Privatization Under Incomplete Information and Bankruptcy Risk

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Abstract:

We study privatization under moral hazard and adverse selection. We show that if the fraction of efficient investors is either insignificant or productivity differences between efficient and inefficient investors are negligible, the government would offer a pooling contract and sell the same fraction of equity to both types of investors. The lower the productivity difference, the greater the equity stake offered to investors. On the other hand, if the fraction of efficient investors is significant or productivity differentials are large, the optimal policy consists of a dual method of privatization in which it offers two methods of privatization to outside investors. The first method consists of a sale of 100 percent equity together with a subsidy and charges higher price. Under the second option, the investor pays a smaller price but buys less than 100 per cent equity without any subsidy. Efficient investors opt for the first method while inefficient investors prefer the second. The dual privatization method screens investors and provides them with maximum incentives to invest while minimizing the risk of post-privatization bankruptcy.

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Over the last decade, state owned enterprises (SOEs) across the globe were privatized at an unprecedented scale. For example, the cumulative value of proceeds to the governments involved in privatization from 1988 to 1999 totalled more than $1 trillion as reported by Megginson and Netter (2001). Not surprisingly, a number of papers have dealt with important issues of privatization. For example, Perotti (1995) considers a model where partial and gradual sale of equity signals the government's commitment to long-term privatization to incompletely informed investors. Perotti and Biais (2002) show that even if the median class voters favour left-leaning redistributive policies, a strategic privatization that sells shares at a discount to the public may make their preferences shift towards market-oriented policies. Boyacko, Shleifer and Vishny (1996) assert that the process of privatization forces the politicians to pay for the private share of the profits thus increasing the cost of such payment.

Governments, especially in the transition economies, have adopted a number of privatization methods including issuing new shares to the public, auctions and private negotiations[1]. Although privatization, in general, has led to substantial productivity gains, there are many instances where ownership of assets has been transferred to inept and corrupt individuals. As Shleifer and Vishny (1997) point out in the case of Russia,

" *---Managers in many cases are not competent to restructure the privatized firms, yet in virtue of their control rights remain on the job and "consume" the benefits of control.---- ---- The example of Russian privatization vividly illustrates both the benefits and costs of concentrated ownership without legal protection of minority shareholders*." They also cite several instances where the managers of a privatized company resort to unfair

[1] For auction framework, see Cornelli and Li (1997). For the endogenous choice between the auction and private negotiations, see Fluck, John and Ravid (1999). See Chemmanur and Fulghieri (1995) and Laffont and Tirole (1991) for incomplete information from the perspectives of buyers and sellers respectively. For a discussion on risk sharing and privatization, see Demougin and Sinn (1994). For share issue privatizations, see Perotti (1995). See Saunders and Sommariva (1993) for drawing parallels between different forms of swaps and privatization. See Perotti (1993) for post-privatization problems of concentration of risk in bank lending due to bad loans inherited from pre-privatization era.

practices ranging from a substantial increase in their remuneration to playing a Ponzi scheme with the funds raised from outside financial markets. Indeed, the purpose of privatization is not just the sell of an SOE but also to ensure smooth functioning of markets in the post-privatization era. As succinctly put by Szego (1993), "The main problem in the design of a regulatory system is that of targeting each provision to a specific problem, analyzing their relative costs and effectiveness in achieving some specific goals like: (a) maintaining stability and soundness, reducing overall risk; (b) decreasing customer or taxpayer costs in the event of an intermediary's default: (c) improving both market allocational as well as informational efficiency".

Such concerns about privatization give rise to the following important questions:

1. How should the method of privatization distinguish efficient investors from relatively inefficient investors i.e. mitigate the problem of adverse selection.
2. Should the government sell-off 100% equity to private investors or retain fractional ownership or even offer a subsidy to debt financing.
3. How does the government minimize the ex-post moral hazard problem, offer incentives to the investor to make necessary investments and minimize the risk of post-privatization bankruptcy.

In this paper, we address these interrelated issues. We focus on a scenario where the government is attempting to sell one of its units to a single outside investor via *private negotiation*. Megginson and Netter (2001) in an exhaustive survey report that Governments in most of the countries have followed privatization by directly issuing shares to public, issuing of vouchers or sale of assets to private parties. The last approach could take either the form of an auction or private negotiations. Although an optimal design of auction can solve the problems of asymmetric information as the seller (the Government) could obtain the highest bid from a buyer, there are many instances where auction may not be feasible and the government would need to negotiate with a private investor. Such instances include (a) government agents colluding with bidders[2] (b) political constraints, legal and bureaucratic delays in setting up procedures of auction-

[2] See Fluck, John and Ravid (1999) on how collusion between bidders and the government agent that may create distortions, resulting in private negotiations rather than auctions as a dominant mode of privatization in an endogenous manner.

based of privatization[3] (c) restrictions on foreign ownership[4] and (d) small number of investors who could collude among themselves to bid down prices.

Under these circumstances, the government very often sells to the manager (or a manager with a group of outside investors) of the state-owned enterprise via private negotiations rather than auctions. Brada (1996) documents that a fairly large number of privatizations of this type have taken place for small and medium establishments in Hungary, Czech Republic and via the Treuhand in former East Germany and most recently in India (see Table 1)[5].

Hence, in this paper, we analyze privatization via *private negotiation.* We investigate optimality of different methods of privatization through the mechanism design approach under informational constraints that arise due to agency problems[6].

A typical investor, after buying a state-owned enterprise, borrows funds from the external debt market in order to restructure the privatized unit. The Government encounters the following inter-related problems in designing the privatization. First, all investors can divert borrowed funds away from investment in order to augment their personal benefits. This is the agency problem of a pure moral hazard type along the line of Jensen and Meckling (1976). Second, the debt financing aggravates such problems of moral hazard and leads to under-investment. [See Myers (1977)]. Third, an investor can either be efficient or inefficient and hence, the likelihood of bankruptcy in the post

[3] In India, political oppositions together with procedural delays have led to either cancellations or delays in auction based methods of privatizations. For example, two joint bidders, the Tata group and Singapore Airlines, had to walk out from the bidding process of privatization of the state owned Airlines due to political opposition. The privatization was expected to raise $1 billion to Government. (Source, CNN business news 3rd September 2001 and Forbes.com 3rd March 2000,). Similarly, the privatization of oil sector in India via auctions received a jolt when the Supreme Court had ruled that procedures followed in privatization were inappropriate. (See Asia Times, 23rd November, 2003.)

[4] For example, in China direct restrictions are placed on the foreign ownership as different classes of shares are floated for domestic and foreign residents and these shares are not tradable between them.

[5] Using a sample of 1,992 privatizations that raised $720 billion across 92 countries, Megginson and Netter (2001) find that 1225 companies have been sold via private negotiations. Brada (1996) documents that 8700 companies were sold to private investors in Hungary and between 30,000 to 80,000 units in Poland by 1992. These are small companies but nevertheless account for a sizable number of privatizations.

