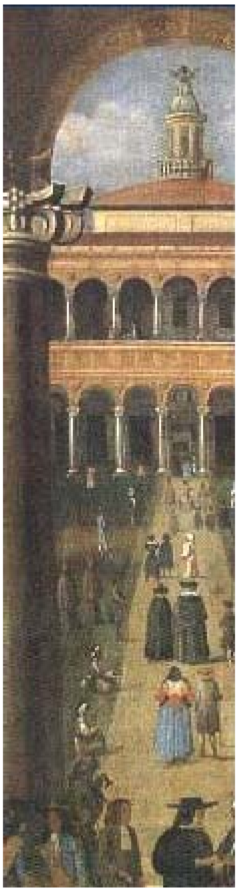

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Reforming a Network Industry: Consequences for Cost Efficiency and Welfare

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Reforming a Network Industry: Consequences for Cost Efficiency and Welfare

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Reforming a Network Industry: Consequences for Cost Efficiency and Welfare

Abstract: To introduce competition in an industry with an upstream natural monopoly infrastructure requires vertical separation. However, given the well-known advantages of vertical integration, such a reform would have to reduce costs in order to increase social welfare. We ask whether this would be the case if marginal costs depend on a downstream agency problem. It turns out that the opposite holds true. While entry after vertical separation can be beneficial despite higher costs, the best solution in terms of cost efficiency and welfare tends to be a welfare-maximising vertically integrated or bilateral monopoly. Vertical separation and competition are outperformed even by a profit-maximising integrated monopoly.

Keywords: liberalisation, privatisation, vertical separation, cost efficiency.

JEL-classification: L32, L33, L44, H42.

1. Introduction

The network industries represent 15% of the production and 7% of the employment of the EU15-countries (Martin et al., 2005), and they have recently been restructured through liberalisation, and in general also privatisation. However, many of the network industries, such as electricity, gas, telecommunications and railways, are typically associated with an upstream bottleneck infrastructure which is a natural monopoly. Competition therefore requires the natural monopoly to be separated from the services that use the infrastructure (vertical separation). This contribution deals with the social costs and benefits of such a restructuring.

Such reforms are part of the so called Washington-consensus (Williamson, 2000) and are also prescribed by the EU, as reflected in directives such as 2003/54/EC and 2003/55/EC (as cited in Reforming Network Industries, 2006). They are based on a belief in price reductions (by up to 36% in EU network industries according to Martin et al., 2005) through competition, because of lower profit margins, higher cost efficiency and, in the long run, enhanced dynamic efficiency (Reforming Network Industries, 2006).

The old-fashioned vertically integrated public utilities were in general associated with non-commercial objectives, such as full or partial welfare maximisation. There would be no scope for lower profit margins in a welfare maximising public monopoly.[1] It follows that restructuring can increase welfare only if costs are thereby reduced, at least if there is no increase in dynamic efficiency. These reductions would have to overshadow the costs of sacrificing the well-known benefits of an integrated structure (see for example Vickers, 1995). The potential costs of vertical separation include excessive network access charges (vertical foreclosure), markups both up- and downstream (double marginalisation), and underinvestments in the infrastructure.

We therefore ask the fundamental question of how a restructuring affects cost efficiency and welfare when marginal costs are endogenous. We assume a downstream agency problem when marginal costs depend on managerial efforts, which are unobservable because of random shocks (as modelled by, for example, Raith, 2003, and

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[1] Prices may in practice be too high, for example because of a need to raise public-sector revenues. But there are other and possibly cheaper ways to reduce profit margins than by breaking up the industry and introducing downstream competition and possibly regulation.

Beiner et al., 2009).[2] De Fraja (1993), Martin (1993), and Beiner et al. (2009) apply agency models on the impact of ownership and competition on marginal costs. However, this contribution is the first to address the welfare impact of the combination of privatisation, vertical separation, and downstream competition.

It turns out that combining profit maximisation, liberalisation and vertical separation leads to lower welfare and higher marginal costs as compared to both a profit- and a welfare-maximising integrated monopoly. The combination of separation and competition can outperform an integrated profit-maximising (but not welfare maximising) monopoly, provided that regulation or public ownership forces the upstream firm to make zero profits. But this applies only to a limited set of points in the parameter space. More precisely, it applies to intermediate values of an agency parameter (which reflects risk, risk-aversion and disutility of effort) and a parameter that indicates level of fixed costs relative to demand. This restriction is caused by the condition that one but not two vertically integrated firms can break even. The analysis also suggests that downstream entry may be beneficial (despite higher marginal costs), but this does not apply to all market structures and agency-parameter values.

In other words, the advantages of vertical integration and welfare-maximising public ownership are strengthened when the downstream agency problem is taken into consideration. This contradicts the conjecture by Newbery (1999) and Vickers (1995) about reduced costs that would overshadow over the advantages of vertical integration and non-profit maximising behaviour. Liberalisation and vertical separation may still be beneficial, but if so, there must be other explanations than stronger incentives to cut costs.

Next section presents the basic model of a market with vertical relations and a principal-agent problem. Section 3 presents the main organisational alternatives, i.e. a welfare- or profit maximising integrated monopoly, vertical separation with competition, and a profit maximising or regulated upstream firm. The main results are presented and explained in section 4, which compares marginal costs, output and welfare under different arrangements. Section 5 presents some concluding remarks and relates the findings to the empirical literature. A separate appendix includes the details of the different solutions that we explore and the formal proofs.

[2] A companion paper is asking by how much costs would have to be reduced so as to overshadow the benefits of vertically integrated profit- or welfare-maximising monopoly if the cost differences are

2. The basic model: Principals, agents and vertical relations

The industry consists of an upstream and a downstream activity, with outputs x and y respectively. Upstream total costs are $TC^U = F + c^U x$, where c^U stands for marginal costs and F for the sunk cost that makes the activity a natural monopoly. Vertical separation would mean that x is provided by a separate firm at the price p (which can also be interpreted as the access charge for using a network infrastructure) to one or more downstream firms.

The activities are related through a simple Leontief-technology, so that y units of downstream output require zy units of x. Downstream variable costs consist of two components. The first component, $c^U zy = c^U x$ under vertical integration, depends on the upstream activity. After separation it becomes $pzy = px$. The second component, $c^D y$, depends on effort and stands for $(c_0 - e - u)y$, where e is the manager's effort, c_0 is a constant and u is an (approximatively) normally distributed random variable with zero mean and the variance σ^2. [3] The shocks are independent if there are several firms after separation. Other downstream fixed costs than the manager's salary (see below) are ignored. There is no upstream uncertainty and hence no agency problem.

Following Raith (2003) and Beiner et al. (2009), the owner can indirectly observe $e+u$, but cannot know whether for example high costs depend on bad luck or laziness. The manager gets a salary that depends on $e+u$ with the coefficient β and the intercept w_0:

$$w = w_0 + \beta(e + u). \tag{1}$$

The manager's utility function is associated with constant absolute risk aversion r. Utility depends on income and a quadratic disutility of effort, $ke^2/2$, where k is a parameter such that $k>1$:

$$U = -\exp\left[-r\left(w - \frac{ke^2}{2}\right)\right]. \tag{2}$$

exogenous, partly within a setting with a downstream mixed oligopoly (Willner, 2008).

