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# Priorities and Sequencing in Privatization:
## Theory and Evidence from the Czech Republic

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While privatization of state-owned enterprises has been one of the most important aspects of the economic transition from a centrally planned to a market system, no transition economy has privatized all its firms simultaneously. This raises the question of whether governments privatize firms strategically. In this paper we examine theoretically and empirically the determinants of the sequencing of privatization. To obtain testable predictions about factors that may affect sequencing, we develop new theoretical models and adapt existing ones. In doing so we characterize potentially competing government objectives as i) maximizing efficiency through resource allocation; ii) maximizing public goodwill from the free transfers of shares to the public; iii) minimizing political costs; iv) maximizing efficiency through information gains and v) maximizing privatization revenues. Next, we use firm-level data from the Czech Republic to test the competing theoretical predictions about the sequencing of privatization. We find strong evidence that more profitable firms were privatized first. This suggests that the government sequenced privatization in a way that is consistent with our theories of maximizing revenue and maximizing public goodwill. Our findings are consistent with Glaeser and Scheinkman's (1996) recommendations for increasing efficiency through informational gains. They are inconsistent with the government pursuing the objective of increasing Pareto efficiency through improved resource allocation. They are also inconsistent with the hypothesis that the government minimized political costs. Our results also suggest that many empirical studies of the effects of privatization on firm performance suffer from selection bias since privatized firms are likely to have characteristics that make them more profitable than firms that remain in state ownership.

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## 1. Introduction

While the privatization of state-owned enterprises (SOEs) has been one of the most important aspects of economic transition from a centrally planned to a market system, no transition economy has privatized all its SOEs simultaneously. Even in countries that strove to privatize SOEs rapidly, (e.g., the Czech Republic, Estonia, Russia, and the Ukraine), the process consisted of a sequence of moves, with some firms being privatized earlier than others.

A government may sequence privatization of SOEs for a number of reasons. First, it may incur excessively high transaction costs if it tries to privatize all firms simultaneously. This was clearly a factor in the Czech Republic and in most other cases. Second, a government may sequence privatization to reveal information about the firms to investors. If firms are sold sequentially, later buyers can observe the quality of the firms sold earlier. This informational advantage of sequencing is particularly relevant in transition economies, since there is usually a high degree of uncertainty about the quality of the firms being privatized. Third, in the context of imperfect information, sequencing can yield higher average revenues for the government than can simultaneous sales. Fourth, sequencing may occur because of political opposition to dramatic reforms (the case in Bulgaria, Poland, Romania, and Slovakia), and it may even increase the feasibility of future reforms (Dewatripont and Roland, 1995).[1] Fifth, instantaneous privatization may lead to costly unemployment, hence the optimal privatization path may be gradual (Aghion and Blanchard, 1994, and Katz and Owen, 1993).

Given that governments are likely to privatize sequentially, the question arises whether they sequence the sale of firms strategically or assign firms for privatization in a relatively random fashion. In this paper we argue that strategic sequencing is likely to be the case, although the government's choice of privatization strategy will depend upon its priorities. We present and test predictions from five models of alternative government objectives. We start by looking at the decision of a government maximizing Pareto efficiency. It is generally argued that the worst firms are the best candidates for privatization from an efficiency perspective since they have the greatest need for

[1] See Roland (2000) for a recent survey of the literature.

restructuring. Hence, the economic model of a government guided by the principle of increasing Pareto efficiency predicts that the government will privatize the least efficient firms first. Second, if the privatization procedure involves transferring shares to citizens, the government is likely to privatize the best (most profitable) firms first so that the shares transferred to citizens are valuable, thereby building political support for the government. Third, privatizing the most efficient and profitable firms first may also be optimal if the government is concerned about the political cost of unemployment. A related hypothesis concerning political costs is that the government is less likely to privatize firms in industries that already have employment difficulties. Fourth, when the primary benefit of privatization is informational in the sense that private firms use and process information more efficiently than public firms, the government may sequence privatization to maximize the flow of information in the economy. In this context Glaeser and Scheinkman (1996), hereafter GS, argue that privatization should begin where there is the most uncertainty, and in areas that transmit information to other agents.[2] Finally, if the government's objective is to raise revenues from privatization, it will sell the best (most profitable) firms first. Also the government may temporarily leave monopolies intact when selling them to get a higher price.[3]