[6] There are a number of related papers that deal with security design. For example, Zender (1991) shows that debt and inside equity serve as optimal financial instrument to resolve the agency problems associated with unobservable investment opportunities. Habib and Johnson (2000) show that outside equity and private placement of debt serve as instruments in the mechanism design problem under asymmetric information. John and John (1993) discuss agency problem of outside debt and equity and show that inclusion of debt parameters, among other variables in the optimal compensation package for CEOs resolve under-investment problems associated with "risk-shifting". Fluck (1998) focused on maturity design and control rights of outside equity.

privatization era will be different across investors. Each investor knows his type but the government only knows the probability distribution of different types of investors and it can neither observe nor can it infer whether a particular investor is efficient or inefficient. This is the source of the adverse selection problem. An efficient investor might try to pay a lower price for buying the state owned unit even though he is able to pay more. Such a possibility arises because the higher the efficiency level of the investor, the higher the expected profitability of the firm and greater is its ability to pay. However, taking advantage of government's incomplete information, a more efficient investor can pose as a less productive one in order to pay a lower price for the transfer of ownership. Similarly an inefficient investor might pay a higher price in order to receive a greater percentage of the ownership. Such manipulations have two adverse effects that we want to address in this paper. First, they cut down the government's revenue and second, by sending noisy signal to credit market about the identity of an investor, they hamper smooth functioning of credit markets. Hence, the primary task of the government is to elicit information from different types of investors and curb their incentives to reduce investments. Faced with these moral hazard and adverse selection constraints, the government has two mutually exclusive options for privatization.

(A) Offer a uniform contract for all types of investors. In this case, the capital market does not obtain any information about different types of investors. (Pooling Equilibrium)

(B) Offer differential contracts for efficient and inefficient types so that the capital market can distinguish between different types of investors who raise funds in the post-privatization era. (Separating Equilibrium)

The first option would address the moral hazard issue while the second would resolve both adverse selection and moral hazard problems. We show that whenever the fraction of efficient investors is either small or the expected productivity gap between efficient and inefficient investor is significantly low, the optimal design of privatization should offer the same contract to each type of investor and the optimal fraction of shares to be retained by the government would depend on the difference between the expected productivities of different types of investors. However, if the fraction of efficient investors or productivity gap is large, the optimal design of privatization should separate

efficient from inefficient investors. Such separation of different types of investors would offer good type investors incentives to invest in an efficient manner and simultaneously enable lenders to distinguish between good and bad investors, which would make post-privatization capital market more efficient leading to a better allocation of scarce resources and appropriate pricing of loans. Under this screening method, the government would offer dual contracts simultaneously. The first contract meant for the efficient investors, would involve an outright sale of 100 percent equity together with a subsidy on risky debt based on the observed cash flows and a *higher price* for the sale of equity. The second contract, meant for the inefficient types, would require the government to retain a fraction of equity with the remainder sold at a lower price. Any investor who opts for this contract will not be eligible for any subsidy. The intuitive reason for the subsidy is that it enhances incentives to invest, leading to an increased value of assets that, in turn, lowers interest costs of financing a project after privatization. This subsidy on the cash flow that depends on investment is not a free lunch because the investor pays a higher price for buying the full ownership of the privatized unit.

We endogenously derive the price and fraction of equity for sale and show that the fraction of equity to be sold to the inefficient investor depends inversely on productivity gap. We also show that such a policy of dual privatization will minimize inefficiencies in investment that follow privatization and mitigate default probabilities of efficient firms. Thus, to avert post-privatization problems, the governments may be well advised to identify efficient investors by offering a choice of ownership (complete or fractional) at different prices and let them raise funds from the market and offer a direct subsidy on the cash flow rather than intervene in the financial markets.

The rest of the paper is organized as follows. In Section I, we introduce the model and outline the constraints imposed on privatizations due to informational frictions. In section II, we analyze the optimal privatization schemes. In section III, we offer concluding remarks.

I. THE MODEL

Let the current cash flow of a private investor who is planning to buy a state-owned firm via private negotiations be (w). The investor also raises an exogenous amount (l) by issuing debt after the purchase of the unit. Hence, the total cash flow available to the private firm at date 0 is equal to ($w + l$). It is used for buying the firm at a price (p), undertaking reorganization investment (k) and current consumption (c^1). Hence, we have the following identity in the first period:

$$w + l = c^1 + k + p \tag{1}$$

In the next time period, the investment (k) will produce a cash flow equal to $y(k) + \theta$ with probability (q) and zero otherwise. In addition, we assume that a part of the investment (δk) is durable and could be converted to cash flow in the next period without any costs. Hence, the expected cash flow from the investment is given by $q[y(k) + \theta] + \delta k$. We introduce the notion of durability of investment for two reasons. First, it captures a realistic feature of the process of investment. Second, a privatized firm could issue a partly secured debt by pledging its fixed assets (investment) as collateral.[7]

Assumptions

1. Throughout the paper, the amount of investment (k) is non-contractible.[8] The private investor decides how much of the surplus fund $(w + l - p)$ to allocate between investment and his personal consumption benefits (c^1). We assume that the investor maximizes his own expected pay-off, while making a choice between current consumption and investment. This is the source of moral hazard in our model. The

[7] If we assume (θ) to be a continuous random variable, all our results would strengthen but it would create unnecessary notational clutter.

[8] Of course, some of the problems can be partially resolved if the government is able to exercise some discretion on investment. However, as long as the private investor retains some control over a part of investment or effort or any other variable that affects either cash flow or investment, all of our results remain intact. For example, we could modify the production function as $y = y(k, e)$ where (e) stands for effort. If the source of moral hazard lies in the choice of effort, then our results would hold even if the government enjoys discretion over investment (k).

optimal privatization program must ensure that investment incentives do not get distorted in the post-privatization era due to the problems of moral hazard.

2. The term (q), which is the probability of a successful completion of the project, also defines the productivity parameter of investor's efficiency in the post-privatization era. We assume that there are two types of investors. The more efficient ones are distributed in the population with the proportion of (γ). Their probability of success in the project is given by (q_1) while the rest $(1-\gamma)$ have a probability of success equal to (q_2) where $q_1 > q_2$. Thus, for the same level of investment, expected cash flow is greater for an investor who has the technology of type (q_1). The investor has private information about his probability of success so that he knows his type. The government, on the other hand, lacks information about individual investors but it knows that efficient and inefficient types are distributed in the population with the proportion of (γ) and $(1-\gamma)$, respectively. This is the source of adverse selection. The presence of both moral hazard (assumption 1) and adverse selection (assumption 2) effectively constrain the design of privatization which governments need to address while formulating an optimal scheme.

