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Privatisation and Market Structure in a Transition Economy

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1 Introduction

In the transition economies of Central and Eastern Europe and the former Soviet Union privatisation has taken place by a variety of methods (see, e.g., Estrin, 1994, Brada, 1996). Following the examples of the Czech Republic and Russia, the most common method (used or proposed) has been voucher, or mass, privatisation. However, Germany privatised the bulk of its state owned enterprises (SOEs) by sale and Hungary has relied on sale to foreign investors. Moreover, from 1995 onwards the Czech and Slovak Republics, Russia and several other countries have switched emphasis to privatisation by sale (EBRD, 1996). In many of these privatisations the state has kept a significant share in the ownership of firms, e.g., in telecommunications and petrochemicals in the Czech Republic and in regional electricity distribution in Hungary. This 'participation' model of sale, which is the subject of the present paper, has been forcefully advocated by Sinn and Sinn (1991) and Bolton and Roland (1992). It has also been analysed formally by Demougin and Sinn (1994), on whose work we build.

In this model, privatisation is undertaken with two objectives in mind: to bring about investment in the modernization of firms and to generate revenue for the state. The investment is required because of decades of poor technological and organisational achievement under communism and then of underinvestment and neglect after the fall of communism (EBRD, 1995). State revenue is a critical factor largely because profit tax revenue has collapsed. At the same time, there has been a substantial rise in some spending needs, particularly for the provision of a social safety net (Blanchard, 1994; Coricelli, 1996).[1]

Unlike Demougin and Sinn, who focus on risk-sharing, we do not allow for uncertainty. This simplification allows us to introduce several other considerations into the analysis. First, in previous theoretical work it does not seem to have been taken into account that the firms being sold may compete against one another in the product market. Yet, both the amount that a buyer is willing to pay for a firm and the willingness of the buyer then to invest in the reorganisation of the firm will depend on how competitive the product market is. In our model this is recognised by supposing that an industry of N firms is being privatised, where $N \geq 1$. The buyer of each firm is assumed to make an investment in its reorganisation before production takes place, after which firms play a Cournot production game.

Second, we assume that investment by the new private owner of a firm involves the allocation of resources in a way that may be unobservable and noncontractible. In contrast, Demougin and Sinn assume for most of their analysis that there is contractibility, with the amount of investment the buyer will make specified in the contract when the firm is bought. This corresponds to the investment targets that were set for buyers of German SOEs and which have recently been specified in Estonia and the Slovak Republic (EBRD, 1996). However, as Brada (1996) notes, it is claimed that 20% of buyers of German SOEs have not met their contractual obligations. Also, as Demougin and Sinn themselves point out, a government will be unable to observe the real cost to a company of transferring managerial know-how to an acquired firm, for this depends on the managers' alternative occupations. In our model the amount of investment is chosen freely by the buyer and may not be observable to outsiders. Thus, we suppose that the full cost of investment is borne by the buyer. The government's participation in the firm relates only to the share it takes of production profit (the government is a sleeping partner). This participation may be interpreted as ownership or as a cash-flow tax. A cash flow-tax may be less open to abuse than a profit tax would be.[2]

Third, we investigate two different forms of reorganisational investment. One form updates methods, reducing marginal cost for a good that is already in production. The other form creates capacity to produce a new output, e.g., as Volkswagen has created capacity in Skoda to produce cars of, for Skoda, a previously unachieved quality. For the latter form of investment we also allow for the possibility that the good is internationally traded, with producers facing a horizontal demand curve.

Fourth, we allow for the possibility that any potential buyer of a firm may be financially constrained. This is to reflect the fact that in transition economies the main source of investment funds, domestic savings, has declined sharply in real terms, while the fragility of the banking sector undermines savings mobilization and financial intermediation. Although there has been a recent increase in sales of firms to foreign companies, this has been concentrated in a few of the transition economies and in particular market segments (EBRD, 1996). Furthermore, foreign companies also have limits on the funds they have available.[3] In our model the finance constraint plays two potential roles. It may prevent a buyer from paying the amount the firm is worth; and given the amount it pays for the firm, the buyer may have insufficient access to funds to raise the amount of reorganisation investment to the profit-maximising level.

We use the model to analyse how big a stake the state should keep in the industry. We examine how this is related to the number of firms in the industry, the form of reorganizational investment, the amount of finance available and the prospects of the industry. The prospects relate both to the supply side, in terms of how effective the investment is, and to the demand side, including whether the good is internationally traded. The model is set up in Section 2 and solved in Section 3 for the basic case, in which finance is unconstrained. Section 4 sketches more briefly the effects of a shortage of finance, and Section 5 introduces some further modifications. Section 6 gives concluding comments. An Appendix provides proofs of propositions and deals with technical points.

2 The Basic Model

There are $N \geq 1$ firms in an industry producing a homogeneous good. All the firms are state-owned; there is no production of the good by the *de novo* sector and no foreign trade in the good. The firms may have been subject to some limited restructuring.[4] They are simultaneously sold into the private sector, where the number of potential buyers is large relative to N.[5] The timing of the model is as follows.

- Decision Stage The government specifies the share $1-s$ that it will take from the profits earned by the firms in the production stage; $1 > s > 0$.
- Sales Stage The government then sells each firm for a cash price P and a share $1-s$. Given s, competitive bidding for each firm determines P.[6]
- Investment Stage The buyer of any firm j then invests a non-negative amount i_j ($j = 1, 2, \ldots, N$).
- Production Stage Finally, the firms play a Cournot game. Each firm j produces output q_j.

Once the firms are sold, the state takes no part in investment or production decisions. Investment is likely to be multi-dimensional, making the writing of a complete contract extremely costly and difficult to enforce. We therefore assume that investment by the new private owner (for short, 'the owner') is noncontractible. Nonetheless, the government can affect investment through its choice of s.

As we shall be considering symmetric equilibria we shall henceforth omit firm subscripts. At the production stage the industry faces the demand curve,

$$p = A - bNq, \quad A > 0, \quad b > 0, \tag{1}$$

where p is the unit price of the good and A and b are constants. Firms play a Cournot game at this stage, with each one generating a gross production profit Π. The characterization of this game depends on the form that the reorganization investment takes. We shall return to this below.

Denote the net profit accruing to the owner of a firm, for the investment and production stages combined, by

$$\pi = s\Pi - i. \tag{2}$$

This is net of the share $1-s$ of gross production profit that goes to the government. The unit cost of investment is normalized at unity. For any given level of i by a firm, the resulting level of its π depends on the amount of investment by other firms. Given s, the owner of each firm chooses i to maximise π, treating investment by other firms as constant. Denote the firm's investment in the resulting Nash equilibrium by $i^*(s)$ and the corresponding value of π by $\pi^*(s)$. Competition between the potential buyers forces the price P paid for a firm up to the level at which it squeezes out all rent for the new owner:

$$P = \pi^*(s) \tag{3}$$

Going back to the decision stage, the government chooses s optimally, taking into account what will happen in the three succeeding stages. It wishes to maximise the concave welfare function

$$w = W(R, CS), \tag{4}$$

where government revenue R is given by

$$R = N[P + (1-s)\Pi] \tag{5}$$

and CS is consumer surplus, which, using (1), is given by

$$CS = b(Nq)^2/2. \tag{6}$$

Since CS is increasing in i in the model, (4) is equivalent to $w = W(R, i)$. We do not include profit as a separate argument of W because, in the solution to the model, π accrues to the government as the price P paid for the firm and so is already taken into account through the appearance of R in (4).

