AN EFFICIENT PRIVATIZATION MECHANISM

by

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Abstract: In this paper, we consider the privatization of State-Owned Enterprises (SOEs) that are legal monopolies but not natural monopolies; their markets can be opened to competition once privatization takes place and other competitors can emerge and compete successfully against them in a few years. But until that happens, these privatized SOEs can have a significant level of market power. The currently used "Revenue Maximization (RM)" privatization scheme maximizes the government revenue from privatization but does not provide sufficient incentives for the privatized SOE eiher to charge a price lower than the monopoly price or to improve production efficiency until competition arises. We propose a new scheme to privatize such SOEs. We term this new scheme the "Welfare Maximization (WM)" scheme. The WM scheme practically yields no revenue to the government from the privatization of any such SOE; however, it induces the privatized SOE to charge a competitive price in the absence of any regulation. It also turns out that the WM scheme provides greater incentives for post-privatization process invention (i.e., for post-privatization cost reduction) than RM scheme.

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I. INTRODUCTION

Privatization policies are currently in progress in more than 80 countries throughout the world. In each of these countries, depending on the type of post-privatization market structure that the privatized SOE will face, the degree of difficulty of implementing privatization varies. For instance, when the sector in which the privatized SOE operates is already competitive, privatization is relatively straightforward; when the SOE in question is a natural monopoly, regulation becomes the conventional framework to approach the issue with.

Many SOE's, however, neither operate in competitive markets nor qualify to be considered as natural monopolies. In many cases, at some point of their existence, these SOEs had been declared as legal monopolies by their governments. Most of these legal SOEs are such that, when their markets are opened to competition once privatization takes place (i.e., when their monopoly status is abolished by the government), in a few years time other competitors can emerge and compete successfully against them. But until that happens, these privatized SOEs can have a significant level of market power. Such a post-privatization market power necessarily implies that the social welfare is not maximized during that interim period.

In this paper, we propose a new scheme to privatize such SOEs which have had legal monopoly status as described above; we term this new scheme the "Welfare Maximization (WM)" scheme. The WM scheme practically yields no revenue to the government from the privatization of any such SOE; however, it induces the privatized SOE to charge an almost competitive price in the absence of any regulation.

Currently, the "Revenue Maximization (RM)" scheme is commonly used; this scheme maximizes the government revenue from privatization but does not provide any incentives for the privatized SOE to charge a price lower than the monopoly price until serious competition arises (in

many cases, the monopoly status of the SOE that gets privatized is not even abolished;[1] i.e., the privatized SOE is allowed to make monopoly profits in the long run too - we will not consider this extreme case in this paper).

We compare the WM scheme to the RM scheme in several respects. First, the WM scheme does not only provide a higher social welfare than the RM scheme does but it also results in a higher consumer surplus and higher profits (i.e., higher producer surplus) for the privatized SOE (the latter happens although the privatized SOE charges a lower price under the WM scheme). It also turns out that the WM scheme provides more incentives for post-privatization process invention (i.e., for post-privatization cost reduction).