3. In order to provide a strong rationale for privatization, we also assume that private investors are more efficient than the government. That is, with government ownership, the technological parameter is (q_0) where $q_1 > q_2 > q_0$. Hence, the expected cash flow ordering is:

$$q_1[y(k)+\theta]+\delta k > q_2[y(k)+\theta]+\delta k > q_0[y(k)+\theta]+\delta k$$

4. The investor borrows funds for the purpose of restructuring the privatized unit in a competitive loan market.

5. All agents - lenders, investors and the government - are risk neutral so that they only care about their expected pay-offs.

Private Investor's Pay-off

The intrinsic uncertainty in the cash flow implies that the privatized firm may go bankrupt if the cash flow is insufficient to repay debt at maturity. Since, the payment of debt is a first priority, the lender would seize cash flow from the un-depreciated part of investment in the event that final output is zero. On the other hand, if the cash flow is positive [i.e $y(k)+\theta>0$], then the investor and government would split the cash flow after debt repayment. Let $(\alpha_{i,} p_i)$ be the share of cash flow to an investor of type (i) and the corresponding price charged for sale of the privatized unit ($i=1,2$). The privatization program would determine optimal values of these variables subject to informational constraints. Therefore, we can view privatization as an optimal contract between an investor and the government.

The expected pay-off of the investor who has a probability of success (q_1) and opts for the contract given by the pair $(\alpha_{1,} p_1)$ is:

$$U_1 = q_1\alpha_1[y(k_{11})+\theta+\delta k_{11}-R_{11}]+(1-q_1).Max\{\delta k_{11}-R_{11},0)+w+l-k_{11}-p_1$$

Suppose there exists a threshold value of $\delta k_{11} \equiv \delta k_{11}^{*}$ such that $R_{11}=\delta k_{11}^{*}$

That leads us to consider two cases:

Case 1: $\delta k_{11}^{*} = R_{11} \le \delta k_{11}$ and Case II $\delta k_{11}^{*} = R_{11} \ge \delta k_{11}$

In case I, the debt is secured even though the project is risky and in case II, the debt is not risk-free. We rule out case I by invoking the assumption that (δ) is not large.[9] Hence, the objective function is,

$$U_1 = q_1\alpha_1[y(k_{11})+\theta+\delta k_{11}-R_{11}]+w+l-k_{11}-p_1 \qquad (2)$$

Similarly, the expected pay-off from the choice $(\alpha_{2,} p_2)$ for an investor with a probability of success (q_2) is:

[9] Under Case I, the analysis is very similar and does not affect our results.

$$U_2 = q_2\alpha_2[y(k_{22}) + \theta + \delta k_{22} - R_{22}] + w + l - k_{22} - p_2 \quad (3)$$

Where, α_i = ith investor's share of the cash flow to be determined endogenously.

k_{ii} = Investment done by the ith investor who has chosen ith type of contract. For example, k_{11} = Investment done by the investor of type (q_1) who has accepted a contract $(\alpha_{1,} p_1)$.

R_{ii} = The maturity value of the loan (l) that consists of both the principal and interest. ($i = 1,2$) for investor of type (i) who has chosen ith type of contract.

Loan Markets

The private investor can raise funds (up to a maximum limit of l) from the competitive financial market. If the privatized firm goes bankrupt, the lender recovers the durable part of investment with a probability of $(1 - q_i)$. On the other hand, if the cash flow is positive, lenders are paid in full. As a result, the maturity value of the debt must be such that the expected return from investing a dollar in the privatized firm should equal the alternative rate of return, which we normalize to zero. Hence, with the assumption of risk-neutral private investors in the financial market, the maturity value of the loan (R_{ii}) will satisfy the following equation:

$$q_i R_{ii} + (1 - q_i)\delta k_{ii} = l \quad (4)$$

The first term of equation (4) captures the maturity value of the loan (principal + interest) in the solvent state, times the probability of success and the second term is what lenders get from the durable capital in the event of failure of the project, multiplied by the probability of failure.[10]

Privatization Program

The privatization program is characterized by two key endogenous variables (p_i) and (α_i), where (p_i) is the price an outside investor will pay for her claim to *ownership of a fraction* (α_i) of the *residual* cash flow $q_i[f(k_{ii}) + \delta k_{ii} - R_{ii}]$ in the event of success.

[10] We assume that $l > k_{ii}$ so that loan is only partly secured.

This approach towards modeling privatization confers a generality because depending on the value of α_i and p_i we have different methods of privatization:

1. $\alpha_i = 1$ *and* $p_i > 0$ corresponds to the case of outright sale of the firm to a private investor via a cash bid of p_i.
2. $0 < \alpha_i < 1$ and $p_i > 0$ captures the situation where the investor pays for a partial ownership.
3. $\alpha_i > 1$ and $p_i > 0$ implies a full ownership with a subsidy on the observed cash flow.

Note that if, in equilibrium, $\alpha_1 = \alpha_2$ and $p_1 = p_2$, then we have a pooling equilibrium, otherwise, we have a separating equilibrium.

Government Objective and Constraint

There could be multiple objectives behind privatization such as employment, ownership distribution, favouring a particular constituency (such as workers) etc. In this paper, we limit the analysis to revenue considerations given the link between privatization, increased efficiency and generation of revenue to the government. Indeed, privatization creates more wealth because outside investors are more efficient than the government. An increase in the level of efficiency leads to higher production at a lower cost, thereby, creating a larger surplus. As a consequence, the government can augment its revenues by charging a higher price to outside investors and thus extract a part of the surplus. Several empirical studies, [see, Megginson (2001)], also show that privatization is an important source of revenue for the government in many emerging economies. Finally, maximization of revenues would help the government pursue other objectives by easing up funds constraint[11]. The government's expected revenue, consisting of sale price of the privatized unit plus its share of the future expected profits, is given by the following equation:

$$E\pi = \gamma[(1-\alpha_1)\{q_1\{y(k_{11}) + \theta + \delta k_{11} - R_{11}\} + p_1] + (1-\gamma)[(1-\alpha_2)\{q_2\{y(k_{22}) + \theta + \delta k_{22} - R_{22}\} + p_2]$$

(5)

Hence, the basic objective of the government is to maximize (5) subject to investors receiving a minimum return that would induce them to participate given the constraints that arise from the presence of adverse selection and moral hazard. Below, we elaborate the nature of these constraints that affect the process of privatization.

