political instability. I disagree, however, because these are not the main characteristics of several developing countries, like Chile. Consequently, I consider it is valid to use a normative view of privatization when highlighting other more important problems, such as informational, contracting and enforceability issues in these countries.

[34] See further details in Saavedra (1999), where the implications of these problems in the Chilean electricity sector are documented.

expected rents, the better it is to fully concentrate all activities of the industry in the regulated monopoly.

I …nally work out an extremely simple example in order to illustrate my results. The simulations suggest that under normal parameterization of the industry, liberalization of the industry seems to be socially preferred. The extreme cases were showed only under radical assumptions on the parameters of the structure of the industry.

There is one important aspect in the regulatory analysis that I expressly left out of the model. If the government departs from the benevolent paradigm, then state owned …rms become much less preferred by society as showed by Shapiro and Willig (1990).[35] Quantitative implications of incorporating this aspect into the analysis matter but qualitative implications do not a¤ect our conclusions, however.

Further research on this topic could proceed in several directions. One route is to consider network expansion with asymmetric marginal costs. That is, the monopoly incurs extra costs when providing its input to competitors. However, those costs are negligible when providing the intermediate good itself to produce the …nal good. In such a case, the regulator has more unknown parameters than instruments. This assumption may help in explaining many noncompetitive practices by the monopoly when integrated, such as discrimination, market foreclosure, and predation. In turn, it implies that vertical separation of the private monopoly becomes much more desirable to the society under network expansion than under common network, everything else constant.

Likewise, it may be useful to take as given a speci…c institutional setup and analyze the e¢ciency implications of the other two mentioned shortcomings. For example, it may be interesting to study the consequences of the change from well prepared regulatory agencies to other less prepared. One simple way is to assume that the set of states of nature is a little bit more complicated than that used here, such that well prepared regulators know signals of the true state of nature and then compute their posterior when regulating by incentives. On the contrary, poorly prepared regulators do not know those signals and, therefore, will compute their priors when designing a true-telling mechanism. Notice however, that the result that would be attained is trivial because the procedure is exactly the same as that used in sections 3 and 4 in this paper. Poorly prepared regulators ought to pay more to e¢cient …rms in their truth-telling mechanism than better prepared regulators. Therefore, it may be easy to show that, for example, vertical separation becomes more desirable than conglomerates under these circumstances.

Future research should concentrate on the economic implications of ambiguity in the regulatory framework. Ambiguity is beginning to be studied and one of the more convincing approaches is the new literature on awareness.[36] The problem is that the theoretical aspects of awareness are not fully studied yet, so that applications to ambiguities in the regulatory framework should remain as a further research for long time.

Finally, after theoretically assessing the pros and cons of di¤erent industry and ownership structure designs, it seems to be valuable to empirically validate our conclusions. One possibility is to do case studies, focusing on the relative advantages of di¤erent institutional arrangements, as seen in this paper. An alternative way is to build a computable general equilibrium model in order to assess the economic implications of the privatization process in developing countries.

[35] This statement is always true in our setting (incomplete contracts and asymmetric information). However, Shapiro and Willig's conclusion does not necessarily hold under other contexts.

[36] Modica and Rustichini (1994) or Dekel, Lipman, and Rustichini (1998).

Appendix A : Proof of Propositions

Proposition 3.1

Let see …rst the last statement. Since government's payo¤s are inversely related to the public manager's (monopolist) payo¤s, then the government optimally chooses w (respectively, the menu of contracts and z) to drive the agent to her reservation utility, U = 0.

Replacing the individual rationality constraint (IR) of the manager (or the monopolist's, it does not change anything) into the government's objective function, we obtain the government's problem, which matches the planner's problem, in period 3/2:

$$\underset{\{x_m;x_f\}}{Max}\ \{v(x_m + x_f) - k(\mu)\cdot[\psi(x_m) + x_f] - C(x_m;\mu) - c\cdot x_f - e\}$$