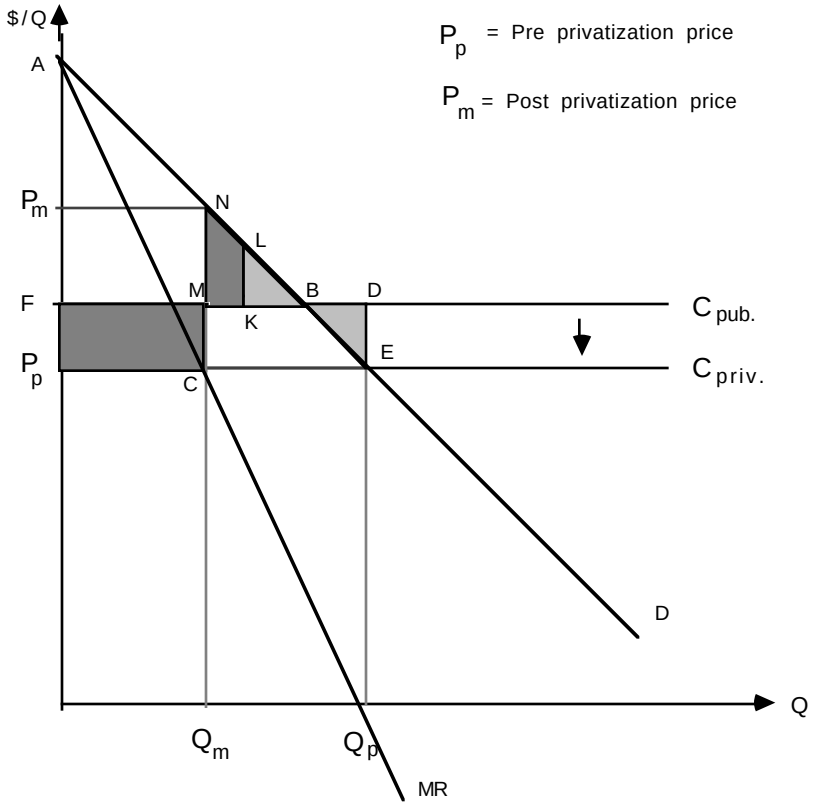
II. POST-PRIVATIZATION SCENARIOS

(A) The Market with the Post-Privatization Interim Monopoly May or May Not Be More Efficient than That of the Pre-Privatization SOE

The scheme currently used in privatization practices, the Revenue Maximization (RM) scheme, is such that the highest bidder acquires the SOE by paying a substantial amount of money to the government. In many cases, this system provides no incentives for the privatized SOE to strive to sell its product at a price near the competitive price. If left alone, the privatized SOE will charge a monopoly price (which will necessarily be coupled with the low monopoly output level) and thus will make monopoly profits. Also, a private monopoly (because of the lack of competitive pressures) will not be able to get rid the pre-privatized SOE's X-inefficiencies entirely. Even if the privatized SOE's monopoly price turns out to be below the artificially low pre-privatization price, the resulting overall inefficiency level can still be comparable to the overall pre-privatization inefficiency level. In Figure 1, we start with a monopolist pre-privatized SOE that incurs losses equivalent to the area of the rectangle $FDEP_p$. Assume that marginal cost is constant. Suppose the pre-privatization price P_p is

[1] There are many such cases. For instance, Manzetti (1993, p. 447) reports that Argentine government sold the state-owned (monopolistic) airline company Aerolineas to Iberia at the end of November 1990 without lifting its monopoly status in domestic routes. Iberia soon charged "fares substantially higher compared to neighboring countries;" meanwhile, Iberia cut "domestic flights by 23 percent", "mechanical failures worsened, and safety standards were said to be deteriorating alarmingly."

FIGURE 1

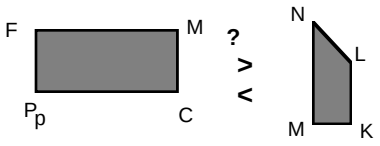


Total Welfare Before Privatization:
Wo = AEPp - FDEPp = ALKF

Total Welfare After Privatization:
W1 = ANPm + PmNCPp = ANCPp

W1 > Wo iff FMCPp > NLKM

since BDE = LBK



lower than the pre-privatization marginal cost C_{pub}. Let Q_p the pre-privatization quantity. Then observe that the social welfare (i.e., the summation of the consumer and producer surpluses and government revenue -- the latter is supposed to be spent to enlarge the former two) is equal to the area ALKF; this is because BDE and LBK are equal-area triangles. Suppose that, after privatization, X-inefficiencies are reduced and costs are brought down to the level C_{priv} to the extent that this would have eliminated the firm's losses totally under the pre-privatization price P_p. Then the privatized monopolist will choose the price P_m. Observe that there is still a significant efficiency loss. As can be seen in Figure 1, the level of post-privatization inefficiency can be higher or lower than that of pre-privatization inefficiency depending on the relative sizes of the rectangle $FMCP_p$ and trapezoid NLKM.

(B) A Competitive Post-Privatization Firm through Regulation?