The Participation Constraint

The government, while designing any method of privatization must ensure that the terms of the privatization (p_i, α_i) must be lucrative enough to ensure participation of the investor. Hence, the investor's pay-off in privatization should be at least as large as his outside option, which is normalized to zero. Hence, the participation constraint in the privatization program is:

$$U_i = q_i \alpha_i [y(k_{ii}) + \theta + \delta k_{ii} - R_{ii}] + w + l - k_{ii} - p_i \geq 0 \quad (i = 1,2) \qquad (6)$$ [12]

The Incentive Constraints

Adverse Selection

Since the government can not directly control investment and does not observe the efficiency parameter of individual investors, the latter may not reveal information about their type unless they are offered incentives. As an example, efficient firms are able to pay a higher price since they generate larger surplus. However, investors of such firms may claim to be less efficient in order to pay a lower price that results in loss of government's expected revenue. On the other hand, the government may want to offer a larger share of the cash flow to the more efficient type so that they tend to invest more, which in turn, may cause the inefficient type of investors to grab such contracts. Hence, the terms of privatization program (α, p) must offer incentives to each type of investor to truthfully announce her type characterized by the probability of success. Hence, the relevant self-selection constraints for type (q_1) are:

$$\alpha_1 q_1 \{y(k_{11}) + \theta + \delta k_{11} - R_{11}\} - p_1 - k_{11} \geq \alpha_2 q_1 \{y(k_{12}) + \theta + \delta k_{12} - R_{12}\} - p_2 - k_{12} \qquad (7)$$

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[11] We thank Dileep Mookherjee and Chris Jacobs for this interpretation.

[12] Alternatively, one may assume that the relevant participation constraint is $U_i = q_i \alpha_i [y(k_i) + \theta + \delta k_{ii} - R_{ii}] + w + l - k_{ii} - p_i \geq w$. Since it scales up the participation constraint by a constant, the ensuing analysis is the same.

and for the type (q_2):

$$\alpha_2 q_2\{y(k_{22})+\theta+\delta k_{22}-R_{22}\}-p_2-k_{22}\geq\alpha_1 q_2\{y(k_{21})+\theta+\delta k_{21}-R_{21}\}-p_1-k_{21} \qquad (8)$$

Equations (7) and (8) can be interpreted as follows: Equation (7) indicates that type (q_1)'s expected pay-off from accepting the contract indicated by the pair (p_1,α_1) must weakly exceed the expected pay-off from the contract summarized by (p_2,α_2). The term k_{12} is the investment that type 1 undertakes if it grabs the contract meant for type 2. Similarly, the equation (8) says that type 2 investor's expected pay-offs from the contract (p_2,α_2) must weakly exceed those from the contract (p_1,α_1).

Moral Hazard

Since the privatized firm borrows funds in order to make investment, this constraint is related to the diversion of funds from investment to personal benefits of the investor. The cost of diversion of funds towards current consumption is the forgone investment that will lead to a decrease in future expected cash flow. Hence, optimal investment for each type balances such gains and costs at the margin. That is, the optimum investment is the outcome of the following maximization problem:

$$\max_{.\{k_{ij}\}} U_{ij}=q_i\alpha_i[y(k_{ij})+\theta+\delta k_{ij}-R_{ij}]+w+l-k_{ij}-p_i \qquad (9)$$

The relevant first-order condition for the type (i) is:

$$\alpha_i q_i\{y'(k_{ij})+\delta\}=1 \qquad (10)$$

The equation (10) reflects the incentive constraint that arises due to the moral hazard problem. While designing privatization, the government knows that the investor will divert "funds" optimally. The right hand side of equation (10) is the incremental gain to the private investor if a \$ is diverted towards current benefits. The left hand side is the forgone cash flow from reduction in investment $\alpha_i[y'(k_{ij})+\delta]$ that accrues to the investor with a probability of q_i. An immediate consequence of (10) is that investor who can manage the restructured firm more efficiently will tend to invest more because a larger value of (q_i) will make incremental future gain from investment also larger.

II. OPTIMAL DESIGN OF PRIVATIZATION

The privatization program must ensure participation of the agents (equation 6), take into account adverse selection (equations 7 and 8), and moral hazard (equation 10) constraints and deliver post-privatization equilibrium in credit markets (equation 4). First, we consider the optimal pooling contract in which both types of investors are offered a single contract. Then, we analyze whether the government can do better by offering a menu of contracts designed for each type. That is, we define conditions under which switching from a single pooling contract to a multiple separating contract is optimal. Finally, we outline the optimal separating contract and implications for efficiency of investment made during the post-privatization era. The propositions 1, 2 and 3 below summarize our findings about optimal pooling and separating contracts.

Proposition 1

The optimal pooling contract (α_s, p_s) *that offers the same deal to both types* of investors *is given by the following:*

$$\alpha_s = \frac{1}{1+\psi}, \quad p_s = q_2\alpha[y(k_{2s}) + \theta + \delta k_{2s} - R_s] + w + l - k_{2s}$$

where $$\psi = \frac{\dfrac{(q_1 - q_2)\gamma[y(k_{1s}) + \delta k_{1s} - y(k_{2s}) - \delta k_{2s} + \varepsilon_R R}{\dfrac{\delta k_{1s}}{\delta \alpha_s}} - \delta[(1-q_1) + (1-q_2)\beta]}{\gamma + (1-\gamma)\beta}$$

and $$\beta = \frac{\dfrac{\delta k_{2s}}{\delta \alpha}}{\dfrac{\delta k_{1s}}{\delta \alpha}}$$

and subscript (s) denotes value of the variables under a single contract.

Proof: see Appendix A.

Intuitively, the government charges a single price such that participation constraint of the inefficient investor is satisfied. At a higher price the inefficient investor will make losses and hence will not participate, thereby lowering the government's revenue. The optimal share will depend on the productivity gap and the resulting cash flow differences between the two types of investors and the degree of collateralization that is determined by the durability of assets (δ). A higher value of (δ) increases investment of both types of investors resulting in greater output and lower interest rate and thus, higher cash flow. On the other hand, if the productivity gap is very large, the government reduces the ownership shares to investors because otherwise it would end up subsidizing the inefficient types.

Next, we discuss whether the government can do better by switching to a menu of contracts in proposition 2 below.

Proposition 2 *If* $\frac{\gamma}{1-\gamma} > \frac{q_2 \Delta y_2 + (\delta - 1)\Delta k_2}{q_1 \Delta y_1 + (\delta - 1)\Delta k_1}$, i.e, *the fraction of the efficient type of investors relative to inefficient type exceeds a critical number given by the ratio of expected incremental cash flows under each type, then switching to a dual mode of privatization from single contract is optimal.*

Where, $\Delta y_i = y_i - y_s$ and $k_i - k_s$ are the differentials in the cash flow and investment of the ith type of investors (respectively) between separating and pooling contracts.

Proof: See Appendix B.

If the government resorts to multiple mode of privatization, incentive compatible contracts would require selling a larger fraction of equity at a higher price (in comparison to pooling equilibrium) to the efficient investor. This would result in increased investment and expected net cash flow (see corollary 1). Similarly, the inefficient investors should be offered a lower share of the cash flow, which, then would lead to a reduction in investment and the expected net cash flow in comparison to pooling equilibrium. Thus, the multiple mode of privatization is a better policy than a single contract, if the increase in the net expected cash flow, due to larger investment of the efficient investors outweighs the reduction in the net cash flow due to smaller investment

by the inefficient types. This condition is likely to be met when (a) the proportion of efficient investors is large and/or (b) expected productivity of the efficient type is larger than that of the inefficient type. Rewriting the condition, we get:

$$\gamma[q_1\Delta y_1 + (\delta - 1)\Delta k_1] > (1-\gamma)[q_2\Delta y_2 + (\delta - 1)\Delta k_2]$$

The expressions in the parentheses are the expected changes in output ($q_i\Delta y_i$) net of depreciation and investment ($\delta - 1)\Delta k_i$ generated by switching from single mode to dual mode of privatization. Hence, privatization will be optimal if the marginal benefits from such a policy outweighs marginal costs measured in terms of incremental cash flows.