This is the first study to examine both theoretically and empirically how competing government objectives give rise to different privatization strategies. Our approach is to investigate the extent to which the implications of these alternative objectives are consistent with firm-level data in the Czech Republic, one of the leading transition economies.[4] By identifying the nature of sequencing of privatization, our analysis contributes to a better understanding of the behavior of governments and firms. Further, the issues that we consider are relevant for all the transition economies, and for developing countries such as Argentina, Brazil, and India that have sizable state sectors and are pursuing privatization. Finally, our study has an important methodological ramification. It suggests that empirical studies need to take into account the potential

[2] Many firms in the transition economies faced substantial uncertainty because of the collapse of product and input markets after the break-up of the former Soviet Union.
[3] This was the case with fixed-line telephone companies in a number of Central and East European countries.
[4] We do not assume that the government has a single objective. However, the competing objectives can be nested in an overall objective function (Svejnar, 1982).

selection bias brought about by strategic sequencing. We show that government's priorities often lead to the decision to privatize the best firms first. Studies that treat the sequencing of privatization as a random process and estimate the effect of privatization by simply comparing the performance of privatized and non-privatized firms will overstate the positive effect of privatization on performance.

Our paper is organized in four sections: We begin in Section 2 by examining the institutional framework of the large-scale privatization program in the Czech Republic.[5] We then describe five models of privatization and their corresponding testable predictions in Section 3. Specifically, we present models aimed at maximizing efficiency through resource allocation; maximizing public goodwill from free transfers of shares to the public; minimizing political costs; and maximizing efficiency through information gains (GS). Finally, to investigate the implications of maximization of privatization revenues, we use an asymmetric information model that generates predictions about the sequencing of privatization. We conclude the section with a brief discussion of issues that are relevant for studies of privatization in general but are not applicable to the Czech case. Using data on the population of medium-size and large manufacturing firms in the Czech Republic, we test the predictions of the theoretical models and investigate the priorities of the government in Section 4. We find strong evidence that the Czech government privatized more profitable firms first. This outcome is consistent with the government placing priority on maximizing privatization revenues and public goodwill. It is also consistent with minimizing political costs, but our data do not support the secondary hypothesis that labor market conditions were an important determinant of privatization because of their effect on political costs. The results also allow us to rule out the hypothesis that improving Pareto efficiency was a key objective of the government. Further, we find that the privatization process was consistent with the GS definition of informational efficiency: firms likely to be more responsive to changes in demand conditions were privatized first. Finally, the government was more likely to privatize firms with higher market shares, supporting the hypothesis that the government wanted to maximize public good or privatization revenues, but contradicting the GS

[5] The large-scale privatization program privatized virtually all medium-size and large firms in the Czech Republic.

recommendation that the government delay privatizing such firms. Avenues for future research and the problem of selection bias in studies evaluating the impact of privatization are discussed in the concluding Section 5.

## 2. The Czech Privatization Program

In January 1990 the Czech Republic, part of the former Czechoslovakia, started its transition to a market economy from a position of virtually total state ownership. In 1989 only 1.2% of the labor force and 2% of all registered assets belonged to the private sector, and in 1990 only 4% of the gross domestic product was attributed to the private sector (Dyba and Svejnar, 1995). Yet, by the end of 1995, about 75% of all assets had been privatized as a result of three main initiatives.