If a competitive market immediately emerged following privatization, a private competitive firm, because of the competitive pressure it faces, could get rid of the x-inefficiencies entirely; such a firm, then, could charge an efficient post-privatization product price which could still be lower than the artificially and inefficiently low pre-privatization product price. However, as mentioned above, even if such an ex-monopoly SOE's market is opened to competition as soon as it is privatized, presumably no serious competition can take place against the privatized SOE to generate net welfare gains for a while.[2] Thus, in the absence of such an immediate invasion of this market by competitive firms, one way one could think of making the post-privatization firm behave as competitively as possible is to have some form of regulation. The costs of forming a regulatory body to monitor that firm (recall that it is not a natural monopoly) and using a significant amount of resources to learn the firm's cost and demand conditions in the interim monopoly period, however, may not justify the potential benefits from regulating that firm (as will be discussed briefly in the Concluding Remarks,) regulation, even in the presence of long-term -- and thus less asymmetric -- relationships, can be ineffective and can have undesirable indirect effects (Averch and Johnson, 1962) (Braeutigam, and

[2] Karaaslan (1995) simulates net welfare changes to pre-privatization price elasticities and shows that under the RM scheme welfare gains can be obtained only at high elasticities even if a privatized public monopoly is pressured to reduce its X-inefficiency by an emerging competitive fringe of price followers.

Panzar, 1989).

(C) An "Ideal" Outcome for the Society

Suppose the government knew which potential buyer of a SOE had the lowest (constant marginal) cost -- assume for simplicity that there is only one firm with that cost. Let that cost be c*. Then the government can have a precondition that, in order to enter the auction to acquire that SOE, each firm has to charge a post-privatization SOE product price $P_{priv} = c^*$. Then only the firm with cost c* would be able to enter the auction by proposing a zero acquisition price for the SOE (i.e., the government would get no revenue from the sale of the SOE) but by promising that it would charge $P_{priv} = c^*$. Any other firm would make losses if it promised the same low post-privatization product price. This would be the best outcome for the society because it would entail maximizing the social welfare. (In this story, we implicitly assumed that the winning buyer of SOE would not have any incentives to shut down the operations and sell off the assets of SOE once the government handed the SOE over to that firm. The amount that the firm can earn from this sale of assets may exceed the producer surplus, although it may not cover any of the consumer surplus. Thus, in spite of the social inefficiency of such a sale of assets, the firm might have the incentives to do so. Such incentives may be strong especially in countries where capital assets have an active second hand market. However, there is always a simple remedy against such opportunistic behavior: the government can remove any such incentives by requiring a collateral equivalent to the scrap (or liquidation) value of the SOE until the firm faces serious competition from several rivals -- meanwhile the firm would be required to produce as much as the public would like to purchase at $P_{priv} = c^*$, otherwise it could lose part of the collateral as well as the right to own and run the privatized SOE.)

In addition, achieving such an outcome is a less costly signal to send for an "honest" government (i.e., a government that has the intention of acting as an agent of the consumers and producers combined) than it is for a less honest government (i.e., a government that would like to use the privatization revenue for election economies or to boost welfare of the interest groups that support it) to indicate that it is really an honest government. This way the society can more easily distinguish between an honest and a less honest one.

(D) The Best Way of Implementing an "Ideal" Outcome under "Unideal" Conditions: Auctions

I. Public Offerings and Private Sales of Shares:

The government typically does not know which firm has the lowest cost. Therefore, in the real-life version of the above example, the government will most likely regret that either it set the product price too high or too low. In either case, the government's best bet is to revise the required product price in the appropriate direction after it observes many positive product price bids by the potential buyers of the SOE or after it observes no such bids (such a revision of the product price by the government can take place many times -- it may follow a repeated back-and-forth path too). This, however, is a costly way of implementing the above-mentioned "ideal" outcome.

Instead, direct competitive bidding procedures can be much more preferable in the sale of SOE's. The two most common bidding ways in privatization have been "public offering of shares" and "private sale of shares." In the public offering of sales, typically the shares are offered to the public at a fixed price (this price is set before the offering). If the demand for shares of some SOE at the initial fixed price falls below the number of shares available, then the demands are met at that price; in many cases this price is reduced for the next round. If the demand exceeds supply, bidders get proportionately fewer shares than they asked for at that fixed price; i.e., the number of shares sold to each bidder is scaled down in proportion to total. The advantage of this method is to widen the ownership of the shares in the society.