The variance of the salary is $\beta^2\sigma^2$. Substitute (1) for w and use the fact that the shocks are normally distributed to write the expected utility as the following function of expected income and variance:

$$V = w_0 + \beta e - \frac{r\beta^2\sigma^2}{2} - \frac{ke^2}{2}. \tag{3}$$

Incentive compatibility means that the manager maximises her expected utility given the parameters of the reward function. Maximising (3) yields

$$e = \frac{\beta}{k}. \tag{4}$$

We normalise the reservation utility v_0 to zero, like in Beiner et al. (2009). The binding participation constraint then becomes $V=v_0=0$.[4] Solve for w_0 and insert w_0 and e into the expected wage $Ew=w_0+\beta e$:

$$w = \frac{1}{2}\left(\frac{\beta}{k}\right)^2\left(r\sigma^2 k^2 + k\right). \tag{5}$$

The expressions (4) and (5) will remain the same when the industry is reorganised (although we add subindices i to β and e if there is competition), but the equilibrium value of β will change.

It will be convenient to introduce the following abbreviation:

$$\varphi = r\sigma^2 k^2 + k. \tag{6}$$

The assumption $k>1$ implies that this expression is greater than unity. It us increasing in risk (interpreted as σ^2, risk-aversion, and strength of the disutility of effort (via k), so φ

[3] Strictly speaking, this assumption implies that u has an infinite range, but it works as a convenient approximation if the distribution is bell-shaped and such that $\sigma^2 \approx (\hat{u}/3)^2$ if $u \in [-\hat{u}, \hat{u}]$.

[4] A nonzero reservation utility v_0 would work as a downstream fixed cost. This would limit the number of downstream firms, and would mean that an increase in n duplicates v_0. The fact that we ignore such fixed costs suggests that the model overstates the benefits of competition.

indicates the severity of the agency problem. We therefore interpret it as an agency parameter. Its size will be crucial for assessing the desirability of reforming the industry.

In contrast to Beiner et al. (2009), the downstream output is homogeneous. Let the downstream price be denoted by q and let a stand for a positive intercept. Normalising the slope to −1, the inverse demand is:[5]

$$q = a - y\,. \tag{7}$$

It will be convenient to introduce another abbreviation,

$$\alpha = a - c^{U} z - c_0\,, \tag{8}$$

which stands for a net demand shift parameter that reflects demand and (the exogenous components of the) marginal costs. Feasibility rules out too low values relative to *F*, whereas the natural monopoly assumption rules out too high values. This restricts the set of relevant combinations of φ and F/α^2, which is convenient when analysing where in the parameter space that a given welfare ranking applies.

As there is no upstream incentive problem, the total costs of a vertically integrated firm are

$$TC = zyc^{U} + (c_0 - e - u)y + F + w = zyc^{U} + c^{D} y + F + w\,. \tag{9}$$

Vertical separation means that the up- and downstream firms (indexed by *U* and *D* respectively) have the cost functions

$$TC^{U} = c^{U} x + F\,, \tag{10}$$

$$TC^{D} = pzy + (c_0 - e - u)y + w = pzy + c^{D} y + w\,. \tag{11}$$

with subindices i added to x, y, w_0 and e if there is also liberalisation and entry.

3. From a vertically integrated public monopoly to competition

3.1. Public ownership vs privatisation in a vertically integrated monopoly

Consider a vertically integrated public monopoly that chooses the highest expected total surplus (or in this case consumer surplus) that yields zero profits, given (4) and (5).[6] Derive the optimal output given β and Ew before solving for the optimal values of β and w_0. As explained in the Appendix, we then get the following effort, output and total surplus in equilibrium:

$$e^* = \frac{\beta^*}{k} = \frac{\alpha + \sqrt{\alpha^2 - 2F(2\varphi - 1)/\varphi}}{2\varphi - 1}, \tag{12}$$

$$y^* = \frac{\varphi\left[\alpha + \sqrt{\alpha^2 - 2F(2\varphi - 1)/\varphi}\right]}{2\varphi - 1}, \tag{13}$$

$$TS^* = \frac{1}{2}\left\{\frac{\varphi\left[\alpha + \sqrt{\alpha^2 - 2F(2\varphi - 1)/\varphi}\right]}{2\varphi - 1}\right\}^2 \tag{14}$$

In a profit maximising monopoly the corresponding values are:

$$e^M = \frac{\beta}{k} = \frac{\alpha}{2\varphi - 1}, \tag{15}$$

$$y^M = \frac{\varphi\alpha}{2\varphi - 1}. \tag{16}$$

$$TS^M = \frac{\varphi\alpha^2(3\varphi - 1)}{2(2\varphi - 1)^2} - F. \tag{17}$$

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[5] Linear demand means that the analysis is formally similar if we assume demand uncertainty, in which case the owner can observe $a - c_0 + e + u$ but not e. The random parameter u is then reinterpreted as a normally distributed demand shock that affects each downstream firm independently.

3.2. Vertical separation with profit maximisation up- and downstream

Suppose now that the upstream activity has become separated so as to become a private profit-maximising monopoly, whereas the downstream activity has become an n-firm Cournot oligopoly. Each oligopolist decides about its output and managerial reward given its competitors' strategies and the input price. Firm i:s profits are then:

$$\pi_i = qy_i - zpy_i - c_i^D y_i - w_i \,. \tag{18}$$

Use (5)-(7) to write their expected value as follows:

$$E\pi_i = ay_i - y_i^2 - y_i \sum_{j \neq i} Ey_i - zpy_i - c_0 y_i + \frac{\beta_i}{k} y_i - \frac{\beta_i^2}{2k^2}\varphi \,. \tag{19}$$

While (19) is concave in y_i given β_i, the maximum profits as a function of β_i or e_i may be non-concave, as follows from (A.5) in the appendix. To exclude such cases we add the additional assumption $\varphi > 2n^2/(n+1)^2$, which rules out combinations of large values of n and low values of φ.[7] We get the following symmetric equilibrium (see Appendix):

$$e^V = \frac{\beta^V}{k} = \frac{\alpha n}{\varphi(n+1)^2 - 2n}\,, \tag{20}$$

$$y^V = \frac{n(n+1)\alpha\varphi}{2\left(\varphi(n+1)^2 - 2n\right)}\,, \tag{21}$$

$$TS^V = \frac{\left[(3n+4)(n+1)^2\varphi - 4n(2n+1)\right]\alpha^2\varphi n}{8\left[\varphi(n+1)^2 - 2n\right]^2} - F\,. \tag{22}$$

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[6] Setting prices equal to marginal costs might yield even higher social welfare, but assessing the possible social costs of funding a deficit is outside our scope.

[7] The Hessian would always be positive under the alternative assumption of simultaneous maximisation, because $\phi>1$. But the oligopolistic interaction in determining β would then be ignored.

Near-perfect competition (a very large number of firms) would mean that output tends towards $\alpha/2$ and the total surplus to

$$TS_0^V = \frac{3\alpha^2}{8} - F. \tag{23}$$

The special case of $n = 1$, i.e a downstream monopoly, would on the other hand yield the output $\alpha\varphi/[2(2\varphi-1)]$ and the total surplus

$$TS_1^V = \frac{(7\varphi - 3)\alpha^2\varphi}{4(2\varphi-1)^2} - F. \tag{24}$$

3.3. Vertical separation with upstream regulation or public ownership

The analysis of the profit-maximising monopoly in sections 3.1 and 3.2 are important intermediate steps for several results in section 4. But a bottleneck monopoly would in most cases in reality either remain in public ownership or be regulated. Regulating the monopolist so that the price yields zero upstream profits (below associated with the superscript *R*) would eliminate double marginalisation. In what follows we refer to regulation, but the outcome technically the same as when there is upstream public ownership.