Finally, we distinguish two cases, corresponding to the two forms that reorganisational investment may take. First, suppose investment is in cost reduction (Case CR). In this case, we assume that, given the amount of investment i by a firm, it has a constant unit cost of goods production c, where

$$c = C(i), \quad C'(i) < 0, \quad C''(i) > 0. \tag{7}$$

We write $C(0) \equiv \bar{C}$ and assume that $A > \bar{C} > 0$. Given i, the equilibrium of the ensuing Cournot production game yields

$$\begin{aligned} q &= \{A - C[i(s)]\} / b(N+1), \\ \Pi &= q^2. \end{aligned} \tag{8}$$

Alternatively, investment may be in capacity expansion (Case CE):

$$\bar{q} = Q(i), \quad Q'(i) > 0, \quad Q''(i) < 0, \tag{9}$$

where $\bar{q}$ is a firm's output capacity. We assume that in this case unit cost c is constant and the same for all firms ($c > A$). In the solution, each firm will only install capacity that will be fully used in the production stage. Analytically, the investment and production stages therefore collapse into one stage. For each firm,

$$\begin{aligned} q &= Q[i(s)], \\ \Pi &= \{A - bNQ[i(s)] - c\} Q[i(s)]. \end{aligned} \tag{10}$$

In the Nash equilibrium each firm sets $i = i^*(s)$ to maximise (2) subject to (10). As a subcase, we can accommodate the assumption of free international trade in the good at the given unit price by supposing that $b = 0$. Then, from (1) and (10), $p = A$ and $\pi = (A - c)Q[i^*(s)]$.[7]

3 Solution of the Basic Model

3.1 Investment in Cost Reduction (CR)

Assuming first that investment is in cost reduction, we begin by finding the (symmetric) Nash equilibrium investment $i = i^*$ in each firm. It is taken into account in finding i^* that production will then be a Cournot game as represented by equation (8), with unit production costs depending on i. In considering the investment stage we can disregard the price P paid for the firm because this is a by-gone. In the Nash equilibrium, i is chosen to maximise π, as defined by (2), given s and subject to (8). The f.o.c. for an internal solution is

$$[A - C(i^*)]\, C'(i^*) = \frac{-b^2(N+1)^2}{2Ns}. \tag{11}$$

We assume throughout that for all $i \geq 0$

$$\phi \equiv [A - C(i)]\, C''(i) - [C'(i)]^2 > 0. \tag{12}$$

This ensures that $d^2\pi/di^2 < 0$, so that the π-maximum is unique.

Firms will invest if the private ownership parameter s is sufficiently large. It is shown in the Appendix that $i^* > 0$ if $s > s_0$, where

$$s_0 = \frac{-b^2(N+1)^2}{2NC'(0)\left(A - \bar{C}\right)}. \tag{13}$$

If, however, $s \leq s_0$, firms set $i^* = 0$. From (11) it is found that

$$\frac{di^*}{ds} = \begin{cases} -[A - C(i^*)]C'(i^*)/s\phi > 0 & \text{for } s > s_0, \\ 0 & \text{for } s \leq s_0. \end{cases} \tag{14}$$

Thus, if the share of production profit Π going to the owner of the firm is large enough to induce positive investment, a higher share induces more investment. Also, note from (11) that i^* is increasing in N for $s > s_0$.

We now go back to the decision stage. In choosing s the government takes into account what will happen in the three succeeding stages. We assume first that the government chooses s to maximise revenue.

Proposition 1 *When investment is in cost reduction, revenue R is maximised by setting $s = \bar{s}_R$:*

(i) $\bar{s}_R = 1/N$ if $s_0 < 1/N$;

(ii) $\bar{s}_R \in (0, \min\{s_0, 1\}]$ if $s_0 \geq 1/N$.

When $s_0 < 1/N$, if the industry is a monopoly the government should not take any share of production profit $(1 - s = 0)$. Rather, it should extract the largest possible price for the firm. With a duopoly, the government should take a 50% share, while for an industry with three or more firms it should take a majority share. Conclusions are different, however, if $s_0 \geq 1/N$, in which case we can only narrow the solution down to a range of s values, with an upper limit of $\min\{s_0, 1\}$. Before noting the conditions that determine whether $s_0 \gtreqless 1/N$, we illustrate Proposition 1 diagrammatically.

In each panel of Figure 1 PC denotes the 'participation constraint', which is the locus of (s, P)-combinations such that (3) is satisfied. For any given s, we denote the corresponding P that exactly satisfies this constraint by $P(s)$. Above (below) PC, $P > (<) \pi$. Also using (2), (8) and (11), the slope of PC is

$$\text{PC}: \quad \frac{dP}{ds} = \left[\frac{A - C(i^*)}{b(N+1)}\right]^2 - \left(\frac{N-1}{N}\right)\frac{di^*}{ds}. \tag{15}$$

[Fig.1 about here]

In each panel there are two distinct segments of PC. For $s \leq s_0$, $i^* = 0$ and PC is an upward-sloping straight line: a higher private ownership share s raises π proportionately, and $P(s)$ rises correspondingly. For $s > s_0$, $i^* > 0$, and the dependence of i^* on s introduces curvature into PC.[8] When $N = 1$, the curved segment of PC has positive slope; but, for $N \geq 2$, the slope cannot generally be signed. This is because the slope depends on a combination of two factors. First, as shown by the first term on the r.h.s. of (15), the direct effect of an increase in s, holding i constant, is for π to rise, as therefore does $P(s)$. Second, however, as shown by the second term on the r.h.s. of (15), the 'indirect' effect of a higher s is that investment rises, and this reduces π, lowering $P(s)$. For any s, given that $N \geq 2$, competitive investment by each firm reduces π below the maximum that could be achieved through collusive investment. The yet higher investment resulting from a higher s has a further negative effect on π, and so on $P(s)$.

Iso-revenue loci are illustrated in the figure by the dashed lines. These are found from (5), (8) and (11), and have slope

$$\text{RR}: \quad \frac{dP}{ds} = \left[\frac{A - C(i^*)}{N+1}\right]^2 - \frac{1}{N}\left(\frac{1-s}{s}\right)\frac{di^*}{ds}. \tag{16}$$

Higher loci represent more revenue. The loci are upward-sloping straight lines for $s \leq s_0$, but curve for $s > s_0$.