First, between 1990 and 1991 shops, restaurants, housing, and other properties valued between $2.5 billion and $4.2 billion were restituted to previous owners. Second, between 1991 and 1993 small firms in retail trade, catering, and other services were privatized in a $1 billion small-scale privatization program, mostly through auctions.[6] Third, the method by which most medium and large state-owned enterprises were privatized was the large-scale privatization program, accounting for about $30 billion in asset values (Dyba and Svejnar, 1995).

In order to handle the large number of firms, the large-scale privatization program was divided into two waves. Firms were approved for privatization in the first wave at the end of April 1992 and shares were made available to new owners at the end of May 1993. (We classify firms as privatized in the first wave if they changed their legal registration from state-owned to joint stock company by the second quarter of 1992.) In the second wave, the privatization projects were approved at the end of 1993 and shares were made available to new owners toward the end of 1995. The approximately two year interval between the two waves motivates our models of sequencing in Section 3.

The large-scale privatization program employed several privatization methods. The most common was a transformation of firms into joint stock companies and the subsequent privatization of their shares.[7] In fact, joint stock firms accounted for about

[6] The exchange rate during this period was about $1 to 30 Czechoslovak Crowns.
[7] In terms of asset value, over 86% of the firms assigned to the large-scale program were transformed into

77% of the privatization revenues received by the Czech government. In terms of share value, 20% to 30% of all the shares of joint stock companies were sold to foreign and domestic buyers for cash through direct sales, via tenders, or through financial intermediaries (World Bank, 1999). The revenues from these sales went directly to the government, thus motivating our focus on revenue maximization as a government objective. Joint stock firms accounted for about 77% of the privatization revenues received by the Czech government.[8] In some firms a fraction of shares was sold for cash,[9] and another fraction was distributed through a voucher privatization scheme.

The voucher privatization scheme was an important component of each wave of the large-scale privatization program. Under this scheme every Czech citizen over eighteen could buy a book of vouchers containing 1,000 investment points for a nominal fee of $34. Citizens could use these voucher points to bid directly for shares, or they could transfer the points to investment privatization funds (IPFs) that bid for shares on their behalf.[10] Although the government did not receive revenues from the shares distributed through vouchers, voucher privatization helped create widespread support for the reforms, thus motivating our focus on public goodwill as a government objective.

In the first wave nearly two-thirds of the participating public invested their vouchers in nearly 450 IPFs, with the 14 largest IPFs collecting over 78% of the voucher points remitted to the funds (World Bank, 1999). Many of the largest funds were created and operated by local banks that temporarily remained majority state-owned.[11] The control of the largest IPFs by majority state-owned banks was an unexpected outcome for the Czech government since it, unlike the Polish government, left the creation of IPFs to

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joint stock companies (Mejstrik, Marcincin, and Lastovicka, 1997).

[8] The total revenues from large-scale privatization in the first half of the 1990s were estimated at about $8 billion (World Bank, 1999).

[9] About 350 firms were sold to domestic and foreign buyers for cash in the large-scale privatization program (World Bank, 1999). Examples of joint stock companies in our data that were sold for cash include Skoda (automobile) sold to Volkswagen, Tabak Kutna Hora (tobacco) sold to Philip Morris, and Cokoladovny (chocolate) sold to Nestle.

[10] Like mutual fund companies in the United States, IPFs in the Czech Republic were expected to diversify risk for individual investors by investing in many firms.

[11] Fund involvement resulted in potentially concentrated control over managers, but did real privatization take place? Some have argued that the conflict of interest resulting from bank-owned funds owning firms that were indebted to these banks prevented meaningful restructuring. It was not until after the recession of 1997 that the government began to address these issues and undertook banking sector reforms. The last remaining state-owned bank, Komercni banka, was privatized to French Societe Generale in 2001.

market forces.[12] There is every indication that the government expected voucher privatization to constitute a legitimate transfer of ownership to private owners (Dyba, 1996 and World Bank, 1999).