This would mean the following levels of effort and downstream output:

$$e^R = \frac{\beta^R}{k} n \frac{\alpha + \sqrt{\alpha^2 - 4\left[\varphi(n+1)^2 - 2n\right]F/(n+1)n\varphi}}{\varphi(n+1)^2 - 2n}, \tag{25}$$

$$y^R = n(n+1)\varphi \frac{\alpha + \sqrt{\alpha^2 - 4\left[\varphi(n+1)^2 - 2n\right]F/(n+1)n\varphi}}{2\left[\varphi(n+1)^2 - 2n\right]}. \tag{26}$$

However, a simplification may be useful for the welfare comparison. Instead of a break-even constraint, we may assume that the upstream firm maximises a weighted sum of the consumer surplus (*CS*) and its profits. The weight parameter is denoted λ, i.e.

$\lambda CS+\pi^U$. Values of λ of 0 and 1 would then correspond to pure profit and welfare maximisation respectively, so there must exist a particular value λ_0 in the open interval (0,1) such that the upstream firm only just breaks even. A welfare comparison that applies for any λ in (0,1) then also applies for λ_0. We index this solution by C:

$$e^C = \frac{\beta^C}{k} = \frac{2n\alpha}{2\varphi(n+1)^2 - 4n - \lambda\varphi(n+1)n}, \tag{27}$$

$$y^C = \frac{n(n+1)\alpha\varphi}{2\varphi(n+1)^2 - 4n - \lambda\varphi(n+1)n}. \tag{28}$$

If $\lambda = \lambda_0$, the total surplus consists of the consumer surplus $(y^C)2/2$ and the downstream profits $n(y^C/n)^2$:

$$TS^C = \frac{\left[(n+2)(n+1)^2\varphi - 4n^2\right]\alpha^2\varphi n}{2\left[2\varphi(n+1)^2 - 4n - \lambda_0\varphi n(n+1)\right]^2} - F. \tag{29}$$

Finally, vertical separation can also mean a bilateral monopoly with welfare-maximisation both up- and downstream. The downstream firm then chooses a zero-profit y and maximises CS with respect to β. Set $y_i=y$ and $\beta_i=\beta$ in (19) and solve for y when $\pi=0$ to get $y(\beta)$. Maximise $y(\beta)$ to get $\beta=ke$ as a function of p and insert into $e=\beta/k$ and y to get:

$$e(p) = \frac{\beta(p^U)}{k} = \frac{2(a - c_0 - zp)}{2\varphi - 1}, \tag{30}$$

$$y(p) = \frac{2\varphi(a - c_0 - zp)}{2\varphi - 1}. \tag{31}$$

To get the upstream price, solve $zy(p)(p-c^U)-F=0$ and index the solution by B:

$$p^B = \frac{1}{z}\left[c^U z + \frac{\alpha}{2} - \sqrt{\left(\frac{\alpha}{2}\right)^2 - \frac{(2\varphi-1)F}{2\varphi}}\right]. \tag{32}$$

Inserting (32) into (30) and (31) implies that the optimal values of y and e are identical to (12) and (13).

4. A comparison of cost efficiency, output and welfare

4.1. The ownership effect

Few would recommend the privatisation of a monopoly without regulation (see on the other hand Bradburd, 1995). However, there would be a trade-off if profit margins are lower but costs higher in a public monopoly, as often believed. Lemma 1 deals with the ownership effect as such:

Lemma 1. A vertically integrated public monopoly that maximises welfare subject to a break-even constraint and where there is an upstream bottleneck activity and a downstream agency problem yields a) lower marginal costs, b) a higher output, and c) a higher total surplus than under private ownership.

Proof: See appendix.

Part a) is needed for the proof of Proposition 3, but it is significant also because of the importance of privatisation in the restructuring of utilities in the UK and many other countries. The result extends the agency models by De Fraja (1993) and Willner and Parker (2007) to vertical integration, and its intuition is based on the fact that wider objectives strengthen the incentive to cut costs. Pure profit maximisation means that only the impact on profits matter, whereas welfare maximisation takes consumers into consideration as well.

It may appear trivial that a welfare maximising monopoly yields a higher total surplus, in particular because marginal costs are also lower.[8] However, the fact that a firm maximises a given variable does not rule out even higher values if some other objective is chosen. For example, the total surplus can become higher in a mixed oligopoly if the

[8] Note that the manager gets her reservation utility under both forms of ownership, and there is no deficit or surplus that may affect the taxpayers, so the welfare change affects only the consumers and the owners.

public firm maximises profits rather than welfare if marginal costs are increasing (De Fraja and Delbono, 1989). But a firm may also get higher profits than the profit maximisers by maximising a weighted sum of profits and welfare (Fershtman, 1990).

4.2. The separation effect

While vertical separation is usually seen as just a precondition for downstream competition, it makes sense also to analyse its impact as such when there is also an agency problem. It turns out that this kind of vertical separation is inferior also when costs are endogenous if both the upstream and the downstream firm maximise profits, but not if they maximise welfare as described in section 3.3. We shall refer to this case as a bilateral public monopoly.

Lemma 2. a) Splitting a profit-maximising monopoly into an up- and a downstream profit-maximising monopoly leads to higher marginal costs, lower output, and a lower total surplus. b) Splitting a welfare-maximising monopoly into a bilateral public monopoly does not change the marginal costs, the output and the total surplus.

Proof: See appendix.

Part a) adds to the previous literature on advantages of vertical integration (see for example Perry, 1978; Vickers, 1995; Buehler, 2005; Willner, 2008) by showing that they are reinforced by the presence of a downstream agency problem. However, part b) implies that this applies only to profit maximisation, because separation as such has no adverse effects on costs and welfare if we get a bilateral public monopoly. The benefits of vertical integration are therefore not in our model associated with economies of scope.[9]

4.3. The impact of competition in a vertically separated industry

In this section we analyse the impact of a change in the number of downstream firms in an industry where the up- and downstream activities have been separated. The belief that competition has a stronger positive effect than ownership (see Vickers and Yarrow, 1988; Parker, 2006) has often been the rationale for vertical separation as a prelude to liberalisation. It will follow that the conventional wisdom applies to output and hence to the consumer surplus, but not to the marginal costs, which become higher by entry. Moreover, the direction of the change in the total surplus depends on the market structure and the agency parameter.

To assess the impact of competition requires differentiation with respect to the number of firms, we reinterpret n as a variable in R^+. A positive value of the derivative of a function $f(n)$ then means that it is associated with larger value for n+1 than for n, at least if $f(n)$ is monotone.[10] The maximum profits are concave in e or β only if φ is above the boundary $\varphi_1(n)= 2n^2/(n+1)^2$ in Figure 1, as explained in more detail the proof of Proposition 1 below. The total surplus increases with entry above and to the left of another boundary, $\varphi_2(n)$.

<Figure 1 about here>

Proposition 1. An increase in the number of firms in a vertically separated industry with an upstream profit-maximising monopoly leads a) to higher marginal costs, b) to a higher output c) to a higher total surplus for values of n above and to the left of a boundary $\varphi_2(n)$ *and vice versa.*

Proof: See appendix.