For any s, competition between potential buyers will always bid P up such that the solution is on PC. Comparing (15) and (16), for $s > s_0$ the slope of $PC \gtreqless$ the slope of RR as $s \lesseqgtr 1/N$. Hence in panel (i) there is a unique R-maximising solution, $\bar{s}_R = 1/N$. In panel (ii) the highest RR-locus that can be reached is coincident with the straight-line segment of PC. Thus, $\bar{s}_R \in (0, s_0]$. To examine the conditions that underlie whether panel (i), with its positive-i^* solution, or panel (ii), with its zero-i^* solution, applies, consider the determinants of s_0. From (13), $s_0 < 1/N$ is more likely if (a) N is small, so that the markup of the goods price enables a large pay-off to any given investment; (b) $A - \bar{C}$ is large, i.e., the markup for a given N is large; and (c) $|C'(0)|$ is large, i.e., the unit cost reduction caused by the first unit of investment is large. Roughly speaking, if $s_0 \geq 1/N$ firms have (or the firm has) poor prospects. Even then however, given that $s > 0$ (i.e., that there is some transfer of ownership), $P > 0$ in the solution: the government should not give firms away and rely on its profit share for revenue.[9]

Intuitively, part (i) of the proposition can be justified as follows. At the investment stage a firm chooses i to maximise $\pi = s\Pi - i$. If the government were choosing i for the firm it would do so to maximise R, which, using (2), (3) and (5), reduces to the maximisation of $N(\Pi - i)$. When $N = 1$, the maximisation problems of the firm and government can therefore be made equivalent by setting $s = 1$, which is the first-best solution. When $N = 2$, however, this equivalence cannot be obtained, given that the two firms are investing non-collusively. If the government were to set $s = 1$ in this case, competition between the firms would cause them to invest (and produce) in excess of the collusive equilibrium. There is no value of s at which the first-best solution is reached, but the government can achieve a second-best by reducing s below 1 (specifically to $s = 1/2$), causing investment (and output) to fall towards the first-best level. This result comes about because competition between firms is, in itself, harmful from the point of view of government revenue.[10] It is reinforced by the problem that investment duplication is wasteful in the sense that any given amount of investment funds could be used to create the biggest reduction in unit production costs if all the investment were made in a single firm. Similar considerations apply for $N = 3, 4, \cdots$.

We now modify Proposition 1 to allow for the more general welfare function $W(R, CS)$. Note that, given the value of s, i^* is determined, as consequently are R and CS; the marginal rate of substitution W_{CS}/W_R is therefore obtained.

Proposition 2 *When investment is in cost reduction, welfare $W(R, CS)$ is maximised by setting $s = \tilde{s}$:*

(i) $\tilde{s} = \min\left\{\frac{1}{N} + \frac{b}{2}\frac{W_{CS}}{W_R}, 1\right\}$ *if* $s_0 < \frac{1}{N} + \frac{b}{2}\left(\frac{W_{CS}}{W_R}\right)_0$,

where $\left(\frac{W_{CS}}{W_R}\right)_0$ *is the value of* $\frac{W_{CS}}{W_R}$ *when* $s = s_0$;

(ii) $0 < \tilde{s} \leq \min\{s_0, 1\}$ *otherwise.*

To explain Proposition 2 intuitively, suppose first that the government wishes to maximise CS. From (8), equilibrium output in each firm is increasing in i. Since i is non-decreasing in s (eq.(14)), but $s \leq 1$, it follows that CS is maximised at $s = 1$ (though this is only a unique solution if $s_0 < 1$). In Proposition 2, however, we have the government valuing both R and CS, so that the optimum s is essentially a compromise between the R-maximising s and the CS-maximising s: $1 \geq \bar{s} \geq \bar{s}_R$. Unlike in Proposition 1(i), the value of $\bar{s}$ in Proposition 2(i) depends not just on N, but, through W_{CS}/W_R, on all the parameters of the model. When part (i) of Proposition 2 applies, if the industry is a monopoly the government should transfer 100% of ownership to the private buyer, regardless of the specific form of W. For a duopoly, between 50% and 100% should be transferred, the appropriate percentage depending on W_{CS}/W_R. For higher N the value of $\bar{s}$ is smaller. Suppose, e.g., that $W = R + CS$, so that $W_{CS}/W_R = 1$, and that $b = 1$. From (16), if $N = 1$ or 2 then $\bar{s} = 1$; if $N = 3$, $\bar{s} = 5/6$; if $N = 4$, $\bar{s} = 3/4$; as $N \to \infty$, $\bar{s} \to 1/2$.[11]

Proposition 2 can also be illustrated diagrammatically by reference to the participation constraint and iso-W curves. From (4), (8), (9) and (11) an iso-W curve has slope,

$$\text{WW}: \quad \frac{dP}{ds} = \left[\frac{A - C(i^*)}{b(N+1)}\right]^2 - \frac{1}{2Ns}\left[2(1-s) + N\frac{W_{cs}}{W_R}\right]\frac{di^*}{ds}. \tag{17}$$

Suppose first that a positive-i^* solution holds ($\bar{s} > s_0$). Equating the slopes of PC and WW we obtain the value of s shown in part (i) of the proposition. If this value of s exceeds unity, we have a corner solution $s = 1$. Apart from this qualification, panel (i) of Figure 1 applies in this case, but with the RR loci relabelled WW and $1/N$ relabelled $1/N + \frac{1}{2}W_{cs}/W_R$. With similar relabelling, panel (ii) of Figure 1 depicts part (ii) of Proposition 2. This case occurs if, at $(s_0, P(s_0))$, the slope of the curved segment of PC is less than the slope of the curved segment of WW.

Then, $i^* = 0$ in the solution.

Finally, note that in some cases the optimum value of s does not depend on the cost function, so the government does not need *ex ante* information on this function. This occurs with a general welfare function if $N = 1$, with a linear welfare function $W = R + CS$ if $N = 1$ or 2 and with either $W = R$ or $W = CS$ for any N. Nonetheless, in all cases bidders need to know the cost function *ex ante*.

3.2 Investment in Capacity Expansion (CE)

We deal more briefly with Case CE because the analysis is similar to that for Case CR. In Case CE unit costs at the production stage are fixed at c for all firms. Investment i is in capacity expansion, with output always set at the capacity level: $q = Q(i)$. The investment and production stages are, in effect, combined, yielding a Nash equilibrium $i = i^*$ in which i is chosen to maximise π, subject to (10) and given the value of s. For an internal solution the f.o.c. is

$$sQ'(i^*)\,[A - c - (N+1)bQ(i^*)] = 1. \tag{18}$$

It is shown in the appendix that $A - c - (N+1)bQ(i^*) > 0$ in this solution, and also that for $i^* > 0$ it is necessary that $s > s_0$, where

$$s_0 = 1/Q'(0)(A - c). \tag{19}$$

If $s \leq s_0$, then $i^* = 0$ and so there is no output. (An industry can be made commercially unviable by a combination of one or more of: a small ownership share s, a small markup $A - c$ and an investment function $Q(i)$ for which the first unit of investment has a relatively low productivity.) From (18),

$$\frac{di^*}{ds} = \begin{cases} \frac{-Q(i^*)[A-c-(N+1)bQ(i^*)]}{s\left\{Q''(i^*)[A-c-(N+1)bQ(i^*)]-b(N+1)[Q'(i^*)]^2\right\}} > 0 & \text{for } s > s_0, \\ 0 & \text{for } s \leq s_0. \end{cases} \tag{20}$$

If $s > s_0$, $di^*/ds > 0$, while i^* is decreasing N.

Parallel to Proposition 1, we have the following:

Proposition 3 *When investment is in capacity expansion, revenue R is maximised by setting $s = \bar{s}_R$:*

$$\bar{s}_R = \frac{A - c - 2NbQ\left[i^*(\bar{s}_R)\right]}{A - c - (N+1)bQ\left[i^*(\bar{s}_R)\right]} \tag{21}$$

Note that if $\bar{s}_R < s_0$, any value of $s \in (0, s_0]$, including $s = \bar{s}_R$, gives the same outcome: investment and output are zero.