Next proposition defines the optimal fraction of shares and prices to be charged to different types of investors.

Proposition 3

*Under adverse selection and moral hazard the optimal privatization policy consists of a dual method of privatization: (***a***) Selling 100 per cent equity combined with a subsidy on risky debt at a higher price and (***b***) Selling a fraction of the equity at a lower price with no subsidy on cash flows.*

The terms of privatization are given by the following:

$$\alpha_1 = \frac{1}{1-(1-q_1)\delta} > 1, \quad \alpha_2 = \frac{1}{1-(1-q_2)\delta + Z} < 1 \quad \text{if } q_1 >> q_2$$

$$\text{where, } Z = \frac{(1-\gamma)[q_1 y(k_{12}) - q_2 y(k_{22}) + \delta\{k_{12}(1+\eta_1) - k_{22}(1+\eta_2)\}}{\theta \dfrac{dk_{22}}{d\alpha_2}} > 0$$

$$\text{where, } \eta_1 = \frac{dk_{12}}{d\alpha_2}\frac{\alpha_2}{k_{12}} \text{ and } \eta_2 = \frac{dk_{22}}{d\alpha_2}\frac{\alpha_2}{k_{12}}$$

Proof: See Appendix C

The proposition is illustrated in Figure 1. The figure draws iso-expected pay-offs for both types of investors. They are upward sloping because a higher price charged for the sale of equity has to be compensated by an increase in the share of equity. The more

efficient type chooses the pair (p_1, α_1) and the less efficient one chooses (p_2, α_2), where α_1 and α_2 are given in the proposition above. The intuition behind the result is that while the more efficient investors are willing to pay a higher price for buying equity, they are averse to sharing the cash flow. On the other hand, inefficient investors are willing to grab the subsidy but they can not afford to pay a price as high as (p_1) because at (p_1), the net cash flow for the project run by the inefficient investor is negative. Hence, they are strictly worse-off if they opt for (p_1, α_1).

In the presence of informational frictions, the nature of privatization will crucially depend on two elements, the degree of uncertainty summarised by the probability of success (q_i) and the extent of durability of capital determined by (δ). While the probability of success determines the expected productivity of the investor, the durability of assets (that serves as collateral) lowers the cost of financing. Both elements have a bearing on the generation of cash-flow after privatization. Different industries have different degrees of uncertainty and durability of its assets. Indeed, the terms of privatization must address these issues carefully. To illustrate the point, we resort to two benchmark cases: (A) $\delta = 0$, and (B) $q_1 = 1 > q_2$. In both cases, $\alpha_1 = 1$ and $0 < \alpha_2 \leq 1$ from proposition 2. However, when $0 < \delta \leq 1$ and $q_i > 0$, the optimal privatization calls for debt subsidy to more productive investor against the payment of a larger price for the sale of the privatized unit. On the other hand, the government sells less than 100 per cent ownership to the less productive investor at a lower price. The role of subsidy to more productive investors arises whenever the debt is risky and the endogenous collateral makes debt partly secure. In the scenarios where these two elements are missing, the government would still float a dual mode of privatization but without any subsidy to more productive investors.

Our analysis thus far links the method as well as terms of privatization to raising finance and undertaking investment by the private investor in the post-privatization era. One of the key reasons for adopting privatization via sales of assets to a group of private investors rather than issuing shares to public is that the government expects private investor to commit a substantial amount of funds for the purpose of restructuring. [See, Megginson, Nash, Netter and Poulsen (2001).] However, the presence of moral hazard

and adverse selection complicates the investment and financing decisions in the post-privatization era since the amount of investment depends on endogenous variables such as price of equity, fraction of ownership as well as return on debt. Hence, the question arises as to what extent, terms of privatization (p_i, α_i) affect optimal investment in the post-privatization era and how it is related to subsidization of debt? Propositions (4) and (5) below address these issues.

Proposition 4

The subsidization of risky debt to efficient investor leads to an optimal amount of investment and maximization of the expected cash flow. The less efficient investor under-invests in equilibrium.

Proof: The optimal choice of investment by the efficient investor will be the solution to equation (10), $\alpha_1 q_1 \{y'(k_{11}) + \delta\} = 1$. Plugging the value of $\alpha_1 = \dfrac{1}{1-(1-q_1)\delta}$ from proposition (2), we get,

$$q_1 y'(k_{11}) + \delta = 1 \tag{11}$$

The expected net cash- flow (net of investment) from an investment of magnitude (k_{11}) is :

$q_1[y(k_{11}) + \theta] + \delta k_{11} - k_{11}$. This expression is maximized (with respect to the choice of k_{11}) when equation (11) is satisfied.

On the other hand, since $\alpha_2 = \dfrac{1}{1-(1-q_2)\delta + Z} < \dfrac{1}{1-(1-q_2)\delta}$, the relatively less efficient investor would under-invest in comparison to full information optimum, i.e, in the absence of adverse selection.

The proposition (4) states that efficient investor will undertake an investment that would maximize the value of the firm. However, it is necessary that the government should subsidize the debt issued by the firm in the post-privatization era. One of the objectives of the government is to generate maximum revenue through privatization.

Since subsidization of private debt is costly to government, the question still remains as to how such subsidy gets financed? In the proposition 5, we address this issue.

Proposition 5

The larger the amount of investment subsidy, the larger the price of equity charged to efficient investors.[13]

The intuition behind proposition 4 is that bankruptcy acts as a tax that lowers incentives to invest because lenders seize un-depreciated part of the investment (as collateral) if cash flows are insufficient to meet debt payments. However, subsidization of risky debt together with 100 per cent ownership sold to the investor restores incentives to invest. The government then charges a price high enough to cover financing for the subsidy. Such a price is feasible because extra investment due to subsidy also enhances the total value of the project. Thus, while the subsidy on cash flow tackles the under-investment problem of the efficient types, it is also self financed since the government can cover the cost by charging a higher price for the equity while maximizing incentives to invest.

However, informational constraints also impose distortions leading to an under-investment by the less efficient type of investors. In order to deter each type not to grab contracts meant for the other, the government charges a lower price for the equity and sells a fraction of ownership to less efficient type, which, in turn, causes under-investment. The following proposition sums up the determinants of the magnitude of such under-investment by the less efficient types.