By the assumptions on functions $v(x_m + x_f)$, $C(x_m;\mu)$, and $\psi(x_m)$, for all $(x_m;x_f)$, the Hessian of this problem is negative de…nite, for each $\mu \in \{\underline{\mu};\overline{\mu}\}$. Thus, FOC's are necessary and su¢cient for a maximum. They are:

$$v_{x_m}(x_m^{ai c}(\mu) + x_f^{ai c}(\mu)) = k(\mu)\cdot\psi'(x_m^{ai c}(\mu)) + C'(x_m^{ai c}(\mu);\mu)$$

$$v_{x_f}(x_m^{ai c}(\mu) + x_f^{ai c}(\mu)) = k(\mu) + c$$

Since $v_{x_m}(\cdot) = v_{x_f}(\cdot)$ are the inverse demand function of x, $P(\cdot)$, equations (3.1) and (3.2) are established. By the Implicit Function Theorem, there exists a unique $\begin{matrix} x_m^{ai c}(\mu) \\ x_f^{ai c}(\mu) \end{matrix}$, for each $\mu \in \{\underline{\mu};\overline{\mu}\}$.

The …rst best access price, $a^{ai c}(\mu)$, for each $\mu \in \{\underline{\mu};\overline{\mu}\}$, is determined by (3.2) and market clearing condition in the downstream market. Hence,

$$a^{ai c}(\mu) = k(\mu)$$

which is the same as (3.3).

Finally, let see what happens with the …rst best cost reducing activities, $e^{ai c}$. The true parameter μ is unknown at the moment of undertaken cost reducing activities (period 1/2). Hence, in the full contracting case the planner's problem in period 0 is:

$$\underset{e}{Max}\ \{q(e)\cdot W^{ai c}(\underline{\mu}) + [1 - q(e)]\cdot W^{ai c}(\overline{\mu}) - e\}$$

FOC:

$$q_e(e^{ai c})\cdot[W^{ai c}(\underline{\mu}) - W^{ai c}(\overline{\mu})] = 1$$

Single crossing property and assumptions on $v(x_m + x_f)$, $C(x_m;\mu)$ and $\psi(x_m;\mu)$, for all x_m, ensure a positive square bracket. Moreover, SOC's are $q_{ee}(e^{ai c})\cdot[W^{ai c}(\underline{\mu}) - W^{ai c}(\overline{\mu})] < 0$ by strict concavity on $q(e)$, for all $e \geq 0$. Therefore, (3.4) is established. This completes the proof ■

Proposition 3.2

Two facts. The individual rationality constraints of the inefficient type, $IR(\bar{\mu})$, and the incentive compatibility constraint of the efficient type, $IC(\underline{\mu})$, bind. Then,

$$\bar{U} = -z + \bar{T} - k(\bar{\mu}) \cdot \left[\tau(x_m(\bar{\mu};\theta)) + x_f(\bar{\mu};\theta) \right] - C(x_m(\bar{\mu};\theta);\bar{\mu}) - \theta = 0$$

and

$$\begin{aligned} \underline{U} &= -z + \underline{T} - k(\underline{\mu}) \cdot [\tau(x_m(\underline{\mu};\theta)) + x_f(\underline{\mu};\theta)] - C(x_m(\underline{\mu};\theta);\underline{\mu}) - \theta \\ &= -z + \bar{T} - k(\underline{\mu}) \cdot \left[\tau(x_m(\bar{\mu};\theta)) + x_f(\bar{\mu};\theta) \right] - C(x_m(\bar{\mu};\theta);\underline{\mu}) - \theta \end{aligned}$$

Adding and substracting $k(\bar{\mu}) \cdot \left[\tau(x_m(\bar{\mu};\theta)) + x_f(\bar{\mu};\theta) \right] + C(x_m(\bar{\mu};\theta);\bar{\mu})$, and using $\bar{U} = 0$

$$\underline{U} = R^U(\theta) + R^D(\theta)$$

Therefore, (3.8) is established.

By the assumptions on $v(x_m + x_f)$, $C(x_m;\mu)$, $\tau(x_m)$, and $q(e)$, for all $(x_m; x_f; e)$, the government's problem in period 3/2 is strictly concave. The solution is interior – $x_j^{pic}(\underline{\mu}); x_j^{pic}(\bar{\mu}) >> 0$, for $j = \{m; f\}$ – then FOC's are sufficient for a maximum (let us omit θ as argument of these solutions because there exists only one θ in equilibrium, as proved in the next proposition).