In the private sale of shares, the government auctions a SOE among a group of pre-identified group of potential purchasers. Private sale of shares may be the only feasible alternative in the absence of developed capital markets where a public offering is difficult to carry out and/or where the size of the enterprise may not justify a public offering. Even when the above-mentioned problems are not present, public offering of shares may lead to a corporate-governance problem; i.e., under public offering, the SOEs' shares sold could be dispersed among the population without any blockholders emerging to monitor the managers and to enforce efficiency. This is a problem since many weak performing SOEs need strong owners ("stakeholders") with relevant industrial, financial, commercial and other experiences and a high financial stake in the success of the firm who can turn

things around rather rapidly.

In many privatization practices, the two methods are used together. First, a significant block of shares of a SOE is sold to a stakeholder. Then the rest is sold through a public offering. That way, corporate governance and wider ownership of shares issues are resolved simultaneously. In our analysis, we will assume that a privatized SOE has a stakeholder.

ii. Auction Types:

There are four types of auctions in use; the English auction, the Dutch auction, the first-price sealed-bid auction (FPSB), and the second-price sealed-bid auction (SPSB). The first two are oral auctions and are less practical in the sale of SOE's. Under the FPSB auction, potential buyers submit sealed bids and the highest bidder is awarded the item for the price he bid. With the SPSB auction, bidders submit sealed bids having told that the highest bidder wins the item but pays a price equal to the second-highest bid.

The SPSB auction system economizes on information gathering and bid preparation costs: Although no bidder knows the level of the best bid, it turns out that it is a dominant strategy for each bidder to bid exactly his own true valuation of the item. In the FPSB auction each bidder's bid depends on his beliefs about the distribution of the other bidders' valuations (as well as his risk preference and his beliefs about the distribution of the other bidders' risk aversion coefficients). For that reason, the FPSB auction may entail significant information gathering and bid preparation costs. In addition, in an environment where the bidders have observably different characteristics, the equilibrium outcome of the FPSB auction is inefficient with some positive probability.[3]

III. THE "RM" AND "WM" SCHEMES AND THE RESULTS

Throughout our analysis, we will assume that the output of the privatized SOE can properly and

[3] Suppose that there are two bidders. The first one has a valuation of $201 and the second one's valuation is either $100 with probability 4/5 and 150 with probability 1/5. The first bidder is assumed not to know the valuation of the second but he knows its distribution. If the first bidder bids $201, he will win $100 (his valuation minus his bid at least 4/5 of the time, yielding an expected profit of at least $80). If he bids $122 or more he can win no more than $79 (= $201-$122), so he will never make that choice. Since the first bidder never bids as much as $122, an optimizing second bidder must win sometimes when his valuation is $150, and the allocation then is inefficient -- whereas a SPSB auction would always lead to an efficient allocation in such an environment.

precisely be specified, the technology is relatively simple, and the future development of demand and technology is fairly predictable (many SOEs in many countries are in sectors such as sugar processing, cellulose and paper products, fuel oil, glass, iron, steel, cement, etc., and these sectors share most of the above characteristics).

As mentioned in the Introduction, we will compare the WM scheme to the RM scheme. Define the social welfare as W = CS + PS + G. It is a well-known result that "any increase in a firm's PS is an increase in that firm's profits, ; i.e., PS = π + k where k is some constant." Thus, the social welfare can also be defined as W = CS + π + G + k.

We will consider a linear (inverse) demand function for the product that the SOE produces, p(q) = a-bq where p denotes the product price, q denotes the output level and a, b > 0. A "firm" refers to any stakeholder that enters the bidding to take over the privatized SOE. Each firm is assumed to know what its cost will be when it owns and runs the privatized SOE; it does not, however, know the other firms' costs (we also assume that for any firm it is very costly to get information on the other firms' costs). Let c_i be the constant marginal cost of Firm I. Index all firms according to their cost rankings such that the least cost firm is called Firm 1, the second least cost firm is called Firm 2, and so on. Given its cost c_i, let p_i^m be the monopoly price that Firm I would charge and $_i^m$ be its monopoly profit if it took over the privatized SOE and had the monopoly status during the interim monopoly period. To avoid some unnecessary complications, we assume that any two c_i, c_{i+1} are arbitrarily close.

The RM scheme is such that the government holds a bidding in which each bidder has to bid how much it would pay to acquire the privatized SOE; the bidder that bids the highest acquisition price wins the bidding and takes over the privatized SOE but must pay the second highest bidder's acquisition price; that is, the government uses a second-price sealed-bid auction. The owner of the privatized firm can charge any price after it takes over the privatized SOE. Next, employing the SPSB auction, we consider the RM and WM schemes *seriatim*.