Part a) contradicts the belief that competition leads to higher cost efficiency, but extends an earlier result on the impact of competition by Martin (1993) to vertical relations and welfare comparisons.[11] To understand the intuition, note that the presence of n in the numerator of (20) reflects the positive impact of lower costs as compared to a firm's rivals. This effect gets stronger if there are more firms. However, the term $\varphi(n+1)^2$

[9] Kwoka (2002) associates the benefits of vertical integration in the US electricity industry from economies of scope, meaning that a firm that produces both the up- and the downstream output has lower costs than the sum of the costs associated by producing each output separately.

[10] Differentiating in such cases may however sometimes be misleading, for example if the derivative is zero between two values n and n+1. A positive derivative in n does not therefore always ensure that $f(n+1)>f(n)$, because the derivative can be zero for $n+\varepsilon$, where $0<\varepsilon<1$.

in the denominator reflects the impact of a higher n on the ability to afford a salary that yields a high effort. The latter effect dominates, so β decreases and $c_0-\beta/k$ increases with n. Part b) shows on the other hand consumers may benefit despite higher marginal costs, but part c) shows that entry reduces welfare if n is higher than a critical number.

For example, suppose that the post-liberalisation outcome is imperfectly competitive, as in many liberalised network industries. The profits are always concave in β in a monopoly or duopoly, but the critical value of φ increases from 1.125 to 1.635 as n increass from 3 to 10. Entry always increases welfare if n=1, but the critical value of φ grows from 1.333 to 1.947 as n grows from 2 to 10. Combinations (n, φ) such as (4, 1.6), (6, 1.7) or (10, 1.8) would therefore mean that entry reduces welfare, because of higher costs and lower downstream profits. It becomes more likely that further entry reduces welfare at some point if the values of the variance, the risk aversion and/or the coefficient for the disutility of effort are low, as follows from the definition of φ.

The possibility of an optimal number of firms if $\varphi<2$ can be illustrated as follows. The derivative of TS^V is zero if n=5 and φ=1.819, as follows from (A.17) in the appendix. Set α^2=100 and F=10.[12] Welfare then increases from 26.760 to 27.795 as n increases from 2 to 4, but decreases from 27.812 to 27.726 as n increases from 6 to 10. Welfare is highest for n=5 (TS^V =27.824), because φ was chosen so as to imply a zero derivative for n=5. Choosing φ=1.5 would on the other hand mean that the highest value (TS^V =29.583) is reached for n=3 (because it is the nearest integer to 2.524).

However, it follows from (22) and (24) that a downstream duopoly is always superior to a monopoly, because $\varphi>1$ must hold true. Comparing (23) with (22) when n=2 shows that a duopoly is superior to near-perfect competition if φ <1.185, whereas it follows from (23) and (24) that a monopoly is superior to near-perfect competition if φ<1.358.

[11] Beiner et al. (2009) have on the other hand shown that more intense competition can lead to higher efficiency in a setting with a given number of firms.

[12] As follows from the proof of Proposition 2b, these values of $\varphi\alpha^2$ and F imply that one but not two vertically integrated firms can break even.

4.4. Vertical integration in a profit-maximising monopoly vs. separation with liberalisation

To compare liberalisation and separation with such an extreme market form as a private profit-maximising monopoly might seem pointless. However, the outcome is also needed for the proof of Proposition 3.

While the superiority of competition to monopoly in conventional industries is well established, Lemma 2 implies strong synergies associated with vertical integration (as compared to separation without competition) also when there is a downstream agency problem. Moreover, Proposition 1 has shown that the impact of competition on welfare is then ambiguous and that marginal costs will in fact increase. The ranking between a vertically integrated commercial monopoly and vertical separation with competition is on the other hand unambiguous:

Lemma 3. The vertically integrated profit maximising monopoly always yields a) lower marginal costs, b) a higher output, and c) a higher total surplus than after vertical separation and Cournot-competition.

Proof: See appendix.

There are two explanations for this result. The first is based on the well-known benefits of vertical integration; we have shown that these are reinforced by the principal-agent problem (see the discussion after Lemma 1). But competition makes it in addition harder to afford paying for the managers' cost-reducing efforts (see 6.3).

4.5. The case of upstream public ownership or regulation

Suppose that the upstream monopolist remains in public ownership or is regulated, so that the access price is so low that the firm only just breaks even. Will this lead to a superior result as compared to vertical separation without upstream regulation, and how does the solution compare to the vertically integrated profit-maximising monopoly?

While it turns out that regulation as described in 3.3 improves the consumer surplus (and welfare at least if there are many firms), a vertically integrated profit-maximising monopoly may nevertheless be superior. The comparison depends on the significance of the agency problem and the sunk costs relative to net demand. Production is never feasible for combinations of $f=F/\alpha^2$ and φ above or to the left of a boundary f_1 in Figure 2. Two vertically integrated firms would on the other hand break even for combinations along or below another boundary, f_2. A restructuring that combines upstream regulation, vertical separation and a very large number of downstream firms outperforms the vertically integrated profit-maximising monopoly for combinations below or to the right of a third boundary f_3. However, f_1 and f_2 restrict the relevant part of this area to E in Figure 2 below:

<Figure 2 about here>

Proposition 2. a) Regulating the upstream firm leads to lower marginal costs, a higher downstream output and a higher consumer surplus than under profit maximisation. b) Vertical separation, near-perfect downstream competition and upstream regulation lead to a higher total surplus than in a vertically integrated profit maximising monopoly for combinations of φ *and* F/α^2 *in an approximately triangular area E with the corners (2.7446, 0.1070), (2.7562, 0.1108) and (2.8310, 0.1073).*

Proof: See appendix.

This proposition means that competition (a large number of downstream firms), vertical separation and upstream regulation can outperform a vertically integrated profit-maximising monopoly. But this applies only to a tiny area, because production would not otherwise be feasible, or the natural monopoly assumption would be violated. This area consists of a subset of those combinations of f and φ where $0.111>f>0.107$ and $2.831>\varphi>2.745$. Note also that double marginalisation has been ruled out by the assumption of upstream regulation, and that Lemma 1 rules out economies of scope under welfare maximisation. The integrated profit-maximising monopoly is therefore superior except for in E mainly because of is its superior solution to the agency problem.

4.6. An overall comparison

We know from Lemma 1 that welfare maximisation makes a vertically integrated public monopoly superior to an otherwise similar profit maximising firm, and from Lemma 3 that a profit maximising vertically integrated monopoly is superior to vertical separation and liberalisation for any number of downstream firms. Lemma 2 in turn establishes that a vertically separated bilateral monopoly performs equally well as under vertical integration, provided that both firms maximise welfare. This establishes the superiority of the integrated or bilateral public monopoly to vertical separation with competition between profit maximising firms (including a profit-maximising monopoly, oligopoly or near-perfect downstream competition) in Proposition 3 below. Also, it follows from Proposition 2b that vertical separation can in some cases outperform an integrated private monopoly if separation and competition are combined with upstream regulation, but not the integrated or bilateral public monopoly.

Proposition 3. The vertically integrated or bilateral welfare-maximising public monopoly always yields lower marginal costs and higher welfare than vertical separation and competition when the upstream monopolist is a) profit-maximising or b) regulated.

Proof: See appendix.

We refer to the discussions after Lemma 1 and Lemma 3 for the economic explanation of part a). As for part b), regulation reduces the deadweight loss caused by an upstream profit-maximising monopoly, but separation and competition lead to excessive marginal costs. Maximisation of the total surplus takes both consumers and owner in consideration, and this strengthens the motive to reduce costs.