From (21), if $N = 1$, $\bar{s}_R = 1$, the same result as that found for Case CR; but, unlike in Case CR, if $N \geq 2$, an explicit solution for $\bar{s}_R$ is not obtained. Nonetheless, using (21) we again find that $\bar{s}_R$ is negatively related to N. The intuition for this result is similar to that given for Case CR. When $N \geq 2$ competition between firms erodes profits, and therefore also government revenue. By setting s below 1 the government induces firms to reduce investment and output towards the collusive outcome, thereby boosting government revenue. It is also found that, for $s > s_0$, $d\bar{s}_R/d(A-c) > 0$ and $d\bar{s}_R/db < 0$. A greater $A - c$ and smaller b each represent greater demand and so greater potential production profit Π. The government then optimally takes a greater share of Π.

Proposition 3 can be illustrated in the same way as Proposition 1. PC and RR-loci can be derived for Case CE that have essentially the same properties for $s > s_0$

(with s_0 redefined) as the corresponding curves in Figure 1. Two amendments to Figure 1 are necessary. First, for $s \leq s_0$, the PC and RR lines in the Figure must be deleted: there is no participation and no revenue. Second, the value of s at which the PC: RR tangency occurs is not (in general) $s = 1/N$.

When we allow for CS in the welfare function we have the following parallel to Proposition 2.

Proposition 4 *When investment is in capacity expansion, welfare $W(R, CS)$ is maximised by setting $s = \tilde{s}$:*

$$\tilde{s} = \min\left\{\frac{A - c - NbQ\left[i^*(\tilde{s}_R)\right]\left(2 - \frac{W_{cs}}{W_R}\right)}{A - c - (N+1)bQ\left[i^*(\tilde{s}_R)\right]}, 1\right\} \geq \tilde{s}_R \qquad (22)$$

The intuition underlying this result is similar to that given for Proposition 2. Since, for $s > s_0$, $di^*/ds > 0$, CS is increasing in s. When CS, as well as R, is valued by the government, there is a rationale for raising s above $\tilde{s}_R$. It must also be taken into account, however, that s cannot exceed 1. The corner solution $\tilde{s} = 1$ may occur for any N. Interestingly, if we take the illustrative welfare function $W = R + CS$, we find from (22) that $\tilde{s} = 1$ for all N. The weight put on CS in this welfare function, and the associated tendency to raise s to the maximum value, outweighs the tendency, if $N \geq 2$, to reduce s below 1 for revenue purposes. However, the urgency with which revenue is generally required in transition economies may make this particular welfare function unrealistic.

For the special case of $b = 0$, with unlimited international trade at price $p = A$, (21) and (22) yield $\tilde{s}_R = \tilde{s} = 1$: regardless of the value of N and of whether CS is included in the welfare function, the government should surrender all ownership.

With the constant output price there is no strategic interaction between firms, so that, in choosing s, the government can consider each firm separately. The argument for restricting s below 1 to limit revenue-damaging competition no longer applies.

Finally, note that, for Case CE in general, the government does not need to know the function $Q(i)$ if any of the following hold: $N = 1$, $W = R + CS$ and $b = 0$. Under any of these circumstances, it should set $s = 1$. Otherwise, however, knowledge of $Q(i)$ is required by the government to set s appropriately.

4 Constrained Finance

In the model of Sections 2 and 3 the new owner of a firm makes 'up-front' payments $P + i$, only receiving a return at the production stage. However, transition economies suffer from severe imperfections in capital markets and sometimes from a general shortage of means of payment. It is therefore of interest to examine how the working of the model is affected if potential bidders for a firm have limited access to finance. To keep our analysis brief, we shall make the simplifying assumption that all potential bidders have the same amount of finance F available.[12] If bidders have formed coalitions, pooling their financial resources, this can be regarded as already reflected in the value of F.

The modifications that must be made to our previous analysis are illustrated in Figure 2 for Case CR (we shall return to Case CE below). The first modification is that price P cannot exceed F. This is represented in the figure by the 'finance constraint' (FC):

$$\text{FC}: \quad P = F. \tag{23}$$

Secondly, we introduce the 'unconstrained investment boundary' (UIB), which is given by

$$\text{UIB}: \quad P + i^*(s) = F. \tag{24}$$

This is the locus of (s, P)-combinations for which, given any P, the investment level $i^*(s)$, as represented by (11), just causes $P + i^*(s)$ to exhaust the finance available.[13] When $s \leq s_0$, $i^*(s) = 0$ and so UIB reduces to $P = F$, i.e. UIB coincides with FC. For $s > s_0$, however, it is found from (14) and (24) that UIB is downward-sloping. At (s, P)-combinations above UIB but below PC, the owner of the firm would like to set $i = i^*(s)$, but has only $F - P < i^*(s)$ available to spend. In this case $i = F - P$. At (s, P)-combinations on or below UIB, $i = i^*(s)$.

[Fig. 2 about here]

The participation constraint PC from Figure 1 is also shown, with the value of s at which it intersects UIB denoted by s_1. Panels (i) and (ii) in the figure show the cases of $s_1 \geq s_0$ and $s_1 < s_0$, respectively. In panel (i) PC intersects the downward-sloping segment of UIB; in (ii) PC intersects the horizontal segment of UIB. In Section 3 PC was derived on the assumption that $i = i^*(s)$; but, now, for $s > s_1$, PC is above UIB and so investment $i^*(s)$ is infeasible. We therefore define a new 'constrained participation constraint', PC′. For $s \leq s_1$ the finance constraint does not bind and so PC′ coincides with PC; but for $s \geq s_1$, $i = F - P < i^*(s)$, causing PC′ to diverge from PC. Using $i = F - P$, (2), (3) and (8), the slope of PC′ where PC′ ≠PC is found to be

$$\mathrm{PC}'(s \geq s_1): \quad \frac{dP}{ds} = -\frac{[A - C(F-P)]}{2sC'(F-P)} > 0. \tag{25}$$

For any s, competitive bidding for firms will now lead to the attainment of a point on whichever is the lower of PC' and FC in the figure.[14]

We can now generalize Proposition 1:

Proposition 5 *When investment is in cost reduction and there is a limit on finance F for each bidder, revenue R is maximised by setting $s = s'_R$ where*

(a) if $s_1 \leq s_0$, $s'_R \in (0, \min\{s_1, 1\}]$;

(b) if $\tilde{s}_R > s_1 > s_0$, $s'_R = s_1$;

(c) otherwise, Proposition 1 holds.

In part (a) of the proposition the condition $s_1 \leq s_0$ can be interpreted as a relatively small F. This is illustrated in Figure 2 (ii). As in part (ii) of Proposition 1, there are multiple solutions for s along PC′ = PC, but the finance constraint imposes a limit F on the price P that can be paid. The range of multiple solutions is therefore more restricted than in Proposition 1. Part (b) of the proposition relates to a relatively larger F, as illustrated in Figure 2 (i). s_1 now exceeds s_0, but, because it is less than $\tilde{s}_R$, the solution in Proposition 1 cannot be achieved. Competitive bidding for a firm ensures that, for any s, P will be given by the lower of PC′ and FC. It is shown in the Appendix that revenue is maximised at $s = s_1$. The limit on finance thus leads to a lower solution value for s ($s'_R < \tilde{s}_R$), i.e., the government should keep a larger ownership share. Finally, part (c) of the proposition relates to the case in which F is large enough not to affect the solution.