LEMMA 1: *Under the RM scheme, Firm 1 wins the auction by paying an acquisition price to the government equal to* π_2^m. *Firm 1 charges* p_1^m *after it takes over the privatized SOE.*

The proof of Lemma 1 is straightforward: In a second-price sealed-bid auction, each bidder bids its reservation price. In this case, it means that each Firm I will bid π_i^m. Thus, Firm 1 will have made the highest bid and consequently will win the auction. By the procedure of the RM scheme, Firm 1 then will have to pay π_2^m to the government in order to take over the privatized SOE. Since it is allowed to charge any price after it takes over the privatized SOE, Firm 1 will charge $p_1{}^m$.

The WM scheme is such that the government holds a bidding in which bidder has to bid what product price it will charge if it became the owner of the privatized SOE; the bidder that bids the lowest product price wins the bidding and must charge the second lowest bidder's product price after it takes over the privatized SOE.[4] (To keep things simple, we assume that the above-mentioned measures are feasible and deterrent enough against some problematic privatized SOEs that (I) sell off assets and shut down the operations and (ii) refuse to supply as much as the public demands at the guaranteed low product price.)

LEMMA 2: *Under the WM scheme, Firm 1 wins the auction by bidding a product price* $p = c_1$. *Firm 1 charges* $p^* = c_2$ *after it takes over the privatized SOE.*

Again, in a second-price sealed-bid auction, each bidder bids its reservation price. In this case, it means that each Firm I will bid $p = c_i$. Thus, Firm 1 will have made the lowest bid and consequently will win the auction. By the procedure of the WM scheme, Firm 1 then will have to charge $p^*_1 = c_2$ after it takes over the privatized SOE.

PROPOSITION 1: *(I) The product price,* p_1^*, *under the WM scheme is lower than the product price,* $p_1{}^m$, *under the RM scheme.*

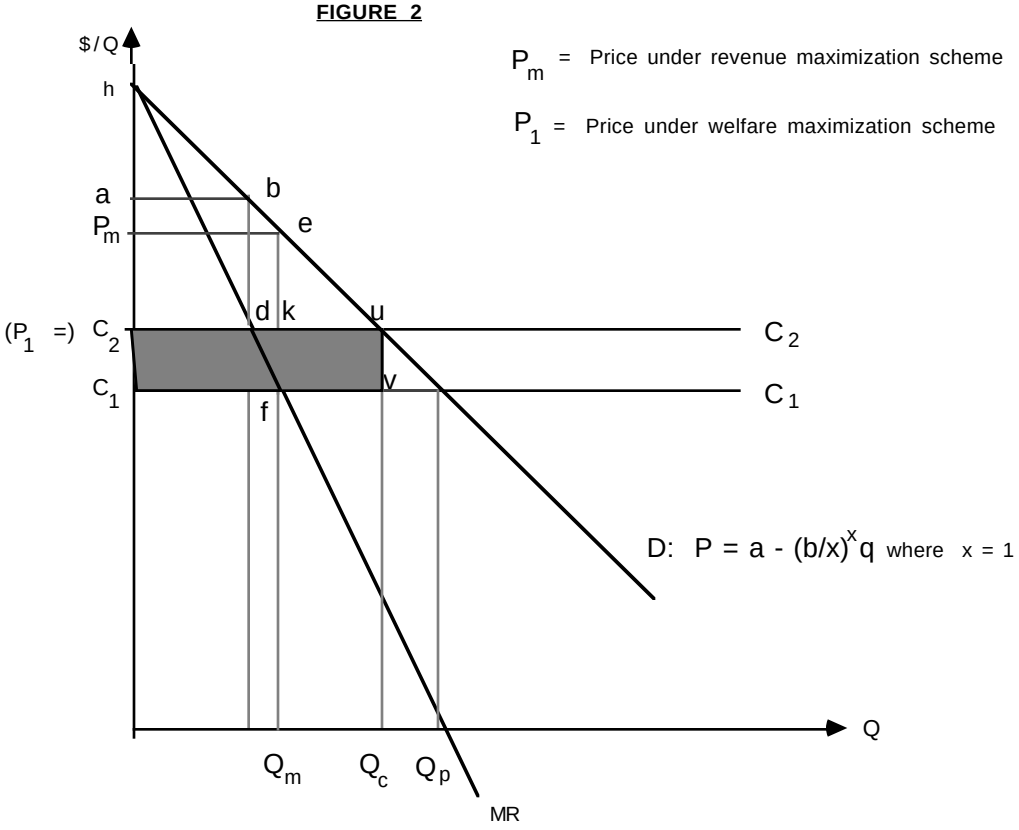
(ii) A higher output is produced under the WM scheme than under the RM scheme.