5. Discussion and concluding remarks

Our analysis has started from widespread belief that the benefits of competition are sufficiently large so as to dominate over the benefits of vertical integration and welfare maximisation. We have asked whether this is true if marginal costs depend on the unobserved efforts of a manager, and we have based the analysis on standard components such as the Cournot-oligopoly and a principal-agent model with approximately normally distributed cost (or demand) shocks and constant absolute risk-aversion.

Some results can be interpreted in favour of vertical integration and/or competition. Splitting the incumbent into an up and a downstream welfare-maximising monopoly will neither increase costs nor reduce welfare. An increase in the number of firms given that vertical separation has taken place always increases output, and can increase welfare (despite higher marginal costs) if the variance of the random shocks is large, if the manager is highly risk-averse and/or if her disutility of effort is high. Also, the combination of vertical separation, near-perfect competition and upstream regulation can outperform a vertically integrated and private monopoly, but this applies only to a small set of market structures and values of a variable that increases with the variance, the degree of risk-aversion and the disutility of effort.

However, our main results indicate that the possible favourable effects of privatisation, vertical separation and liberalisation must be sought elsewhere than in higher efforts from the managers. Privatisation without separation increases costs and reduces welfare, and profit maximising monopolies both up- and downstream are worse than an integrated profit maximising monopoly. While the impact of increased competition is at most ambiguous after vertical separation, the combination of vertical separation and competition is inferior even to a profit maximising integrated monopoly, and consequently also to a welfare-maximising monopoly or bilateral welfare maximising monopoly. This striking result has been reached despite abstracting from the possibility of duplication of downstream fixed costs, and despite the absence of genuine economies of scope.

Our results are not necessarily controversial when confronted with the empirical literature. For example, privatisation, which has in many countries been an integral part of the restructuring process has been questioned by many authors. Kwoka (2006) finds that public ownership enforces cost discipline in the US electricity industry.[13] Martin and Parker (1997), Hodge (2009), Iordanoglou (2001), Florio (2004), and Parker (2006) have shown that privatisation does not always improve corporate performance.[14] As for vertical integration, Kwoka (2002) suggests that restructuring in the U.S. electricity industry might mean a sacrifice of benefits related to vertical integration. There is evidence of benefits

[13] An earlier contribution suggests that the comparative advantage of public ownership lies in electricity distribution, whereas the reverse applies to generation (Kwoka, 2005)

from vertical integration in the electricity industry also in Japan (Nemoto and Goto, 2004), Spain (Jara-Diaz et al., 2004) and Italy (Fraquelli et al., 2005). Urakami (2007) find evidence of vertical integration from the water industry in Japan, but Garcia et al. (2007) find such evidence only for the smallest utilities in the U.S.

The most controversial finding is the suggestion that competition can increase costs, and hence not compensate for the lost benefits of vertical integration, when there is an agency problem. We may have to accept that competition makes it more difficult to afford paying a manager whose effort is for sale, but a natural extension of our analysis would be to look for richer ways of analysing motivation at different levels of an organisation. Most evidence suggest a positive impact of competition on cost efficiency, but Kwoka (2006) finds that competition does not strengthen the performance of public firms. Also, his critical review of studies of the restructuring of the US electricity industry as a whole suggests that there is no reliable and convincing evidence in favour of restructuring as a whole (Kwoka, 2008). Other critical viewpoints on the restructuring process of the electricity sector in U.S. and Britain have been provided by Rothkopf (2007) and Thomas (2005), albeit with different criteria in mind.

Our analysis cannot rule out beneficial effects of liberalisation and vertical separation, but they do not then depend on higher managerial efforts. There may be internal rent capture in the industry, so that for example the wage costs are excessive in a public monopoly, or the incumbent's objectives may be distorted.[15] On the other hand, there are also disadvantages related to competition and vertical separation that our analysis has not dealt with, such as issues related to quality, reliability, price volatility, and remaining market power (Jiang and Yu, 2004; Lieb-Dóczy et al., 2003; Thomas, 2005; Rothkopf, 2007).

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[14] To summarise the empirical literature on public and private ownership seems to be difficult. Megginson and Netter (2001) have concluded in favour of private ownership, but Boyd (1986), Millward (1982) and Willner (2001, 2003) suggest that the differences in cost efficiency tend to go both ways.

[15] However, a companion paper dealing with the case of internal rent capture generated by Nash-bargaining reaches a similar conclusion on vertical separation and competition, because separation leads to internal rent capture both up- and downstream (Grönblom and Willner, 2008). Taking network externalities into account also throws some doubts on the benefits of competition, at least if it does not affect dynamic efficiency (Willner, 2006).

Appendix

Deriving the monopoly solutions in 3.1. The optimal output is obtained from the equality $\alpha y - y^2 + ey - w - F = 0$. As for the next stage, the constraints yield w_0 and e; combining (4)-(6) and (7)-(8) yields the following expressions for expected profits and output:

$$\pi = \alpha y - y^2 + \frac{\beta}{k} y - \frac{\varphi}{2}\left(\frac{\beta}{k}\right)^2 - F = 0, \tag{A.1}$$

$$y(\beta) = \frac{\alpha + \beta / k}{2} + \sqrt{\left(\frac{\alpha + \beta / k}{2}\right)^2 - \frac{\beta^2 \varphi}{2k^2} - F}\ . \tag{A.2}$$

The use of the upstream activity (i.e., the upstream output) is then $x = zy(\beta)$.

The zero-profit condition means that the total surplus is $y(\beta))^2/2$. Straightforward but tedious calculations will show that $y(\beta)$ is concave. We get the optimal β in (12) by differentiating (A.2) and setting the derivative equal to zero. The expected downstream marginal costs are therefore $c_0 - \beta^*/k$. Inserting (12) into (A.2) and rearranging yields the downstream output in (13); the total surplus in (14) is then $(y^*)^2/2$. The upstream output is zy^*.

Next, consider a profit-maximising monopolist. Maximising the profits with respect to y given β yields:

$$y(\beta) = (\alpha + \beta / k)/2\,. \tag{A.3}$$

Gross profits are then $y(\beta))^2$. Subtract $F + \varphi\beta^2/2k^2$ to get net profits and differentiate with respect to β to get (15). The second-order condition requires $\varphi > 0.5$, but we know that $\varphi > 1$. Inserting (15) into (A.3) yields output. Adding consumer surplus and profits yields the total surplus.