Proposition 6

The greater the difference between the efficient and inefficient types [the larger is $(q_1 - q_2)$], the lower the fraction of ownership to be sold to the inefficient types and the greater is the magnitude of under-investment.

[13] The proof of the proposition is lengthy and is omitted from the paper. It can be obtained from the authors on request.

Proof: The larger is the difference between q_1 and q_2, the greater would be the value of the numerator in (Z) and the lower is the value of its denominator, leading to an increase in (Z) and to a fall in α_2.

Thus far, our analysis shows that while designing privatizations, it is important for the government to address post-privatization problems of bankruptcy and the associated informational constraints. The dual method shows that appropriately designed privatization would solve the under-investment problem for the efficient investors and limit under-investment to minimum (given the constraints of moral hazard and adverse selection) for the inefficient types. These results hold because terms of privatization take into consideration the characteristics of each type of investors and their effects on the maturity value of debt. Hence,

Corollary 1: *The likelihood of bankruptcy in the post privatization era is smaller when the design of privatization takes into account its effect on the maturity value of debt.*

III. CONCLUDING REMARKS

Success of privatization programs has been far from universal. Post-privatization crises have also led to the postponement or abandonment of the process in some countries. Prominent examples are Russia, Poland and other East European countries. Very often, the blame has been placed on either the lack of far-sighted government policies or inept investors. In this paper, we attempt to address these issues. The key element in privatization lies in sorting out efficient and inefficient investors by introducing a screening mechanism. The government can sort out potential investors by offering a menu in its privatization program. The relatively more efficient investors will opt for 100% equity with a subsidy on the observed cash flows and pay a higher price. On the other hand, the less efficient investors would prefer sharing ownership and pay a lower price for buying the firm and will not be eligible for the subsidy. The government will be forced to concede some rents to the more efficient investors but they will make an optimal amount of investment. Thus, to avert post-privatization problems, governments

may be well advised to identify the efficient investors from the inefficient investors by offering appropriate choice of ownership and allowing them to raise financing with a direct subsidy on the cash flow rather than intervening in financial markets.

Though, we have presented our conclusions in a simple framework, our results are quite general as long as these informational constraints bite on the process of privatization. For example, we have employed the assumption of universal risk-neutrality, moral hazard in investment and access to the market for borrowing but not to a wider capital market. Introduction of a risk-averse investor would in fact strengthen the result on subsidy on investment of the efficient investors. However, the government now should bear some risk for the inefficient investors, leading to a sale of smaller fraction of ownership to them. Introduction of other forms of financing, such as sale of equity in stock market, however would pose different forms of informational constraints. For example, under-pricing of equity could be a major impediment to privatization. In this mode of financing, informational problems will negatively affect the more efficient firm as its equity is undervalued. On the other hand, the less inefficient firm benefits since it can sell over-priced equity. Hence, the former will try to separate itself from the latter by paying a larger price to buy the privatized firm so as to get a fair price for its equity subsequent to privatization. The design of privatization will then depend on whether equilibrium outcome is pooling or separating. However, we conjecture that the extent and magnitude of subsidy to efficient firms would be lower under equity financing in comparison to debt financing as the problems of bankruptcy tend to be of lesser importance in the post-privatization era. On the other hand, if the privatized firm resorts to private equity financing from the venture capitalists, equilibrium outcome will depend on its bargaining power as well as venture capitalist's contribution to final output and degree of control exercised by the venture capitalists. We plan to formally address the issue of privatization in the context of equity market in our future research.

Appendix A

Proof of the proposition 1:

The optimal pooling contract is the solution to the following maximization program:

$$E\pi_s = (1-\alpha_s)[\gamma q_1\{y(k_{1s}) + \theta + \delta k_{1s} - R_s\} + (1-\gamma)q_2\{y(k_{2s}) + \theta + \delta k_{2s} - R_s\} + p_s$$

(A1)

subject to the following constraints.:

$$U_{1s} = q_1\alpha[y(k_{1s}) + \theta + \delta k_{1s} - R_s] + w + l - k_{1s} - p \geq 0 \qquad \text{(A2)}$$

$$U_{2s} = q_2\alpha[y(k_{2s}) + \theta + \delta k_{2s} - R_s] + w + l - k_{2s} - p \geq 0 \qquad \text{(A3)}$$

$$\alpha_s q_1\{y'(k_{1s}) + \delta\} = 1 \text{ and } \alpha_s q_2\{y'(k_{2s}) + \delta\} = 1 \qquad \text{(A4)}$$

and $[\gamma q_1 + (1-\gamma)q_2]R_s + \delta[\gamma(1-q_1)k_{1s} + (1-\gamma)(1-q_2)k_{2s}] = l$ (A5).

Since $q_1 > q_2 \Rightarrow k_{1s} > k_{2s}$ (from A 4). Hence, $y(k_{1s}) + \delta k_{1s} > y(k_{2s}) + \delta k_{2s}$ and $U_{1s} > U_{2s}$.

Hence, the price that satisfies constraints (A2) and (A3) is given by:

$U_{2s} = 0 \Rightarrow p_s = q_2\alpha[y(k_{2s}) + \theta + \delta k_{2s} - R_s] + w + l - k_{2s}$ and the constraint (A2) does not bind. Substituting (p_s), the optimal values of (k_{1s}) and (k_{2s}) from (A3) and the value of (R_s) from (A5) into the objective function (A1) and taking the first derivative of the resulting expression of (A1) with respect to (α_s) and setting it equal to zero, we get:

$$\alpha_s = \frac{1}{1+\psi} \text{ where}$$

$$\psi = \frac{\dfrac{(q_1 - q_2)\gamma[y(k_{1s}) + \delta k_{1s} - y(k_{2s}) - \delta k_{2s} + \varepsilon_R R}{\dfrac{\delta k_{1s}}{\delta \alpha_s}} - \delta[(1-q_1) + (1-q_2)\beta]}{\gamma + (1-\gamma)\beta}$$

and $\beta = \dfrac{\dfrac{\delta k_{2s}}{\delta \alpha}}{\dfrac{\delta k_{1s}}{\delta \alpha}}$

Appendix B

Proof of the proposition 2:

Suppose that initially the government offers a single contract to both types of investors, which is specified by a single pair of (α, p).

The expected pay-off to the investor of type (i) is:

$$U_{is} = q_i \alpha[y(k_{is}) + \theta + \delta k_{is} - R_s] + w + l - k_{is} - p \qquad \text{(B-1)}$$

The expected revenue for the government from the same type of contract is:

$$E\pi_s = (1-\alpha)[\gamma q_1\{y(k_{1s}) + \theta + \delta k_{1s} - R_s\} + (1-\gamma)q_2\{y(k_{2s}) + \theta + \delta k_{2s} - R_s\} + p \qquad \text{(B-2)}$$

where, k_{is} = Investment done by the ith type of investor (i = 1,2) when offered the same contract (α, p).