(iii) Consumer surplus is larger under the WM scheme than under the RM scheme.

Proof: (I) It follows from the facts that (a) by Lemmas 1 and 2, Firm 1 is the winner under both schemes, (b) for a monopolist Firm 1, $p_1{}^m > c_1$, and since any two c_i, c_{i+1} are assumed to be

[4] The commitment to a low price is not well-defined unless the quality of the product or service is well-defined. Posner (1972, p.115) addresses this problem in defense of franchise-bidding in the Cable TV industry and proposes a pre-bidding solicitation process to guarantee service quality. However, this problem arises because of the finite contract period under franchise-bidding. Under the WM privatization mechanism we propose, management of the privatized interim monopoly is less likely to risk consumer confidence by poor product quality in the face of future potential competition.

FIGURE 2



P_m = Price under revenue maximization scheme

P_1 = Price under welfare maximization scheme

Total Welfare Under Revenue Maximizing Privatization Scheme:

Wo = hePm + C2dfC1 + PmefdC2 = hefC1

Total Welfare Under Welfare Maximizing Privatization Scheme:

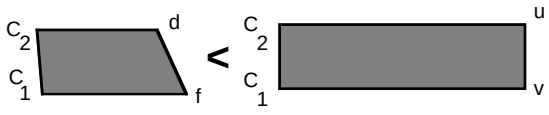
W1 = huC2 + C2uvC1 = huvC1

Difference in Welfare:
W1 - Wo = euvf

Note That the winning bidder gets to keep C2dfC1 under the revenue maximizing privatization scheme,

PmefC1 - abdC2 = C2dfC1 .

But, it keeps C2uvC1 under welfare maximizing privatization scheme.
As it could also be graphically observed (see below) winning bidder is better off under welfare maximization scheme



arbitrarily close, there is always some $c_2 \in (c_1, p_1^m)$ and by Lemma 2 we have $p_1^* = c_2$.

(ii) It directly follows from Part (I) of this Proposition and the facts that (a) by Lemmas 1 and 2, Firm 1 is the winner under both schemes, and (b) the demand curve it faces, p(q), is downward sloping.

(iii) It directly follows from Parts (I) and (ii) of this Proposition and the facts that (a) by Lemmas 1 and 2, Firm 1 is the winner under both schemes, and (b) the demand curve it faces, p(q), is downward sloping. Q.E.D.

PROPOSITION 2: *Firm 1's profit is larger under the WM scheme; consequently, the producer surplus is larger under the WM scheme.*

Proof: By Proposition 1(I), $p_1^m > p_1^* = c_2$. By Lemma 1, under the RM scheme, Firm 1 wins the auction and ends up paying the amount of profits Firm 2 bids. Thus, Firm 1, charging a monopoly product price, keeps the difference between $\pi_1^m(c_1) - \pi_2^m(c_2)$ (equal to the trapezoid C_2dfC_1 in Figure 2) where π_1^m denotes Firm I's monopoly profits. By Lemma 2, under the WM scheme Firm 1 wins the auction and ends up charging a product price equal to the marginal cost of Firm 2. Obviously, $p_1^* = c_2$ yields some profits for Firm 1; let S denote that profit (equal to the rectangle C_2uvC_1 in Figure 2). Thus, we need to compare S to $\pi_1^m(c_1) - \pi_2^m(c_2)$, and Lemma 3 in the Appendix establishes that S is greater than $\pi_1^m(c_1) - \pi_2^m(c_2)$. Since, an increase in profit is an increase in producer surplus, the WM scheme entails a higher producer surplus than the RM scheme does.

Q.E.D.

PROPOSITION 3: *The WM scheme Pareto-dominates the RM scheme.*

It immediately follows from Proposition 1(iii) and Proposition 2.