When the monopoly is efficient, FOC's are:

$$\begin{aligned} v_{x_j}(x_m^{pic}(\underline{\mu}) + x_f^{pic}(\underline{\mu})) = k(\underline{\mu}) \cdot \left[\delta_j \cdot \tau'(x_m^{pic}(\underline{\mu})) + (1 - \delta_j) \right] \\ + \delta_j \cdot C'(x_m^{pic}(\underline{\mu});\underline{\mu}) + (1 - \delta_j) \cdot c \end{aligned}$$

where $\delta_j = \begin{cases} 1 \text{ if } j = m \\ 0 \text{ if } j = f \end{cases}$

In turns, the efficient firm produces the first best levels, $x_j^{pic}(\underline{\mu}) = x_j^{fb}(\underline{\mu})$, for $j = \{m; f\}$, as required in (3.9).

FOC's in the inefficient type case are:

$$\begin{aligned} v_{x_m}(x_m(\bar{\mu}) + x_f(\bar{\mu})) &= k(\bar{\mu}) \cdot \tau'(x_m^{pic}(\bar{\mu})) + C'(x_m^{pic}(\bar{\mu});\bar{\mu}) + \frac{\phi}{1-\phi} \cdot [R_{x_m}^D(\theta) + R_{x_m}^U(\theta)] \\ v_{x_f}(x_m(\bar{\mu}) + x_f(\bar{\mu})) &= k(\bar{\mu}) + c + \frac{\phi}{1-\phi} \cdot [R_{x_f}^U(\theta)] \end{aligned}$$

where all $R_{x_j}^i(\theta) \equiv \frac{\partial R^i(\theta)}{\partial x_j}$, for $i = \{U; D\}$ and $j = \{m; f\}$, are strictly positive by single crossing property and monotonicity assumptions on $C(x_m;\mu)$ and $\tau(x_m;\mu)$, for all x_m, except $R_{x_f}^D(\theta) = 0$.

By the Implicit Function Theorem, there exists a unique pair $x_m^{pic}(\bar{\mu}); x_f^{pic}(\bar{\mu})$ solving FOC's for the inefficient type firm. Finally, assumptions on $v(x_m + x_f); C(x_m;\mu)$ and $\tau(x_m;\mu)$, for all x_m, guaranteed $\begin{pmatrix} x_m^{pic}(\bar{\mu}) \\ x_f^{pic}(\bar{\mu}) \end{pmatrix} < \begin{pmatrix} x_m^{fb}(\bar{\mu}) \\ x_f^{fb}(\bar{\mu}) \end{pmatrix}$. This completes the proof ■

Proposition 3.3

The owner's problem when undertaken investments is:

$$\max_e \{EU(e) = q(e) \cdot \left[R^U(\theta) + R^D(\theta) \right] + [1 - q(e)] \cdot 0 - e\}$$

Since $\left[R^U(\theta) + R^D(\theta)\right] > 0$ and $q(e)$ is strictly concave, for all $e \geq 0$, FOC is sufficient for a maximum.[37]

FOC:

$$q_e(e) \cdot \left[R^U(\theta) + R^D(\theta)\right] = 1$$

Let show that $0 < e^{pic}(\theta) < e^{oic}$. Let us use the second best production levels, $x_j^{pic}(\underline{\mu})$ and $x_j^{pic}(\overline{\mu})$, for $j = \{m, f\}$. By definition,

$$\left[R^U(\theta) + R^D(\theta)\right] = \left[k(\overline{\mu}) - k(\underline{\mu})\right] \cdot \left[v'(x_m^{pic}(\overline{\mu})) + x_f^{pic}(\overline{\mu}) + C(x_m^{pic}(\overline{\mu}); \overline{\mu}) - C(x_m^{pic}(\overline{\mu}); \underline{\mu})\right]$$

by single crossing property:

$$< \left[k(\overline{\mu}) - k(\underline{\mu})\right] \cdot \left[v'(x_m^{oic}(\overline{\mu})) + x_f^{oic}(\overline{\mu}) + C(x_m^{oic}(\overline{\mu}); \overline{\mu}) - C(x_m^{oic}(\overline{\mu}); \underline{\mu})\right]$$

adding and substracting $v(x_m^{oic}(\overline{\mu}) + x_f^{oic}(\overline{\mu})) + c \cdot x_m^{oic}(\overline{\mu})$, it becomes:

$$\begin{aligned} = &\left[v(x_m^{oic}(\overline{\mu}) + x_f^{oic}(\overline{\mu})) - k(\underline{\mu}) \cdot \left[v'(x_m^{oic}(\overline{\mu})) + x_f^{oic}(\overline{\mu}) - C(x_m^{oic}(\overline{\mu}); \underline{\mu}) - c \cdot x_m^{oic}(\overline{\mu})\right]\right] \\ &- \left[v(x_m^{oic}(\overline{\mu}) + x_f^{oic}(\overline{\mu})) - k(\overline{\mu}) \cdot \left[v'(x_m^{oic}(\overline{\mu})) + x_f^{oic}(\overline{\mu}) - C(x_m^{oic}(\overline{\mu}); \overline{\mu}) - c \cdot x_m^{oic}(\overline{\mu})\right]\right] \end{aligned}$$

by government's revealed preferences:

$$\begin{aligned} < &\left[v(x_m^{oic}(\underline{\mu}) + x_f^{oic}(\underline{\mu}) - k(\underline{\mu}) \cdot \left[v'(x_m^{oic}(\underline{\mu}) + x_f^{oic}(\underline{\mu}) - C(x_m^{oic}(\underline{\mu}); \underline{\mu}) - c \cdot x_m^{oic}(\underline{\mu})\right]\right] \\ &- \left[v(x_m^{oic}(\overline{\mu}) + x_f^{oic}(\overline{\mu})) - k(\overline{\mu}) \cdot \left[v'(x_m^{oic}(\overline{\mu})) + x_f^{oic}(\overline{\mu}) - C(x_m^{oic}(\overline{\mu}); \overline{\mu}) - c \cdot x_m^{oic}(\overline{\mu})\right]\right] \\ = &\left[W^{oic}(\underline{\mu}) - W^{oic}(\overline{\mu})\right] \end{aligned}$$

This inequality, (3.4) and (3.11) yield:

$$q_e(e^{pic}(\theta)) > q_e(\theta)$$

then, by strict concavity on q

$$e^{pic}(\theta) < \theta$$

On the other hand, since $\left[R^U(\theta) + R^D(\theta)\right] > 0$, then by (3.11) $q_e(e^{pic}(\theta)) > 0$. Thus, by monotonicity on q, $e^{pic}(\theta) > 0$.

Finally, the uniqueness of the equilibrium is showed using the Implicit Function Theorem on (3.11).

$$\frac{\partial \left[q_e(e) \cdot \left[R^U(\theta) + R^D(\theta)\right]\right]}{\partial \theta} = 0$$

equivalently,

$$q_{ee}(e^{pic}(\theta)) \cdot \left[R^U(\theta) + R^D(\theta)\right] \cdot \frac{\partial (e^{pic}(\theta))}{\partial \theta} + q_e(e^{pic}(\theta)) \cdot \left[R^U_\theta(\theta) + R^D_\theta(\theta)\right] = 0$$

hence,

[37] Notice that we are taking derivatives with respect to the level of efforts e and not with respect to beliefs, θ

$$\frac{\partial \left[e^{pic}(\beta) \right]}{\partial \beta} = - \frac{q_e(e^{pic}(\beta)) \cdot \left[R^U_\beta(\beta) + R^D_\beta(\beta) \right]}{q_{ee}(e^{pic}(\beta)) \cdot [R^U(\beta) + R^D(\beta)]}$$
$$< 0$$

by strict concavity on q and negativity on $\left[R^U_\beta(\beta) + R^D_\beta(\beta) \right]$.

We also know that $e^{pic}(0) > 0$ by definition of exports, $e^{pic}(e^{aic}) < e^{aic}$, and by the Implicit Function Theorem $e^{pic}(\beta)$ is decreasing and continuous. Then, the Mean Value Theorem tells us that there exists a unique fixed point β satisfying $e^{pic}(\beta)) = \beta$. This completes the proof. ■

Appendix B: Results of Simulations

Table B.1

First Best Allocations						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	13.75	6.25	–	–	625	250
x_f	35.15	42.50	48.90	48.75	–	–
W	1203.17	1192.19	1195.61	1188.28	1157.41	1041.67
e	0.0734		0.0016		10.18	
q(e)	60.75%		60.02%		86.36%	
V	1198.78		1192.68		1131.44	
Nationalization						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	13.75	6.25	—	—	625	25
x_f	35.15	42.50	48.90	48.75	—	—
W	1203.17	1192.19	1195.61	1188.28	1157.41	1041.67
V	1198.78		1192.68		1131.44	
Privatization						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	13.75	5.80	—	—	625	29.79
x_f	35.15	42.73	48.90	48.52	—	—
Rent	8.43		7.28		53.24	
W	1203.17	1192.14	1195.61	1188.26	1157.41	957.00
e	0.0064		0.0015		5.15	
q(e)	60.08%		60.02%		79.95%	
V	1198.76		1192.57		1112.08	