It is now a simple matter to allow for CS in the welfare function.

Proposition 6 *When investment is in cost reduction and there is a limit on finance F for each bidder, welfare $W(R, CS)$ is maximised by setting:*

(a) $s = s'_R$ if $s_1 \leq s_0$ or $\hat{s}_R > s_1 > s_0$;

(b) $s = \hat{s}$ otherwise.

This proposition states that if either of the conditions stated in parts (a) and (b) of Proposition 5 hold, then the solution $s = s'_R$, which maximises R, also maximises $W(R, CS)$; otherwise, F does not affect the solution, which is therefore given by Proposition 2. A critical factor underlying the proof of Proposition 5 is that for $s \geq s_1$, PC' slopes upward. Along this segment of PC' a higher s is associated with a higher P, and so, since $i = F - P$, with a lower i. In terms both of R and of CS it is therefore preferable not to raise s above s_1.

Finally, we consider the effect of the limit on finance in Case CE.

Proposition 7 *When investment is in capacity expansion Propositions 5 and 6 still hold except that, if $s_1 \leq s_0$, the industry is not privatized.*

In Case CE Figure 2 again applies except that the straight line section of PC must be deleted in each panel. This has a significant effect on the solution in panel (ii). Here, a solution in which privatization occurs does not exist. For $s \leq s_0$ there are no bidders for firms. For $s > s_0$ competitive bidding pushes P towards F, but as P approaches F the new owner of a firm has no finance left to invest in capacity and so a firm is not worth buying.

Setting $b = 0$, so that there is unlimited international trade at price P does not affect the validity of Proposition 7.

5 Further Discussion

We now consider the effects of changing some of our assumptions. First, suppose that the private owner's investment is contractible with the government. Then another possibility arises: instead of taking a share of production profit Π, the government might take a share of overall profit π (which includes the investment cost): (2) is replaced by

$$\pi = s(\Pi - i). \tag{26}$$

When there is no constraint on finance, if (26) holds, maximisation of π yields a value of i^* that is independent of s. Consequently, whatever $s \in (0, 1]$ is set, the value of i^* is the same as when, with (2) holding (i.e., in the model of the rest of the paper), $s = 1$. However, with (2) holding, we have seen that $s = 1$ is not necessarily the optimum value. It follows that, even if i is contractible, it is sometimes better and never worse to use (2) rather than (26) to determine the government's share. Intuitively, this is because the use of (26) eliminates the government's ability to influence i^*. With constrained finance, however, the government has some leverage over investment even when (26) is used: a rise in s is associated with a higher P, and so reduces the funds $F - P$ that the owner has available for investment. In this case clear cut conclusions cannot be reached on the on the relative merits of (2) and (26).

Secondly, we might introduce the assumption that the government could restrict the price at which firms are sold below the competitive level. With unconstrained finance this would be of no benefit, for nothing that happens after the sales stage is affected by the level of P. When finance is constrained, however, restriction of P, for any given s, can increase investment. In fact, as we show in the Appendix, if the government wishes to maximise revenue it should never restrict P in this way. If, however, it wishes to maximise CS, it should get i raised to the highest feasible level. In terms of Figure 2 this involves moving as far to the right along UIB as is feasible. If UIB cuts the s axis at $\bar{s}$, the government should therefore set $s = \min\{1, \bar{s}\}$. Note that if $s = \bar{s}$ is the solution here, $P = 0$. This conclusion holds for both Case CR and Case CE and is the one situation in our analysis in which the government should give the firm away.

Thirdly we might assume that instead of keeping its share in the ownership of firms, the government gives it away to the general population (voucher privatisation). Thus, the government obtains revenue from the sale of the firms, but the share then accrues to the population. With dispersed ownership, we may assume that the general population does not try and influence firm behaviour. Our analysis could then be reworked, either with (2) or with (26), with three arguments in the welfare function - revenue for the population as a whole, revenue for the government and consumer surplus.

A fourth modification would be to allow for competition from imports or *de novo* firms. However, at least on one interpretation, such competition can be treated as being implicitly taken into account already. We may think of our model as being part of a larger model in which goods are differentiated. Suppose that our privatised firms produce goods with one set of characteristics, while imports and the output of *de novo* firms have other characteristics. Consider a simple differentiated-good model in which the demand for each type of good depends linearly on the set of prices. Given the prices fixed by importers and *de novo* firms, our analysis would still hold. If importers or *de novo* firms reduced their price, however, there would be a vertical fall in the demand curve for the output of the privatised firms. In other words, it would simply cause a reduction in A in eq. (1). Among the consequences would be that s_0 would rise and so a solution with zero investment in Case CR and no privatization in Case CE would be more likely to hold.

6 Concluding Comments

To simplify our analysis, we have disregarded some important factors that might be incorporated into the model in future work. In particular, we have not allowed for uncertainty. Demougin and Sinn emphasise the risk-sharing benefits of state participation in the ownership of privatised firms. By excluding this factor we presumably bias our results against state ownership. Also, we make no allowance for the regulatory regime that might be operated after privatisation.[15]

We have shown, however, that market structure has a significant role to play in the choice of an appropriate privatisation policy. To a large extent, our conclusions are unaffected by whether reorganisational investment occurs in cost reduction or in capacity expansion. Suppose that there are no binding constraints on finance.

Then, provided government revenue is given a large enough weight in the welfare function, the optimum retained ownership share for the state tends to be larger when there are more firms in the industry being privatised. When a (commercially viable) monopoly is privatised, the state should not retain any ownership in our model.

Perhaps the most important way in which domestic demand, cost levels and the effectiveness of investment affect the solution to the model is that if these factors are sufficiently unfavourable, investment in privatised firms can only be induced at the expense of government revenue. For the case of reorganisational investment in capacity expansion, we have also allowed for the effect of international trade, through the assumption that unlimited amounts of an industry's output can be sold at a given price. There is then no strategic interaction between domestic firms and so the government treats each firm as if it were a monopoly: provided the industry is commercially viable, the state should not keep any share in ownership.

A limited availability of finance for potential buyers of firms also has significant effects in the model. Generally speaking, the more the finance is limited, the greater is the ownership share that the state should keep. Suppose, e.g., that an industry is sold off to foreign buyers, perhaps because it requires particular reorganisational skills that are not available domestically. If the foreign buyers have a relatively large amount of finance available, then the state ownership share in this industry should be kept relatively low. However, we are disregarding here the political tensions that may accompany extensive foreign ownership.

7 Appendix

Existence and uniqueness of investment: Case CR. Using (11), define the function $G(i)$ as

$$G(i) = -\frac{2Ns\left[A - C(i)\right]C'(i)}{b^2\left(N+1\right)^2} - 1.$$

As $i \to \infty$, $G(i) \to -1$. Given that $G(i)$ is continuously defined for all $i \geq 0$, a solution must exist if $G(0) > 0$, the condition for which is

$$\left[A - \bar{C}\right]C'(0) > -\frac{b^2(N+1)^2}{2Ns}.$$

The definition of s_0 follows from this condition. To establish uniqueness, it is sufficient to show that $G'(i) < 0$ for all $s > s_0$, i.e.,

$$G'(i) = \frac{-2Ns}{b^2\left(N+1\right)^2}\left\{\left[A - C(i)\right]C''(i) - \left[C'(i)\right]^2\right\} < 0,$$

a necessary condition for which is that $\phi = [A - C(i)]C''(i) - [C'(i)]^2 > 0$.