In order to reach a lower cost $c' < c_1$, Firm 1 has to go through a process invention which requires some resources. Suppose, that in order to achieve such a cost reduction, the firm must commit an initial investment of r amount of resources. Then, if there are two situations such that Firm 1 obtains a higher increase in profits due to that cost reduction in one case than in the other case, then one would say that Firm 1 has more incentives to undergo the required process invention in the former rather than in the latter case; this is because, after the cost reduction, when Firm 1 earns

additional profits more than r in the former case it might not earn that much in the latter case. Our last result states that Firm 1 would earn more due to cost reduction under the WM scheme than under the RM scheme. Thus,

PROPOSITION 4: *There is more incentives for process invention under the WM scheme.*

The proof of Proposition 4 mimics that of Lemma 3 in the Appendix (to see that, one only needs to replace c_1 by c' and c_2 by c_1 in that proof).

IV. CONCLUDING REMARKS

Demsetz (1969) in his seminal article challenged the basic intellectual arguments for believing that truly effective public utility regulation is desirable. As an alternative to regulation, Demsetz (1969) proposed that the franchise be awarded annually to the competitor that offers supplying the product or service at the lowest price. As one can see, the privatization scheme we propose is in the spirit of Demsetz's franchising idea. However, franchising idea is not without criticisms. These criticisms apply in the context of public utility regulation; they mostly stem from the presence of the periodical renewal of the franchising contract. However, they do not apply in the context of our privatization scheme since our framework does not entail any such renewal.

Demsetz's franchising idea is more of a conjecture since, although he argued very rigorously that such a franchising would be desirable for the society, he did not use a formal model to show that. We make his idea precise in a context where it can work without the difficulties it would entail in the repeated setting of its intended context of public utilities. But first we will review some of those difficulties suggested by the critics of the franchising idea in the context of public utilities.

Vickers and Yarrow (1988) suggest that although such franchising could be successful in a number of fields, there are many industries where franchising can not work. They mention several difficulties. The first one is the classical "collusion" difficulty that any auction might encounter. But as Demsetz (1969, p. 59) puts it "... there seems to be no clear evidence that cost of colluding is significantly lower than it is for industries for which unregulated market competition seems to work."

The second source of difficulty is that the current holder of a franchise might enjoy a strategic advantage when the franchise is up for renewal since as a consequence of the experience gained from

its past operation of the franchise, the incumbent firm has a better cost reduction opportunity. Consequently, the future franchise is worth more to the incumbent firm than it is to other firms. This fact might deter the others from entering the renewal auction.

Even if we asume that all bidders are equal at each period, the government still faces the problem of setting the "correct value" on the assets of the incumbent so that they could be transferred to the winning bidder. The government would have to audit and look into the accounting records of original costs of the incumbent since an independent market value on the specialized property of the franchise can not be established. Consequently, the original franchisee may rig the prices (Williamson, 1976; p. 85-86) or overinvest (leading to the Averch-Johnson effect mentioned below). Government's efforts in dealing with these problems of franchise-bidding necessarily calls for some form of regulation; and then, Demsetz's proposal of substituting regulation with franchise-bidding is not perfect.

Suppose the government does not get involved in the problem of asset handover, and suppose the incumbent operator of the franchise (call it A) has been defeated in the renewal auction. As Vickers and Yarrow (1988) put it “Unless sunk costs are zero (an extremely unlikely event) efficiency requires that B, the new operator of the franchise, takes over these assets from A. Otherwise there will be inefficient duplication of these assets. But how are the assets to be valued for this purpose? Here there is a problem of bilateral monopoly. If A had no alternative, it would accept as little as the scrap value of the assets. If B had no alternative, it would pay as much as their replacement value. The gap between replacement value and the scrap value is likely to be largest if the assets involve sunk costs, and the expense of bargaining or arbitration regarding the appropriate transfer price might be considerable.” (Vickers and Yarrow (1988), p.112)

Another source of incumbent advantages is that the incumbent operator of the franchise may be more likely to have superior knowledge of cost and demand conditions. Thus, if another firm outbids the incumbent, it is likely that it has bid too much (the `winners curse’).