Deriving the Cournot-solution in 3.2: Firm i:s Cournot-output when marginal costs differ ex ante is:

$$y_i(\beta_1,\beta_2,...\beta_n)=\frac{1}{n+1}\left(a-zp-nc_0+\sum_{j\neq i}Ec_j^D+n\frac{\beta_i}{k}\right). \tag{A.4}$$

Its expected profits are:

$$E\pi_i(\beta_1,\beta_2,...\beta_n)=\frac{1}{(n+1)^2}\left(a-zp-nc_0+\sum_{j\neq i}Ec_j^D+n\frac{\beta_i}{k}\right)^2-\frac{1}{2}\left(\frac{\beta_i}{k}\right)^2\varphi. \tag{A.5}$$

Note that (A.5) is concave if and only if $\varphi>2[n/(n+1)]^2$ as we have assumed. Maximise and impose ex-post symmetry to get $e=\beta/k$ as a function of p:

$$e^V(p)=\frac{\beta^V(p)}{k}=\frac{2n(a-zp-c_0)}{\varphi(n+1)^2-2n}. \tag{A.6}$$

Use ex-post symmetry in (A.4) and insert (A.6) to get the industry output:

$$y^V(p)=\frac{n(n+1)(a-zp-c_0)\varphi}{\varphi(n+1)^2-2n}. \tag{A.7}$$

We have assumed that $x=zy$, so the derived demand for the upstream monopolist's output is

$$x(p)=\frac{zn(n+1)\varphi(a-c_0-zp)}{\varphi(n+1)^2-2n}. \tag{A.8}$$

The upstream monopoly maximises its expected profits $(p-c)x$ or $(p-c)zy$, so the optimal price would be

$$p^M=\frac{a-c_0+zc}{2z}. \tag{A.9}$$

Inserting into (A.6) and (A.7) then yields e^V and y^V, as expressed by (20)-(21). Use (20), (A.8) and (A.9) to get (22), i.e. the total surplus as the sum of the consumer surplus $(y^V)^2/2$, the downstream profits $n(y^V/n)^2$, and the upstream profits $x(p^M)(p^M-c^U)-F$.

Deriving the solutions for upstream regulation in 3.3: The presence of upstream regulation does not change the second-order condition associated with an n-firm downstream oligopoly, because each downstream firm maximises its profits given the upstream price. The derived demand $x(p)$ is expressed by (A.8). Set $x(p)(p- c^U)-F = 0$:

$$p^R = \frac{1}{z}\left[c^U z + \frac{\alpha}{2} - \sqrt{\left(\frac{\alpha}{2}\right)^2 - \frac{\left[\varphi(n+1)^2 - 2n\right]F}{(n+1)n\varphi}}\right]. \tag{A.10}$$

To get (25) and (26), insert (A.10) into (A.6) and (A.7).

As for the simplified setting with a weighted objective function, maximise $x(p)(p-c^U)+\lambda y^2/2$ with respect to p, use (A.8) and note that $y=x/z$:

$$p^C = \frac{1}{z}\left[c^U z + \frac{\left[\varphi(n+1)^2 - 2n - \lambda\varphi(n+1)n\right]\alpha}{2\varphi(n+1)^2 - 4n - \lambda\varphi(n+1)n}\right]. \tag{A.11}$$

Insert (A.11) into (A.6) and (A.7) to get (27) and (28).

Proof of Lemma 1: a) Note that the marginal costs are $zc+c_0-\beta/k$. The results follows directly from the fact that $\beta^*>\beta^M$ according to (12) and (15). Part b) is obvious from (13) and (16). c) Suppose that the reverse is true. According to (13) and (17), this would mean

$$\frac{\varphi\alpha^2(3\varphi-1)}{2(2\varphi-1)^2} - F > \frac{1}{2}\left\{\frac{\varphi\left[\alpha + \sqrt{\alpha^2 - 2F(2\varphi-1)/\varphi}\right]}{2\varphi-1}\right\}^2. \tag{A.12}$$

Rearranging would then yield

$$(\varphi-1)\left[\alpha^2\varphi^2-2F\varphi(2\varphi-1)\right]>2\alpha\varphi^2\sqrt{\alpha^2\varphi^2-2F\varphi(2\varphi-1)}, \tag{A.13}$$

or

$$(\varphi-1)\sqrt{\alpha^2\varphi^2-2F\varphi(2\varphi-1)}>2\alpha\varphi^2. \tag{A.14}$$

Taking the square of both sides and rearranging then yields

$$-(2\varphi-1)\alpha^2\varphi^2-2\varphi(2\varphi-1)(\varphi-1)^2F>3\alpha^2\varphi^4. \tag{A.15}$$

This cannot be true, because $k>1$ implies $\varphi>1$. The antithesis is therefore false. Q.E.D.

Proof of Lemma 2: a) Set $n=1$ in (20) and (21). As follows from (15) and (20), marginal costs are lower in the integrated monopoly, because the relevant part of the marginal costs equals $c_0-\beta/k$. Inspection of (16) and (21) shows that output is higher in the monopoly, and it follows from (17) and (24) that the same applies to the total surplus. Part b) follows directly from the last paragraph of section 3.3. Q.E.D.

Proof of Proposition 1: It is obvious from (20) that a) holds true. As for part b), it is obvious from (21) that output is increasing in n if $\varphi>\varphi_1(n)=2[n/(n+1)]^2$. However, this inequality is also implied by the second order-condition, so output is increasing in n if an optimal β exists at all.

To see the impact of a change in n on the total surplus, differentiate (22) with respect to n and rearrange:

$$\frac{dTS^V}{dn}=\frac{\alpha\varphi\left[\varphi^2(n+1)^3(n+2)-2\varphi(n+1)n^2(n+6)+8n^3\right]}{4\left[\varphi(n+1)^2-2n\right]^3}. \tag{A.16}$$

It follows that this derivative is positive if

$$\varphi > \varphi_2(n) = \frac{n^2(n+6) + \sqrt{n^3(n^3 + 4n^2 + 12n - 16)}}{(n+1)^2(n+2)}. \tag{A.17}$$

It can easily be seen that $\varphi_2(n)$ approaches 2.0 when n approaches infinity and that $\varphi_2(n)<2.0$ for all $n>-0.333$. Any value of φ higher than 2 therefore means that the total surplus is always increasing in n. As for values of φ below 2, note that $\varphi_2(n)$ is a monotone and increasing (see Figure 1). It therefore is obvious that there exist values n^* such that n^* is on one side of $\varphi_1(n)$ and n^*+1 on the other, so that the total surplus is increasing up to n^* and decreasing from n^*+1 onwards. Part c) is thereby proved. Q.E.D.

Proof of Lemma 3: It is obvious from (15)-(16) and (20)-(21) that a) and b) hold true. To understand c), suppose as an antithesis that $TS^V-TS^M>0$ (see (17) and (22)). Insert values for n=1–4 and rearrange so as to get a third-degree inequality in φ. It can easily be seen that the there are no real values of φ strictly above 1.0 for which the antithesis can hold true for these market structures. As follows from (17) and (23), the same applies when n becomes very large. As for intermediate values, suppose first that $\varphi=1$. It is then obvious that the antithesis is false for all values of n such that $n\geq5$; the fact that $\varphi>1$ just reinforces the inequality, because the coefficients for φ^3 and φ^2 are then negative. Q.E.D.

Proof of Proposition 2: a) It is obvious from (20), (21) and (27) and (28) that marginal costs are lower and output and the consumer surplus higher under upstream regulation or public ownership for all values of λ in (0,1) and hence also for λ_0.

b) As follows from (12) and (13), the zero-profit condition for a monopoly has a meaningful solution only if the expression inside the square-root sign is positive. This restricts $f=F/\alpha^2$ to values below or to the left of the curve $f_1(\varphi)$ in Figure 2:

$$f < f_1(\varphi) = \frac{1}{2(2\varphi - 1)}. \tag{A.18}$$

The fact that there is a natural monopoly will be interpreted as requiring that F is so large that two vertically integrated firms cannot break even. Suppose that the vertically integrated firm is a duopoly. This would yield $\beta/k=4\alpha/(9\varphi-4)$ and $y=3\alpha/(9\varphi-4)$. Requiring that two such firms should not be able to break even means that the relevant values of f have to be above the curve $f_2(\varphi)$ in Figure 2:

$$\frac{F}{\alpha^2} > f_2 = \frac{\varphi(9\varphi-8)}{(9\varphi-4)^2}. \tag{A.19}$$

The area that is relevant is thus below f_1 and above f_2, which intersect in the point where φ=2.831 and F/α^2= 0.107.