The government also retained shares averaging 20% to 25% of the share value being privatized. Some of these shares were used to meet restitution claims, while the rest were sold subsequently in the secondary market or to strategic investors (Mejstrik, Marcincin, and Lastovicka, 1997 and World Bank, 1999). Information on the percentage of shares of each firm sold through the various channels is not publicly available. However, we observe information on which firms were privatized in the first wave and which were left for later. In our empirical work we use this information (conditional on the earlier privatization of small firms) to analyze the sequencing of privatization.[13]

## 3. Theories of Privatization

### 3.1 Maximizing Pareto efficiency

In this section we analyze the sequencing decision of a government concerned with increasing economic efficiency through privatization. We incorporate two aspects of privatization that are widely observed: the likelihood that privatization is gradual rather than simultaneous, and the considerable variation in SOE performance prior to privatization.

The transition government's concern with efficiency stems from the fact that unprofitable firms were under the previous regime subsidized and could survive into the transition period alongside the efficient ones. Privatizing the most loss making firms first will hence achieve the greatest increase in efficiency from the private (profit maximizing) as well as the social (GDP maximizing) standpoints. Moreover, central planners strove to generate full employment and firms were penalized heavily for under-fulfilling the plan

[12] World Bank, 1999. However, the government passed a law prohibiting investment funds from gaining a majority stake in any firm: a fund could not own more than 20% of the shares of a single firm, nor could funds established by the same founder buy more than 20% of the same firm.

[13] Karel Dyba, the Czech minister of economy at the time, said small-scale privatization gave Czech citizens "the opportunity to practice capitalism at the grass roots level" (Dyba, 1996, p. 19). The government chose to privatize the smaller firms first because it was simpler and it allowed citizens to "practice capitalism" without having to raise much money in the early stages of the transformation. The firms privatized in the small-scale program were most commonly service oriented. Most of these firms

but little for hoarding excess labor. Hence under planning SOEs operated with surplus labor in the sense that the removal of some workers would not, on average, reduce output. Since surplus workers can make a positive contribution to GDP and profits elsewhere in the economy, a strategy for achieving greater private and social welfare is to privatize first the firms in which the wage rate greatly exceeds the marginal product of labor.[14]

We assume that the government faces increasing transaction costs of privatization, reflecting the fact that with a finite administrative capacity, governments carrying out large-scale privatizations have to increase this fixed capacity by paying overtime rates and hiring consulting and financial firms at a high cost. We also assume that privatization results in restructuring and hence increases allocative efficiency in firms. For expository purposes we first analyze the case when all SOEs are equally efficient and we show that in the presence of sufficiently rising transaction costs the government will privatize sequentially. Having established sequencing, we consider heterogeneous firms and show that the government will privatize the least efficient firms first.[15]

Consider an economy with $\overline{N}$ state-owned firms that can be privatized simultaneously or sequentially over time. The government is interested in maximizing the discounted net efficiency gain due to privatization. The government's total benefit from privatization in period $t$ is $\theta\left(N_t^*\right)$, where the cumulative number of firms privatized up to and including period $t$, $N_t^* = \sum_{r=1}^{t} N_r$, enters as an argument because the government derives the efficiency benefits from privatizing a firm in the current period and in each

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were retail shops and restaurants.

[14] Lau, Qian, and Roland (2000) discuss China's dual track approach that incorporates market liberalization and continued enforcement of the existing plan as a means of achieving Pareto-improving efficiency. The dual track approach would have been difficult to implement in the transition economies of Eastern Europe and the former Soviet Union because first, retaining a command economy may not have been feasible in the post-Communist political climate and second, governments would not have been able to guarantee enforcement of this approach given the collapse of product and input markets following the disintegration of the Soviet system.