Now, suppose that the government *adds* a new contract to the existing contract such that the good type is indifferent between accepting the old contract (single contract) and in addition this new contract is available to both parties simultaneously with the old contract. This new contract offers a larger share of the cash flow $(\alpha + \Delta_1)$ against a payment of an extra price of $(p + \Delta_2)$ such that the good type is indifferent.

Lemma 1: The bad type investor will reject this new contract and will strictly prefer to stick to the old contract.

This new contract is such that

$$q_1\alpha[y(k_{1s})+\theta+\delta k_{1s}-R_s]-k_{1s}-p=q_1(\alpha+\Delta_1)[y(k_1)+\theta+w-R_1]-k_1-(p+\Delta_2)$$
(B3)

where, $k_1 =$ investment done by the type (q_1) if the investor adopts the new contract.

Rearranging the equation, we get:

$$q_1\alpha[y(k_1)-y(k_{1s})+\delta k_1-\delta k_{1s}]-(k_1-k_{1s})+q_1\Delta_1[y(k_1)+\theta+\delta k_1-R_1]+q_1\alpha(R_s-R_1)-\Delta_2=0$$

Since the first two terms of the above expression is zero due to incentive constraint due to moral hazard (that is, we are using the discreet version of the constraint: $\alpha_s q_1\{y'(k_{1s})+\delta\}=1$], we have

$$\Delta_2=q_1\Delta_1[y(k_1)+\theta+\delta k_1-R_1]+q_1\alpha_1(R_s-R_1) \qquad \text{(B-4)}$$

If the low type investor accepts the offer $(\alpha+\Delta_1, p+\Delta_2)$, then the expected pay-off is:

$$U_2=q_2(\alpha+\Delta_1)[y(k_2)+\theta+\delta k_2-R_s]+w+l-k_2-p-\Delta_2. \qquad \text{(B-5)}$$

where, $k_2 =$ investment done by the type (q_2) if the investor adopts the new contract.

On the other hand, the expected pay-off from the pooling contract (α, p) is given by the equation (B-1). So, the difference in the expected pay-off from accepting the new contract is given by

$$U_2-U_s=q_2(\alpha+\Delta_1)\{y(k_2)+\theta+\delta k_2\}-k_2-\Delta_2-[q_2\alpha\{y(k_{2s})+\theta+\delta k_{2s}-R_s\}-k_{2s}]$$

$$=q_2\alpha\{y(k_2)-y(k_{2s})+\delta k_2-\delta k_{2s}\}-R_s\}-(k_2-k_{2s})+q_2\Delta_1\{y(k_2)+\theta+\delta k_2-R_s\}-\Delta_2$$

Again using incentive constraint on investment due to moral hazard and inserting Δ_2 from (B-4) into the above equation, we get,

$$U_2-U_s=q_2\Delta_1\{y(k_2)+\theta+\delta k_2-R_s\}-q_1\Delta_1[y(k_1)+\theta+\delta k_1-R_1]-q_1\alpha_1(R_s-R_1)<0$$

The difference between first two terms $[q_2\Delta_1\{y(k_2)+\theta+\delta k_2-R_s\}-q_1\Delta_1[y(k_1)+\theta+\delta k_1-R_1<0]$ is negative because type (q_1) is more productive than the type $(q_2)\Rightarrow k_1>k_2$ which also implies that $R_s>R_1$ and that makes the last term negative.//

Since the new contract will be accepted by the good type and will be rejected by the bad type, the expected pay-off to the government from *both types* of contracts is given by the following equation:

$$E\pi = \gamma q_1[(1-\alpha-\Delta_1)\{y(k_1)+\theta+\delta k_1 - R_1\}+\Delta_2] + (1-\gamma)[(1-\alpha)\{y(k_{2s})+\theta+\delta k_{2s} - R_s\}] + p$$

(B-6)

Next, we can examine the impact of introduction of dual contracts on the expected profits of the government by taking the difference between (A-1) and (B-6).

Let $\Delta k_1 = k_1 - k_s > 0$, and $\Delta y_1 = y(k_1) - y(k_s) > 0$, then

$$E\pi - E\pi_s =$$

$$\gamma q_1[(1-\alpha)\{\Delta y_1 + \Delta k_1\} - \Delta_1[y(k_1)+\theta+\delta k_1 - R_1] - \alpha(R_s - R_1)] + \gamma\Delta_2 - \gamma q_1(R_1 - R_s)$$

By using equation (B-4), we get,

$$= \quad \gamma[q_1\{\Delta y_1 + \delta\Delta k_1\} - \alpha q_1\{\Delta y_1 + \delta\Delta k_1\}] - \gamma\Delta_2 + \gamma\Delta_2 - \gamma q_1(R_1 - R_s)$$

By using incentive constraint for investment, we get:

$$= \quad \gamma[q_1\{\Delta y_1 + \delta\Delta k_1\} - \Delta k_1\} - (R_1 - R_s)]$$

$$= \quad \gamma[q_1\Delta y_1 + (q_1\delta - 1)\Delta k_1 - q_1(R_1 - R_s)]$$

By using equilibrium condition in the loan market,

$$= \quad \gamma[q_1\Delta y_1 + (q_1\delta - 1)\Delta k_1 + (1-q)\delta\Delta k_1]$$

$$= \quad \gamma[q_1\Delta y_1 + (\delta - 1)\Delta k_1] \geq 0. \qquad \text{(B7)}$$

A similar calculation would reveal that only incentive compatible contract to the type (q_2) will be a new contract such that $\alpha < \alpha_s$ and $p < p_s$ and this contract will be rejected by the investor of the type (q_2). Since, this new contract offers a lower share of

the cash flow, the type (q_2) will invest less and as a result, the decrease in the government's revenue would be given by:

$$(1-\gamma)[q_2\Delta y_2 + (\delta - 1)\Delta k_2] \leq 0 \qquad \text{(B8).}$$

Comparing (B7) and (B8), we find that the following condition must hold for the dual mode of privatization to dominate a single contract:

$$\frac{\gamma}{1-\gamma} > \frac{q_2\Delta y_2 + (\delta - 1)\Delta k_2}{q_1\Delta y_1 + (\delta - 1)\Delta k_1} //$$

Appendix C

Proof of the proposition 3:

The optimization program is:

$$Max_{\{\alpha_1, p_1, \alpha_2, p_2\}}$$

$$\gamma[p_1 + (1-\alpha_1)q_1\{y(k_{11}) + \theta + \delta k_{11} - R_{11}\}] + (1-\gamma)[p_2 + (1-\alpha_2)q_2\{y(k_{22}) + \theta + \delta k_{22} - R_{22}\}$$

Subject to the following constraints:

(1c) Incentive compatibility conditions for investment for both types of investors.

$$\alpha_i q_i\{y'(k_{ij}) + \delta\} = 1$$

(2c) Self -selection Constraints for the efficient investor:

$$\alpha_1 q_1\{y(k_{11}) + \theta + \delta k_{11} - R_{11}\} - p_1 - k_{11} \geq \alpha_2 q_1\{y(k_{12}) + \theta + \delta k_{12} - R_{12}\} - p_2 - k_{12}$$