Table B.2

$\bar{\mu}=_{\underline{\mu}=0:1}$	$V^{pic} \; ¡ \; V^{nic}$	$R^U + R^D$
0.100	0.0000	0.00
0.125	- 0.0007	2.18
0.150	- 0.0026	3.70
0.175	- 0.0054	5.00
0.200	- 0.0089	6.18
0.225	- 0.0126	7.32
0.250	- 0.0154	8.43
0.275	- 0.0147	9.53
0.300	- 0.0056	10.62
0.325	0.0170	11.71
0.350	0.0558	12.90

Table B.3

First Best Allocations						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	13.75	3.75	—	—	2500	500
x_f	185.15	194.75	198.90	198.50	—	—
W	19788.17	19703.94	19780.61	19701.13	18518.52	14285.71
e	3.35		2.28		522.64	
q(e)	4.57%		3.27%		85.42%	
V	19704.43		19701.44		17378.81	
Nationalization						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	13.75	3.75	—	—	2500	500
x_f	185.15	194.75	198.90	48.75	—	—
W	19788.17	19703.94	19780.61	1188.28	18518.52	14285.71
V	19703.94		1192.68		14285.71	
Privatization						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	13.75	3.74	—	—	2500	88.11
x_f	185.15	191.75	198.90	48.52	—	—
Rent	78.93		78.79		53.24	
W	19788.17	19699.39	19780.61	1188.26	18518.52	12187.52
e	2.42		2.27		240.22	
q(e)	3.43%		3.24%		73.11%	
V	19700.02		19700.33		16575.75	

Table B.4

$\bar{\mu}=\underline{\mu}=0{:}1$	$V^{pic} - V^{nic}$
0.20	1.12
0.25	0.53
0.30	0.15
0.35	- 0.11
0.40	- 0.28
0.45	- 0.33
0.50	- 0.31
0.55	- 0.18
0.60	0.01
0.65	0.20

Table B.5

First Best Allocations						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	185.00	168.30	–	–	2500	2272.73
x_f	0.20	16.89	185.20	185.19	–	–
W	18518.52	18393.90	17149.52	17147.67	18518.52	18392.32
e	21.60		.01		21.95	
q	42.14%		0.93%		42.43%	
V	18424.82		17147.68		18423.91	
Nationalization						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	185.00	168.30	—	—	2500	2272.73
x_f	0.20	16.89	185.20	185.19	—	—
W	18518.52	18393.90	17149.52	17147.67	18518.52	18392.32
V	18393.90		1192.68		18392.32	
Privatization						
	Liberalization		Vertical Separation		Full Concentration	
	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$	$\underline{\mu}$	$\bar{\mu}$
x_m	185.00	168.27	—	—	2500	185.78
x_f	0.20	13.92	185.20	183.69	—	—
Rent	113.39		1.84		138.06	
W	18518.52	18389.38	17149.52	17146.54	18518.52	18389.12
e	19.06		0.001		23.63	
q(e)	40.01%		0.93%		43.72%	
V	18421.99		17146.56		18422.06	

Table B.6

$\bar{}=\circ=100$	$V^{pic} \text{ ¡ } V^{pnc}$	$\circ=-=0{:}5$	$V^{pic} \text{ ¡ } V^{pnc}$
0.05	1.57	1.0	7.12
0.10	- 0.12	12.5	- 0.15
0.15	- 0.58	25	- 0.70
0.20	- 0.70	50	- 0.66
0.25	- 0.69	75	- 0.37
0.30	- 0.61	100	- 0.07
0.35	- 0.50	125	0.21
0.40	- 0.37	150	0.45
0.45	- 0.23	175	0.67
0.50	- 0.07	200	0.87
0.55	0.08	—	—
0.60	0.24	—	—
0.65	0.41	—	—
0.70	0.58	—	—

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