Proposition 1. (i) Along PC all profit π is bid away. Using (2), (3) and (8) to substitute into (5) gives $R = N\left(\{[A - C(i^*)]/[b(N+1)]\}^2 - i^*\right)$. Differentiating with respect to s and using (11) yields the f.o.c., $N(di^*/ds)\left\{\frac{1}{Ns} - 1\right\} = 0$. Concavity of W ensures that the s.o.c. is satisfied. The corner solution, $s = 1$, can be ruled out because for $s > 1/N$, $dR/ds < 0$. Therefore $\tilde{s}_R = 1/N$ if $s_0 < 1/N$.

(ii) For $s \leq s_0 \leq 1$, $i^*(s) = 0$, so $\pi = s\left[(A - \bar{C})/b(N+1)\right]^2$ and $R = N\left\{(1-s)\left[(A - \bar{C})/b(N+1)\right]^2 + r\right\}$. PC and RR are therefore parallel with slope $(A - \bar{C})/b^2(N+1)^2$, so that the government is indifferent between all points in $(0, \min\{s_0, 1\}]$. Because $s_0 \geq 1/N$, any $s > s_0$ must imply a lower level of revenue (from part (i) of the proof), so the result follows.

Proposition 2. (i) Differentiating (4) and using (2), (3), (5), (6), (8) and (11) gives the f.o.c. for an internal solution $s = 1/N + (b/2)(W_R/W_{CS})$, from which the solution follows. The s.o.c. is satisfied, given that $W(\cdot)$ is concave.

(ii) Totally differentiating (4) when $i = 0$ gives $dP/ds = \left[\left(A - \bar{C}\right)/b(N+1)\right]^2$. The proof then follows as in Proposition 1(ii). By assumption, $s \leq 1$.

Existence and uniqueness of investment: Case CE. Using the f.o.c. (18), define the function $H(i)$ as

$$H(i) = sQ'(i^*)\left[A - c - (N+1)bQ(i^*)\right] - 1.$$

As $i \to \infty$, $H(i) \to -1$. Function $H(i)$ is continuously defined for all $i \geq 0$, so if $H(0) > 0$ a solution must exist. The definition of s_0 follows directly from this. Differentiating $H(i)$ w.r.t to i at i^*,

$$H'(i^*) = s\left\{Q''(i^*)\left[A - c - (N+1)bQ(i^*)\right] - (N+1)b\left(Q'(i^*)\right)^2\right\}.$$

Substituting from (18) gives $H'(i^*) < 0$ and so the solution is unique.

To show that $A - c - (N+1)bQ(i^*) > 0$, note that with production taking place, there is a positive cost to investment. This implies that marginal revenue must be greater than the marginal unit cost c, or $A - 2bNQ(i^*) \geq c$, from which the proof follows.

Proposition 3. Along PC all profit π is bid away. Using (2) , (3) and (10) to substitute into (5), $R = \left(A - bNQ(i^*) - c\right)Q(i^*) - i^*$. Differentiating with respect to s gives the f.o.c. $\left\{\left(A - 2bNQ(i^*) - c\right)Q'(i^*) - 1\right\}(di^*/ds) = 0$. Using (18) to substitute for $Q'(i^*)$ then gives the result. The s.o.c. is satisfied because

W is concave.

Proposition 4. Differentiating (4) w.r.t. s and using (2), (3), (5), (6) and (10) gives the f.o.c.

$$\frac{di^*}{ds}\{[Q'(i^*)(A-c-2bNQ(i^*))-1]W_R+[bNQ(i^*)Q'(i^*)]W_{CS}\}=0.$$

Substituting from (18) and rearranging, the result is obtained. Concavity of W guarantees that the s.o.c. is satisfied. By assumption, $s \leq 1$.

Proposition 5. (a) If $s \leq s_0$, $i^* = 0$. RR and PC curves are parallel (as shown w.r.t. Proposition 1), so R is constant along PC. From Proposition 1, if $s_1 \leq s_0$, R is lower for all $s > s_0$ than for $s \leq s_0$. Therefore, the government is indifferent to any $s'_R \in (0, \min\{s_1, 1\}]$.

(b) Consider first $s \in [s_1, 1]$. In this interval, competitive bidding ensures the firm is on the lower of FC and PC′. Along FC, $F = P$, so that $i = 0$ and therefore, from (8), Π is independent of s and P. From (5), it follows that $dR/ds < 0$. s should therefore be reduced at least to the level at which PC′ intersects FC. Hence, the solution lies along PC′ below FC.

Using $i = F - P$, (2), (3) and (8), along PC′, $s[A - C(F-P)]/b^2(N+1)^2 - F = 0$. Substituting from this equation for s in (5) and also using $i = F - P$ and (8), R is expressed as a function of P, from which

$$\frac{dR}{dP} = 1 + \frac{2[A - C(F-P)]C'(F-P)}{b^2(N+1)^2}.$$

Note that if the constraint F is just loose enough to enable the firm to choose its optimal unconstrained i (i.e., $F = P + i^*(s)$) we have from (11) that if

$s = 1/N$, $[A - C(F-P)]C'(F-P) = -\frac{b^2}{2}(N+1)^2$. Since, for $s > s_0$, when the constraint bites (i.e., $F < P + i^*(s)$) $i < i^*(1/N)$ and also from (12), $d\{[A - C(F-P)]C'(F-P)\}/di > 0$, it follows that $[A - C(F-P)]C'(F-P) < -\frac{b}{2}(N+1)^2$. Hence $dR/dP < 0$, so that on $s \in [s_1, 1]$, R is maximised at $s = s_1$. From Proposition 1, on $s \in (0, s_1]$, R is maximised at $s = s_1$. s_1 is therefore the optimum value of s.

Proposition 6. (a) From the proof of Proposition 5, for $s > s_1$ $dR/dP < 0$, and from (6) and (8) $dCS/dP = N^2[A - C(F-P)]C'(F-P)/b(N+1)^2 < 0$. Therefore, from (2), $dw/dP < 0$. So if $\bar{s}_R > s_1$, welfare is maximised on $s \in [s_1, 1]$ at $s = s_1$. From Proposition 2, $\bar{s} \geq \bar{s}_R$; so if $\bar{s}_R > s_1$, $\bar{s} > s_1$. In the absence of a limit F, $dW/ds > 0$ for $s \in [s_0, \bar{s}]$. But when there is a limit F it has no effect for $s \leq s_1$. Hence, W is maximised on $s \in [s_0, s_1]$ at $s = s_1$.

(b) This follows from Proposition 4.

Proposition 7. First consider Proposition 5. Investment is decreasing in s for $s > s_1$. To show this consider the slope of PC' for Case CE. This is found from (2), (3) and (10):

$$\left.\frac{dP}{ds}\right|_{\pi=0} = \frac{Q(F-P)[A - c - bNQ(F-P)]}{sQ'(F-P)[A - c - 2bNQ(F-P)]} > 0.$$

For $s > s_1$, $i = F - P$. Along PC', $dP/ds > 0$, so $di/ds < 0$. If $\bar{s} > s_1$, s_1 must therefore maximise R over $s \in [s_1, 1]$. For $s \in (s_0, s_1]$, $dR/ds > 0$ (from Proposition 3). $s = s_1$ is therefore the optimum s.