When n becomes very large, downstream profits tend to zero. If there is regulation that produces zero upstream profits, the total surplus then approaches the downstream consumer surplus $(y^R)^2/2$. As follows from (26) and (17), the solution can outperform the vertically integrated profit maximising monopoly, but only if

$$\frac{\left(\alpha+\sqrt{\alpha^2-4F}\right)^2}{8} > \frac{\varphi\alpha^2(3\varphi-1)}{2(2\varphi-1)^2} - F, \tag{A.20}$$

which can be rearranged to

$$\frac{F}{\alpha^2} < f_3 = \sqrt{\frac{\varphi^2-3\varphi+1}{(2\varphi-1)^2}} - \frac{\varphi^2-3\varphi+1}{(2\varphi-1)^2}, \tag{A.21}$$

so that f is below or to the right of $f_3(\varphi)$. This boundary intersects f_1 in φ =2.7562 and F/α^2=0.1108 and f_2 in φ=2.7446 and F/α^2=0.1070. An integrated monopoly can break even only in *A, B, E* and *G* in Figure 2, and the natural monopoly assumption is satisfied only in *B, C, D* and *E*. The combination of separation, upstream regulation and downstream fragmentation would be superior in *D, E, F* and *G*, but given the requirement of feasibility and natural monopoly, only *E* is relevant. Q.E.D.

Proof of Proposition 3: a) The fact that marginal costs are lower in the public monopoly is obvious from (15) and (20). The fact that welfare is higher follows from Lemma 1 and Lemma 3 (or from the fact that $TS^V > TS^*$ can only if (A.18) and (A.19) are contradicted.

b) It is obvious from (15) and (25) that marginal costs are lower in the public monopoly. To understand why welfare is higher in the vertically integrated public monopoly than after privatisation, vertical separation, competition and upstream regulation, note that the total surplus associated with the welfare maximising public monopoly is

$$TS^* = \frac{1}{2}\frac{\left\{\varphi\left[\alpha + \sqrt{\alpha^2 - 2F(2\varphi - 1)/\varphi}\right]\right\}}{(2\varphi - 1)^2}. \qquad \text{(A.22)}$$

Compare (A.22) with the left-hand expression in (A.20) and abbreviate $(2\varphi-1)/\varphi$ as δ. The antithesis can then formulated as follows:

$$\frac{\alpha + \sqrt{\alpha^2 - 2F\delta}}{\delta} < \frac{\alpha + \sqrt{\alpha^2 - 4F}}{2}. \qquad \text{(A.23)}$$

It is obvious that $\delta<2$, so the numerator of the expression to the left in (A.23) is larger and the denominator smaller. The antithesis is therefore false. Q.E.D.

REFERENCES

Beiner, Stefan, Markus Schmid and Gabrielle Wanzenried (2009), 'Product Market Competition, Managerial Incentives, and Firm Valuation', *European Financial Management* (forthcoming; available online from September 2009).

Boyd, Colin W. (1986), 'The Comparative Efficiency of State Owned Enterprises', in Negandhi, Anant R. (ed.), *Multinational Corporations and State-Owned Enterprises: A New Challenge in International Business,* Greenwich, Conn. and London:Research in International Business and International Relations, JAI Press.

Bradburd, Ralph (1995), 'Privatization of Natural Monopoly Public Enterprises: The Regulation Issue', *Review of Industrial Organization,* vol. 10, no. 3, pp. 247-267.

Buehler, Stefan (2005), 'The Promise and Pitfalls of Restructuring Network Industries', *German Economic Review,* vol. 6, no. 2, pp. 205-228.

De Fraja, Giovanni (1993), 'Productive Efficiency in Public and Private Firms', *Journal of Public Economics*, vol. 50, no. 1, pp. 15-30.

De Fraja, Giovanni and Flavio Delbono (1989), 'Alternative Strategies of a Public Enterprise in Oligopoly', *Oxford Economic Papers*, vol. 41, April, pp. 302-311.

Fershtman, Chaim (1990), 'The Interdependence Between Ownership and Market Structure: The Case of Privatization', *Economica,* vol. 57, no. 227, pp. 219-238.

Florio, Massimo (2004), *The Great Divestiture. Evaluating the Impact of the British Privatizations 1979-1997,* Cambridge, Mass. and London: MIT Press.

Fraquelli, Giovanni, Massimiliano Piacenza and Davide Vannoni (2005), 'Cost Savings from Generation and Distribution With an Application to Italian Electric Utilities', *Journal of Regulatory Economics,* vol. 28, no. 3, pp. 289-308.

Garcia, Serge, Michel Moreaux and Arnaud Reynand (2007), 'Measuring Economies of Vertical Integration in Network Industries: An Application to the Water Sector', *International Journal of Industrial Organization,* vol. 25, pp. 791-820.

Grönblom, Sonja and Johan Willner (2008),'Privatization and Liberalization: Costs and Benefits in the Presence of Wage Bargaining' *Annals of Public and Cooperative Economics*, vol. 79, no. 1, pp. 133-160.

Hodge, Graeme A. (2000), *Privatization. An International Review of Performance,* Boulder, Co.: Westview Press.

Iordanoglou, Christafis H. (2001), *Public Enterprise Revisited. A Closer Look at the 1954-79 UK Labour Productivity Record,* Cheltenham, UK and Northampton, Mass., USA: Edward Elgar.

Jara-Diaz, Sergio, Francisco Javier Ramos-Real and Eduardo Martínez-Budría (2004), 'Economics of Integration in the Spanish Electricity Industry Using a Multistage Cost Function', *Energy Economics,* vol. 26, pp. 995-1013.

Jiang, John N. and Jun Yu (2004), 'Reliability in Electricity Markets: Another Binding Constraint', *Electricity Journal,* vol. 17, June, pp. 43-53.

Kwoka, John (2002), 'Vertical Economies in Electric Power: Evidence on Integration and its Alternatives', *International Journal of Industrial Organization,* vol. 20, no. 5. pp. 653-672.

Kwoka, John (2005), 'The Comparative Advantage of Public Ownership: Evidence from U.S. Electric Utilities', *Canadian Journal of Economics,* vol. 38, no. 2, pp. 622-640.

Kwoka, John (2006), 'The Role of Competition in Natural Monopoly: Costs, Public Ownership and Regulation', *Review of Industrial Organization*, vol. 29, no. 1-2, pp. 127-147.

Kwoka, John (2008), 'Restructuring the U.S. Electric Power Sector: A Review of Recent Studies', *Review of Industrial Organization*, vol. 32, no. 3-4, pp. 165-196.

Lieb-Dóczy, Enese, Achim-Rüdiger Börner and Gordon MacKerron (2003), 'Who Secures the Security of Supply? European Perspectives on Security, Competition and Liability', *Electricity Journal*, vol. 16, December, pp. 10-19.

Martin, Reiner, Moreno Roma and Isabel Vansteenkiste (2005), 'Regulatory Reforms in Selected EU Network Industries', *European Central Bank,* Occasional Paper Series, no. 28, April.

Martin, Stephen (1993), 'Endogeneous Firm Efficiency in a Cournot Principal-Agent Model', *Journal of Economic Theory,* vol. 59, no. 2, pp. 445-450.