[15] Efficiency considerations also dictate shutting down, rather than privatizing, the completely unviable firms. While the Czech government discouraged bankruptcies during the transition, before launching the transition it extensively liquidated unviable parts of firms. Large SOEs were often divided into smaller units, with debts and complex assets concentrated in one enterprise which was subsequently closed down and the assets sold to pay the debts. The government also liquidated some firms that were initially being considered for privatization and subsequently found to be unviable (Hashi, Mladek and Sinclair, 1997).

period after the firm's privatization.[16] We assume that $\theta'\left(N_t^*\right) > 0$ and $\theta''(N_t^*) < 0,$ the benefit to the government from increased efficiency increases with the number of firms being privatized, but at a diminishing rate. We also assume that $\theta(0) = 0, \theta'(0) > 0,$ and $\theta'(\bar{N}) > 0$. To capture the increasing transaction costs of privatization, we define $z(N_t)$ as the transaction cost in each period *t*, where $z'(N_t) > 0$ and $z''(N_t) > 0$. Transaction costs increase at an increasing rate as more firms are privatized, reflecting the higher burden on the bureaucracy of privatizing a large number of firms. We also assume that $z(0) = 0$ and $z'(0) = 0,$ reflecting the fact that the government can easily privatize an arbitrarily small number of firms with its existing bureaucracy.

The government chooses the number of firms to be privatized in each period by maximizing the present discounted value of the efficiency gains from privatization minus the transaction costs of privatization, subject to the constraint that $N_t \geq 0$. The objective function of the government can then be written as the following Kuhn-Tucker problem:

$$\max_{N_1,\ldots,N_T} V = \sum_{t=1}^{T} \rho^t \left(\theta\left(N_t^*\right) - z\left(N_t\right)\right) \text{ subject to } N_t \geq 0 \quad \textit{for } t = 1, 2, \ldots, T. \tag{1}$$

In equation (1) $\rho > 0$ is the discount factor and *T* is the government's planning horizon. In Appendix A1 we show that the objective function in (1) is concave in $\left(N_1, \ldots, N_T\right)$. The Kuhn-Tucker necessary and sufficient conditions for a maximum in each period *t* are

$$\frac{\partial V}{\partial N_t} = \sum_{r=t}^{T} \rho^r \frac{\partial \theta\left(N_r^*\right)}{\partial N_t} - \rho^t \frac{\partial z\left(N_t\right)}{\partial N_t} \leq 0, \tag{2}$$

$N_t \geq 0$ and $N_t \dfrac{\partial V}{\partial N_t} = 0$.

If the number of firms privatized in period *t* is positive, the first line in equation (2) holds with equality. In this case (2) shows that for period *t*, the present discounted value of the efficiency gain to the government of privatizing one more firm equals the marginal transaction cost of privatizing one more firm.

[16] As is customary in the literature, we make the simplifying assumption here and below that the benefit and cost functions are continuous in $N$.

The main implication of this model is that the government has a strong incentive to sequence privatization of firms even though the discounted benefits for a firm privatized in period *t* are obtained for the remaining *T-t* periods, thus creating a potential incentive to privatize all the firms in the first period. To show that the government is likely to sequence, we first show that the government will continue privatizing in period 2 if it has privatized some firms in period 1. Consider the first-order condition for *t=2* from equation (2) when the government privatizes $0 < N_1 < \bar{N}$ firms in the first period. The government will privatize at least one firm in the second period if

$$\sum_{r=2}^{T} \rho^r \frac{\partial \theta(N_1)}{\partial N_2} - \rho^2 \frac{\partial z(0)}{\partial N_2} > 0, \qquad (3)$$

which holds since $\theta'(N_t^*) > 0$ and $z'(0) = 0$. (Note that this condition holds for all *t*.) Next we show that in large-scale privatizations the government has an incentive not to sell all $\bar{N}$ firms in the first period, thus resorting to sequencing. In particular, if the government were to privatize all firms in the first period, the first-order condition $\frac{\partial V}{\partial N_t}$ for *t*=1 would be

$$\sum_{r=1}^{T} \rho^r \frac{\partial \theta(\bar{N})}{\partial N_1} - \rho^t \frac{\partial z(\bar{N})}{\partial N_1} > 0.$$