Turning to Proposition 6, from the first part of this proof, for $s > s_1$, $dR/ds < 0$.

Differentiating (6) w.r.t. P gives $dCS/dP = -bN^2Q(F-P)Q'(F-P) < 0$. The proof is then the same as for Proposition 6.

Effect on R of Restricting P. For $s < s_1$ the firm's behaviour is not constrained by a shortage of finance. Any restriction of P below the competitive level reduces R. Suppose that $s \geq s_1$. In Figure 2(i) define loci $PC' - k$, where k is a non-negative constant. It was shown in the proof of Proposition 5 that, for $s \geq s_1$, R is greater as we move to the left on PC'. Along any locus $PC' - k$ the same property applies, so R is greatest at the intersection of the locus with UIB. We have shown in Proposition 5 that along UIB for $s \geq s_1$, R is maximised at $s = s_1$. But at $s = s_1$, the firm is on PC' so there is no restriction of P. This applies for both Case CR and Case CE

8 Notes

1 A major economic objective of privatisation that we do not consider is change in corporate governance and /or managerial motivation. Also, we ignore political objectives such as to make the reform process irreversible. See Estrin (1994) and Dewatripont and Roland (1996).

2 The problem with the cash-flow tax interpretation of the government's share of production profit is that the optimum share turns out to be industry-specific, and so may be impracticable. Nonetheless, it would be possible to combine the two interpretations of the government's share, with a uniform cash-flow tax imposed on all industries, together with a government ownership share that varies across industries.

3 E.g., Volkswagen was credit-constrained in its investment in Skoda (Sinn And Weichenreider, 1997).

4 Grosfeld and Roland (1995) distinguish 'defensive' restructuring, which is restricted to labour-shedding and downsizing activities, from 'strategic' restructuring, which involves thoughtful business projects and modernisation investments. In practice SOEs have engaged primarily in defensive restructuring. The reorganisation investment that occurs after privatisation in our model may be regarded as strategic.

5 We assume throughout that N is exogenously given. If, instead, N is treated as a choice variable, the obvious results are obtained that government revenue is decreasing in N, while consumer surplus is increasing in N. Another issue that might be examined is that of whether a buyer would wish to purchase more than one firm in the industry. Our results are correct for the case in which each buyer purchases just one firm. If multiple purchases are allowed some modification of our analysis is necessary, depending on the particular

assumptions made, but the general flavour of our results survives. However, an adequate treatment of this problem raises questions that are beyond the scope of the present paper, such as what form the auction of firms should take.

6 We do not allow for discounting and we assume that no output is produced until the production stage. These simplifications do not have significant qualitative effects on the results.

7 If, however, we were to suppose that $b = 0$ in Case CR we would find that firms would wish to produce infinite amounts. We therefore only consider $b = 0$ for Case CE.

8 For the curved segment of PC to increase in slope as s rises, it is sufficient that $C''' > 0$. However, Proposition 1 holds independently of this condition.

9 If the government prefers revenue earlier rather than later, revenue via P is preferable to revenue via $1 - s$. However, this does not necessarily lead to the conclusion that out of the multiple solutions shown in panel (ii), s_0 is the best. Once we take into account time preference for the government we should also take into account time preference for the potential buyers of the firm. This affects the price they are willing to pay and complicates the results considerably.

10 There is a parallel between Proposition 1 and the result obtained by Fershtman and Judd (1987) for strategic delegation under Cournot oligopoly (see also Vickers, 1985). They find that a firm makes more profit if its manager is set a reward function that is increasing in sales as well as profit. Similarly, in our model the government ownership share $1 - s$ diverts a firm from maximization of $\Pi - i$. However, we are concerned with the government's revenue from the industry, which it boosts by effectively imposing some collusion, and this leads to the result that the optimal value of $1 - s$ is increasing in N. In contrast, Fershtman and Judd deal with the point of view of an individual firm, leading to the result that the appropriate diversion from profit-maximisation

(i.e., the optimal weight on sales in the reward function) is decreasing in N.

11 With $W = R + CS$, if $s_0 > \min\{(2+N)/2N, 1\}$ part (ii) of Proposition 2 applies and the solution is $s \in (0, \min\{s_0, 1\}]$, i.e., any allowable s will do.

12 If potential bidders may each have a different F the issue arises of how exactly the auction operates. The resulting complications are beyond the scope of this paper. However, we feel that a brief analysis of the equal-F case gives some useful insights.

13 We assume for simplicity that in the production stage, when variable costs Cq are incurred, a firm pays its bills after sales revenue is received. The rationale for this assumption is as follows. First, the production stage may be regarded as implicitly representing an indefinitely repeated game, with a stream of payments into and out of the firm over time. Thus, out of the cost Cq incurred in the production stage, only a small proportion is payable before revenue is received. To treat this small proportion of Cq as pre-paid in the model would add complications without affecting results significantly. Second, insofar as there is trade credit or wage arrears, the pre-paid portion of Cq would be yet smaller.

14 In general, we cannot say whether, for $s > s_1$, PC' is above or below PC. This is because, for $N \geq 2$, if investment is unconstrained, firms over-invest relative to the collusive equilibrium. In general, for a given $s > s_1$, a constraint on finance that limits investment to some extent may therefore cause π (so also P) to rise; in this case PC' is above PC. Alternatively, a tighter finance constraint may reduce investment to such an extent that π is lower than it would be in the absence of a constraint; in this case PC' is below PC. If $N = 1$, however, PC' is always below PC because the firm never over invests.

15 Another limitation of the model is the assumption that all the firms in an industry are sold simultaneously. There may, however, be advantages from sequential sale. E.g., in a two-firm industry, if the state privatises one firm and allows time for the buyer to make an irreversible investment, before it

privatises the other firm, it will presumably get a 'high' price for the first firm and a 'low' price for the other. It would be interesting to examine the conditions determining whether welfare is higher with this form of sale than the simultaneous form assumed in our model.