Martin, Stephen and David Parker (1997), *The Impact of Privatisation. Ownership and Corporate Performance in the UK*, London and New York: Routledge.

Megginson, William L. and Jeffry M. Netter (2001), 'From State to Market: A Survey of Empirical Studies on Privatization', *Journal of Economic Literature,* vol XXXIX, no. 2, pp. 321-389.

Millward, Robert (1982), 'The Comparative Performance of Public and Private Ownership', in Roll, Lord Erich (ed.), *The Mixed Economy,* London: Macmillan.

Nemoto, Jiro and Mika Goto (2004), 'Technological Externalities and Economies of Vertical Integration in the Electric Utility Industry', *International Journal of Industrial Organization,* vol. 22, no. 1. pp. 67-81.

Newbery, David M. (1999), *Privatization, Restructuring, and Regulation of Public Utilities,* Cambridge, Mass. and London: The MIT Press.

Parker, David (2006), 'The UK's Privatisation Experiment: The Passage of Time Permits a Sober Assessment', Chapter 12, pp. 365-398 in Köthenbürger, Marko, Hans-Werner Sinn and John Whalley (Eds.), *Privatization Experiences in the EU,* Cambridge, Mass. and London, UK: MIT Press and CESifo.

Perry, Martin K. (1978), 'Vertical Integration : The Monopoly Case', *American Economic Review,* vol. 68, September, pp. 561-570.

Raith, Michael (2003), 'Competition, Risk and Managerial Incentives', *American Economic Review*, vol. 93, pp. 1425-1436.

Reforming Network Industries (2006), Highlights of Conference *The Lisbon Strategy: A Motor for Market Reforms of the Network Industries*, jointly organised by the European Economic and Social Committee, the Belgian Central Economic Council and the Belgian Federal Planning Bureau, http://www.ccecrb.be/txt/fr/industrie_reseaux_version_finale_200306.pdf.

Rothkopf, Michael H. (2007), 'Dealing with Failed Deregulation: What Would Price C. Watts Do?', *Electricity Journal,* vol. 20, Aug./Sept., pp. 10-16.

Thomas, Steve (2006), 'The Grin of the Cheshire Cat', *Energy Policy,* vol. 34, pp. 1974-1983.

Urakami, Takuya (2007), 'Economies of Vertical Integration in the Japanese Water Supply Industry', *Jahrbuch für Regionalwissenschaft,* vol. 27, pp. 129-141.

Vickers, John (1995), 'Competition and Regulation in Vertically Related Markets', *Review of Economic Studies,* vol. 62, no. 1, pp. 1-18.

Vickers, John and George Yarrow (1988), *Privatization: An Economic Analysis,* Cambridge, Mass.: The MIT Press.

Williamson, John (2000), 'What Should the World Bank Think about the Washington Consensus?', *World Bank Research Observer,* vol. 15, no. 2, pp. 251-264.

Willner, Johan (2001), 'Ownership, Efficiency, and Political Interference', *European Journal of Political Economy*, vol. 17, no. 4, pp. 723-748.

Willner, Johan (2003), 'Privatization - A Sceptical Analysis', pp 60-86 (Ch. 4) in Parker, David and David Saal (Eds.), *International Handbook of Privatisation,* Cheltenham, UK and Northampton, Mass., USA: Edward Elgar.

Willner, Johan (2006), 'Privatisation and Liberalisation in an Industry With Network Externalities', *Economics Letters,* vol. 91, no. 2, pp. 197-203.

Willner, Johan (2008), 'Liberalisation, Competition and Ownership in the Presence of Vertical Relations', *Empirica*, vol. 35, pp. 449-464.

Willner, Johan and David Parker (2007), 'The Performance of Public and Private Enterprise Under Conditions of Active and Passive Ownership and Competition and Monopoly', *Journal of Economics*, vol. 90, nr. 3, pp. 221-253.

Figure 1. The impact of increased competition on welfare in a vertically separated market

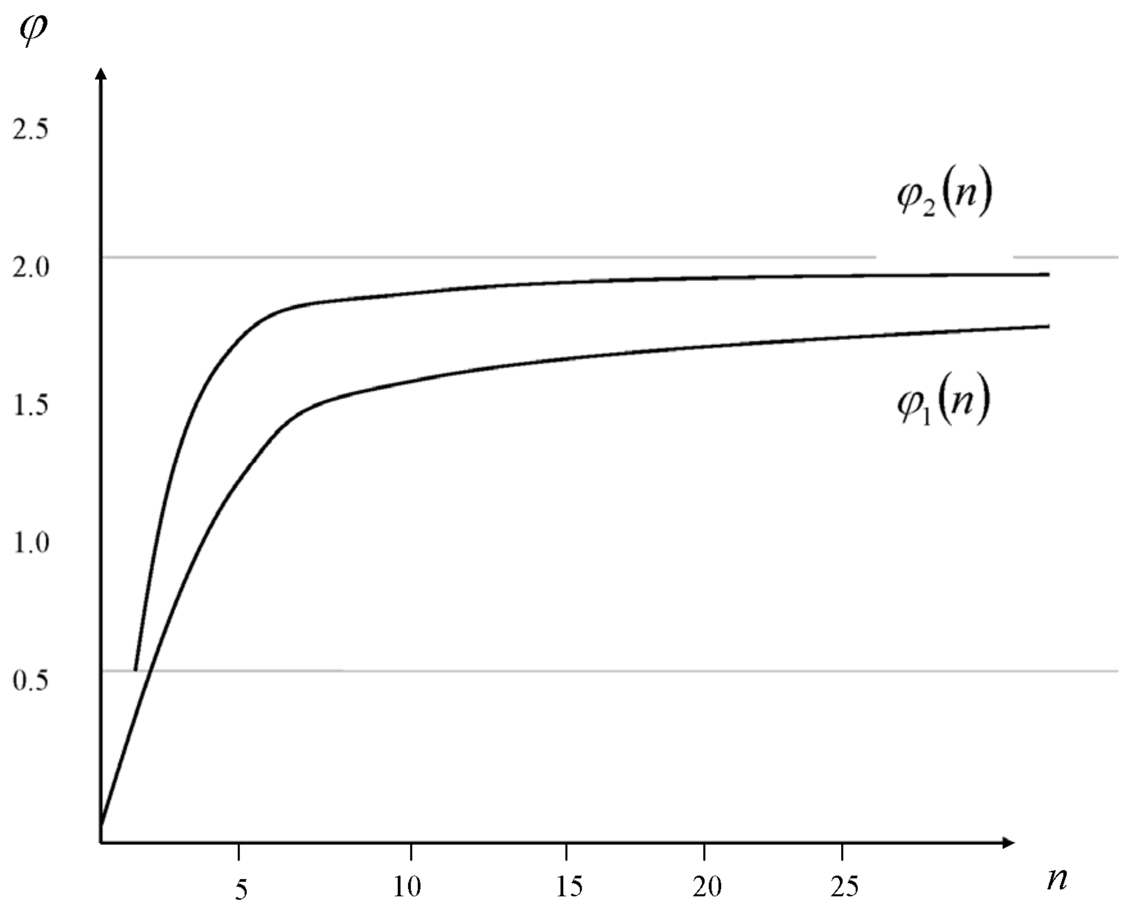

Figure 2. A comparison of vertical separation, competition and upstream regulation with an integrated upstream monopoly.