The government will not privatize all $\bar{N}$ firms in the first period if there is a positive benefit to switching at least one firm from being privatized in period 1 to period 2:

$$\frac{\partial V(\bar{N}, 0, ..., 0)}{\partial N_1} - \frac{\partial V(\bar{N}, 0, ..., 0)}{\partial N_2} < 0.$$

Recall that $z'(0) = 0$ so this condition may be written as

$$\left( \sum_{r=1}^{T} \rho^r \frac{\partial \theta(\bar{N})}{\partial N_1} - \rho \frac{\partial z(\bar{N})}{\partial N_1} \right) - \left( \sum_{r=2}^{T} \rho^r \frac{\partial \theta(\bar{N})}{\partial N_2} - \rho^2 \frac{\partial z(0)}{\partial N_2} \right)$$

$$= \rho \left( \theta'(\bar{N}) - \frac{\partial z(\bar{N})}{\partial N_1} + \rho \frac{\partial z(0)}{\partial N_2} \right)$$

$$= \theta'\left(\bar{N}\right) - \frac{\partial z\left(\bar{N}\right)}{\partial N_1} < 0. \qquad (4)$$

The government will therefore sequence privatization if the first period marginal benefit from privatizing the last firm in period one is less than the marginal transaction cost of doing so, which will hold if the marginal transaction cost of privatization rises sufficiently quickly in *N*. This condition is likely to hold in large-scale privatization programs where $\bar{N}$ is large.

We now relax the assumption of homogeneous firms and let firms vary in pre-privatization efficiency. We assume that the least efficient SOEs experience the greatest increase in efficiency when privatized.[17] Hence the government benefits more from privatizing less efficient firms and it enjoys the efficiency gain from privatizing a firm in period *t* for the remaining *T-t* periods. This implies that the government will rank the $\overline{N}$ SOEs from least to most efficient ones and privatize them in the order of increasing efficiency.[18]

We again let $\theta\left(N_t^*\right)$ denote the government's benefit from all privatization up to and including period *t.* Further $\theta'\left(N_t^*\right) > 0$, since there continues to be efficiency gains from privatizing additional firms. We expect that allowing for heterogeneity among firms will make $\theta\left(N_t^*\right)$ more concave than in the homogenous case, since as more efficient firms are being privatized, the marginal benefit from privatization, $\theta'(N_t^*)$, will decrease even faster. Transaction costs may also depend on the efficiency of firms being privatized. For example, transaction costs will be higher for less efficient firms if the government undertakes restructuring in order to prepare these firms for privatization. This could imply that transaction costs increase less rapidly as the more efficient firms are privatized over time. On the other hand, the government may consider it more worthwhile to hire privatization consultants for the valuable firms, so that transaction costs are higher for the more efficient firms. In this case the transaction cost function

[17] Kikeri, Nellis, and Shirley (1992) and Ahuja and Majumdar (1998) also assume that the worst firms are likely to gain the most from privatization.

[18] This result is analogous to results found in the literature on cost-benefit analysis of investment projects, where projects are ranked and then selected according to their internal rates of return.

would be more convex over time. While the effect on the convexity of $z(N_t)$ is indeterminate, given that $\theta(N_t^*)$ becomes more concave we assume that the objective function remains concave. Thus, the government's maximization problem will continue to be described by equations (1) and (2) and the conditions for sequencing remain as described in equations (3) and (4). As in the homogeneous case, the government will sequence privatization because of increasing transaction costs, but it will rank firms according to efficiency and sell the least efficient firms first. These firms gain more from privatization, and by privatizing them first the government obtains the benefits over a longer period.