As mentioned before, regulation can be ineffective in general and it can also have undesirable indirect effects. Firms are much better informed than the regulators about cost and demand

conditions, especially in the short run. Over time the regulators may overcome this information disadvantage to some extent; but in our framework the regulators will not be needed in the medium- and long-run. If the regulators impose a low price, the firm might claim that it does not cover its costs and thus refuse to supply at that price. In that case, the regulators, not knowing the firm's exact costs, may impose a higher price which might lead to positive profits. Instead of such a price-cap regulation, the regulators then might revert to rate-of-return regulation which allows a fair rate of return on capital (since it is easier to measure the accounting cost of capital of the firm rather than all of its economic costs). Then the well-known **Averch-Johnson (or A-J) effect** is the undesirable indirect effect: the regulated firm has an incentive to overinvest in capital in order to achieve a greater absolute profit (known as the Type I A-J effect), and given an opportunity to choose what market (or markets) to serve the regulated firm has an incentive to expand operations into marginally attractive markets as long as regulation can be counted on to cover the costs (known as the Type II A-J effect). Besides, collusion between the firm and the regulators is not inconceivable.

What would happen if the interim period were several years and it became impossible for Firm 1 to cover its costs at the price p_1*? To prevent such cases, Littlechild (1983)'s RPI-X formula can be applied (RPI is the retail price index [i.e., the rate of inflation] and X is a number specified by the government). The most significant practical problem seems to be to apply our framework to a multiple-commodity SOE, or to one that allows for price discrimination. If it is possible to separate those activities, and identify market segments with respect to elasticities of demand without causing any efficiency loss, then those activities should be auctioned separately. If not, the firms that want to acquire the SOE should bid a vector of prices. If a firm uniformly offers a lower price for each commodity (or submarket) then that firm acquires the privatized SOE. If no firm can offer a lower price for each commodity and/or market segment, then weights can be assigned to the various activities: whichever firm offers the lowest aggregate (weighted) price acquires the privatized SOE.

APPENDIX

LEMMA 3: *S is greater than* $\pi_1^m(c_1) - \pi_2^m(c_2)$.

Proof: First, consider the RM scheme:

$\pi_i^m(c_i) = [(a-c_i)-bq_i^m]q_i^m$

$MR_i^m = a-2bq_i^m$

$c_i = MR_i^m$ yields $q_i^m = [(a-c_i)/2b]$, and thus $\pi_i^m(c_i) = (a-c_i)^2/4b$.

Since $c_2 > c_1$, $\pi_1^m(c_1) - \pi_2^m(c_2) = [(a-c_1)^2-(a-c_2)^2]/4b$.

Now consider the WM scheme. We have $p_1^* = c_2$ and $p_1^* = a-bq^*$, thus, $q^* = [(a-c_2)/b]$.

Then, $S = (c_2-c_1)[(a-c_2)/b]$.

We want to show that $S = (c_2-c_1)(a-c_2)/b > [(a-c_1)^2-(a-c_2)^2]/4b = \pi_1^m(c_1) - \pi_2^m(c_2)$ which reduces to $1 > [(a-c_1)^2 - 4(a-c_2)(c_2-c_1)]/(a-c_2)^2$.

Let, $a-c_1 = \alpha$, $a-c_2 = \beta$, $c_2-c_1 = \gamma$, where $\alpha, \beta, \gamma > 0$. Note that $\alpha = \beta + \gamma$.

Then, $1 > [(a-c_1)^2 - 4(a-c_2)(c_2-c_1)]/(a-c_2)^2$ becomes $1 > (\alpha^2 - 4\beta\gamma)/\beta^2$.

We will finish this proof by forcing a contradiction. Thus, instead of $1 > (\alpha^2 - 4\beta\gamma)/\beta^2$, suppose that

$1 \leq (\alpha^2 - 4\beta\gamma)/\beta^2$. Then we have, $\beta^2 \leq (\alpha^2 - 4\beta\gamma)$.

Since $\alpha^2 = (\beta + \gamma)^2 = \beta^2 + 2\beta\gamma + \gamma^2$, we obtain, $\beta^2 \leq (\beta - \gamma)^2$.

But, since $\beta = (\alpha - \gamma)$, we get $0 \leq -\gamma$, a contradiction since $\gamma > 0$ by assumption. Therefore, $S > \pi_1^m(c_1) - \pi_2^m(c_2)$.

Q.E.D.

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