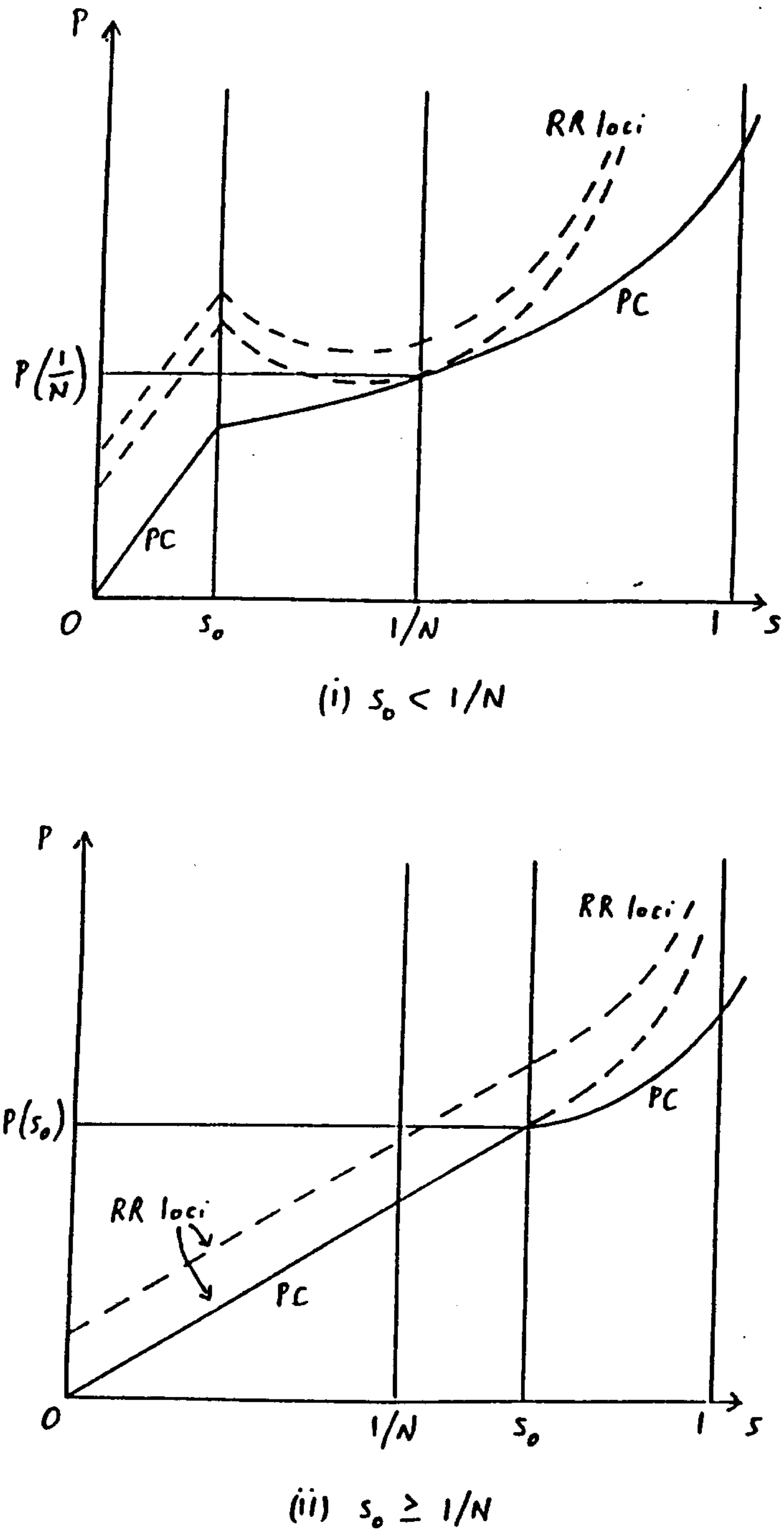

Figure 1. Revenue maximisation

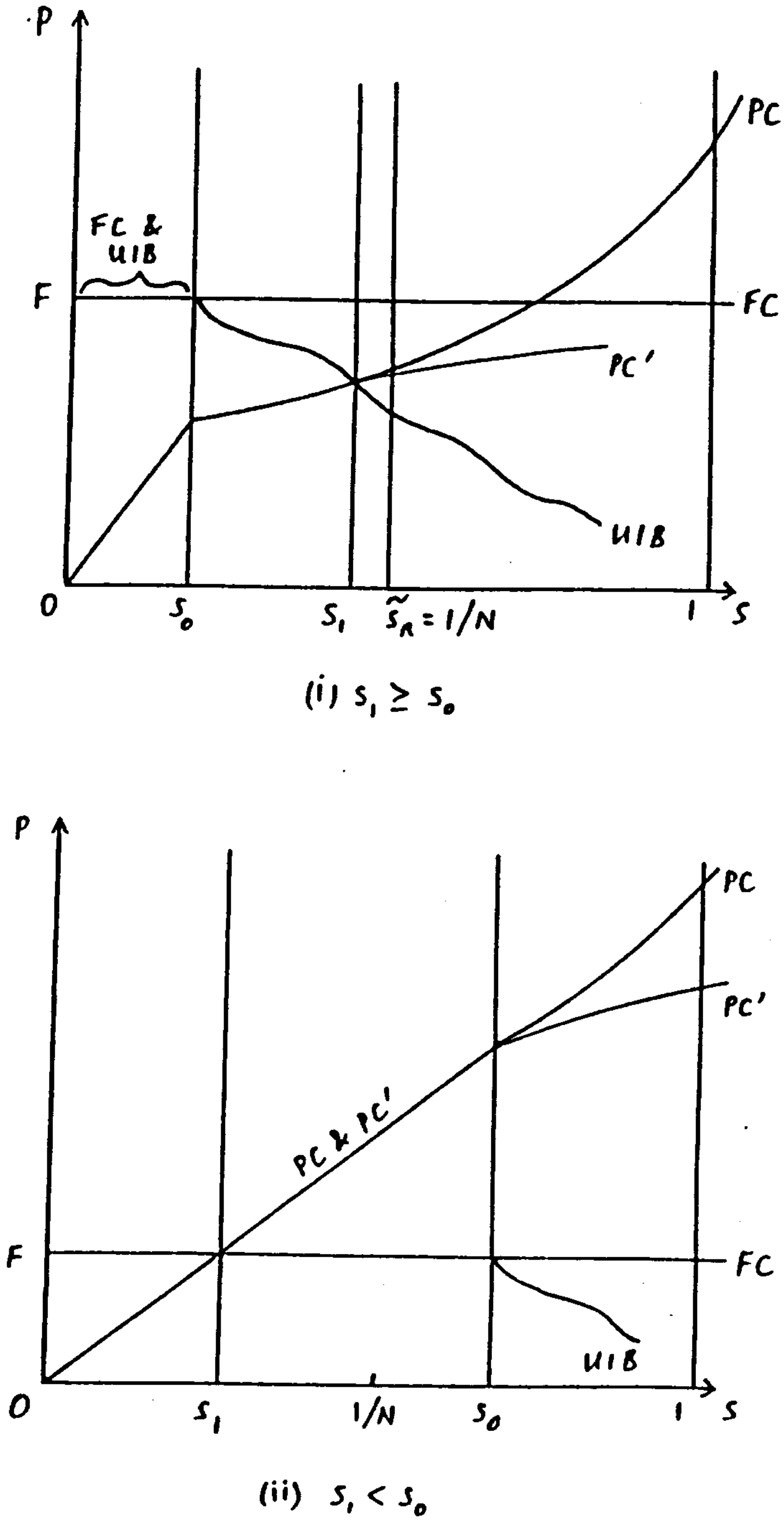

Figure 2. The effect of a shortage of finance

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Privatisation and Market Structure in a Transition Economy*

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Abstract

A model is developed in which an industry of $N \geq 1$ firms is privatised. The 'participation' method of privatisation is used, whereby firms are sold for cash, but the state retains a proportionate share of ownership. In each firm the new private owner has the opportunity to make a reorganisational investment, before output is produced. This investment is unobservable by the state, and therefore noncontractible. There is Cournot competition in the product market. The welfare-maximising retained ownership share for the state is analysed, taking into account that potential buyers of firms may have limited access to finance.

J.E.L. Classification: L33, P21
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