Self-Selection constraint for the inefficient type investor:

$$\alpha_2 q_2\{y(k_{22}) + \theta + \delta k_{22} - R_{22}\} - p_2 - k_{22} \geq \alpha_1 q_2\{y(k_{21}) + \theta + \delta k_{21} - R_{21}\} - p_1 - k_{21}$$

(3c) Individual Rationality constraints:

$U_1 = \alpha_1 q_1 \{y(k_{11}) + \theta + \delta k_{11} - R_{11}\} - p_1 - k_{11} + l \geq 0$ for investor of type 1 and

$U_2 = \alpha_2 q_2 \{y(k_{22}) + \theta + \delta k_{22} - R_{22}\} - p_2 - k_{22} + l \geq 0$

(4c): Break-even condition for the investors:

$q_i R_{ij} + (1 - q_i)\delta k_{ij} = l$ for $i = 1,2$ and $j = 1,2$.

In equilibrium, incentive compatibility constraints for investment for both types and the break-even condition for lenders will hold with strict equality. On the other hand, it follows from the lemma 1 from the previous section, if the self selection condition for the more efficient type investor binds, then the similar constraint for the other type will be slack. A similar argument shows that if the participation constraint for the less inefficient type binds, then the similar constraint for the more efficient type will hold with strict inequality.

The upshots of the above arguments are that (A) we can express $k_{ij} = k_{ij}(\alpha_i)$ by using the equation (1c) and $R_{ij} = R_{ij}(\alpha_i)$ from 4(c) and (B) can write $p_2 = \alpha_2 q_2 \{y(k_{22}) + \theta + \delta k_{22} - R_{22}\} + w - k_{22} + l = p_2(\alpha_2)$ and can insert them in the objective function and the constraints and can convert the maximization problem into the following Lagrangian optimization.

$$\mathcal{L}\{_{\max . p_1, \alpha_1, p_2(\alpha_2), \alpha_2}\} =$$

$$\gamma[p_1 + (1-\alpha_1)q_1\{y(k_{11}) + \theta + \delta k_{11} + (1-q_1)\delta k_{11} - l\}] + (1-\gamma)[p_2 + (1-\alpha_2)q_2\{y(k_{22}) + \theta + \delta k_{22}(1-q_1)\delta k_{11} - l$$

$$+ \lambda[\alpha_1 q_1\{y(k_{11}) + \theta + \delta k_{11} + (1-q_1)\delta k_{11} - l\} - p_1 - \alpha_2 q_1\{y(k_{12}) + \theta + \delta k_{12} - (1-q_1)\delta k_{12} - l\} - p_2 - k_{12} + p_2]$$

First-order conditions:

$$p_1: \quad \gamma = \lambda \tag{5c}$$

$$\alpha_1: \quad \gamma[(1-\alpha_1)q_1\{y'(k_{11}) + \delta\} + (1-q_1)\delta]\frac{dk_{11}}{d\alpha_1} = 0 \tag{6c}$$

$$\alpha_2 : \gamma[(1-\alpha_2)q_1\{y'(k_{22})+\delta\}+(1-q_2)\delta]\frac{dk_{22}}{d\alpha_2} = (1-\gamma)[q_1 y(k_{12}) - q_2 y(k_{22}) + \delta\{k_{12}(1+\eta_1) - k_{22}(1+\eta_2)\}$$

(7c)

where $\eta_1 = \frac{dk_{12}}{d\alpha_2}\frac{\alpha_2}{k_{12}}$ and $\eta_2 = \frac{dk_{22}}{d\alpha_2}\frac{\alpha_2}{k_{12}}$ are elasticity of investment with suspect to shares of the cash flow. By using (1a) in (6a), we can write the latter equation as:

$$\frac{(1-\alpha_1)}{\alpha_1} + (1-q_1)\delta = 0 \;\Rightarrow\; \alpha_1 = \frac{1}{1-(1-q_1)\delta} \tag{8c}$$

In a similar manner, by using the equation (1a) in (7a), we get,

$$\frac{(1-\alpha_2)}{\alpha_2} + (1-q_2)\delta = Z \;\Rightarrow\; \alpha_2 = \frac{1}{1-(1-q_2)\delta + Z} \tag{9a}$$

where, $Z = \dfrac{(1-\gamma)[q_1 y(k_{12}) - q_2 y(k_{22}) + \delta\{k_{12}(1+\eta_1) - k_{22}(1+\eta_2)\}}{\gamma\dfrac{dk_{22}}{d\alpha_2}} > 0$

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FIGURE 1

Dual Method of Privatization

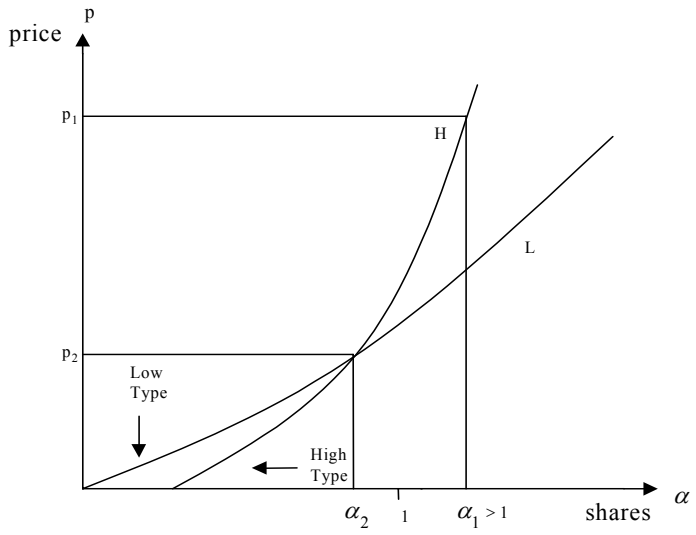

Table 1

Indian Privatizations 2001/02

Entity sold	Buyer	Entity Share sold (%)	Price (Rs millions)	Number of bids
VSNL	Panatone (Tata)	25	14,390	2
IBP	Indian Oil (Govt of India)	33.58	11,535	7
Hindustan Zinc	Sterlite	26	44,450	2
CMC	Tata Consultancy Services	51	1,520	1
Paradeep Phosphates	Zuari	100	1,517	1
Hindustan Teleprinters	Hindustan Futuristic	74	550	3
Jessop	Ruia Cotex	72	182	2
Centaur Hotel Bombay	A L Batra	100	830	1
Lodhi Hotel Delhi	Silverlink	100	762	1
Qutb Hotel Delhi	Sushil Gupta	100	356	1
Laxmi Vilas Hotel	Udaipur Bharat Hotels	100	75	1
Total proceeds			**33,158**	

Source: Ministry of Disinvestment, as reported by The Economist, 1st July, 2002