The empirical prediction of the present model is that a government maximizing Pareto efficiency should privatize the least efficient firms first. In our empirical work, we look at two proxies for efficiency: profitability and labor allocation. The prediction with respect to the first is that the government should privatize more loss making firms first. With respect to the second proxy, the government should privatize first firms in which wages greatly exceed the marginal product of labor. In our data set we observe the average, and not the marginal, product of labor for each firm. However, since the two productivities are positively correlated, and are proportional to one another in production functions such as Cobb-Douglas, we use the difference between the average product of labor and the average wage in each firm as a proxy for firm inefficiency.

### 3.2 Maximizing public goodwill

In many transition economies a fraction of the shares of firms is transferred at a highly subsidized rate to all or a subset of interested citizens. For instance, the Czech Republic, Kazakhstan, Lithuania, Russia, Slovakia, Slovenia, and Ukraine used the voucher privatization method to transfer the shares. Privatization through vouchers alleviates public concerns that privatization enriches only a few individuals and generates public support for the government and its current and future reforms.[19] The Czech government was very much aware of this aspect of the privatization process.[20]

[19] As mentioned earlier, another benefit of the voucher scheme is that it partially overcomes the constraints of an underdeveloped capital market.

[20] The launching of the Czech voucher scheme was accompanied by a major public relations campaign to

Moreover, in the 1990s the average tenure of the governments in most Central European countries was around two years; hence the gap between the first and second waves of the large-scale privatization program gave the Czech government an incentive to sequence privatization in such a way as to maximize voter goodwill.

The government's maximization problem in this case may be cast in a way that is similar to that in the previous section. We briefly describe the problem because in the case of heterogeneous firms the optimal sequencing strategy of a government maximizing public goodwill is quite different from that of a government maximizing efficiency. Again we begin with the case of homogeneous firms and define $G\left(N_t^*\right)$ as a function measuring the government's public goodwill in period *t*, generated by having transferred a total of $N_t^*$ firms to the private sector by period *t* where again $N_t^* = \sum_{r=1}^{t} N_r$ . We assume that $G(0)=0, G'(0)=0$ and that $G'\left(N_t^*\right)>0, G''\left(N_t^*\right)<0$ for all $N_t^*$, i.e. public goodwill increases at a diminishing rate with the number of free transfers. We continue to let $z\left(N_t\right)$equal the transaction cost of privatizing $N_t$ firms in period *t*, and assume that it has the same properties as in the homogenous case of section (3.1). The government's optimization problem may be written (similar to equation (1)) as:

$$\max_{N_1,\ldots,N_T} L = \sum_{t=1}^{T} \rho^t \left(G\left(N_t^*\right) - z\left(N_t\right)\right) \text{ subject to } N_t \geq 0. \qquad (5)$$

Analogous to equation (2), the government chooses the optimal number of firms to be privatized in each period *t* according to

$$\partial L / \partial N_t = \sum_{r=t}^{T} \rho^r \frac{\partial G\left(N_t^*\right)}{\partial N_t} - \rho^t \frac{\partial z\left(N_t\right)}{\partial N_t} \leq 0, \qquad N_t \geq 0, \quad N_t \frac{\partial L}{\partial N_t} = 0. \qquad (6)$$

If $N_t > 0$ the government privatizes firms in period *t* to the point where the present discounted value of the marginal political goodwill equals the marginal transactions cost. Using the first order conditions for *t* = 2 in equation (6) we investigate whether the government will stop privatizing after selling $0 < N_1 < \bar{N}$ firms in the first period:

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generate goodwill for the government. Each voucher book displayed the signature of the prime minister, thus indicating clearly to whom the citizens should be grateful for their newly acquired wealth.

$$\sum_{r=2}^{T} \rho^{r} \frac{\partial G(N_1)}{\partial N_2} - \rho^{2} \frac{\partial z(0)}{\partial N_2} > 0. \quad (7)$$

Since $G'(N_t) > 0$ and $z'(0) = 0$, equation (7) holds. The government will not stop privatizing because it can gain public goodwill from privatizing at least one firm in the next period. The sequencing condition for the limiting case, which considers whether the government will sell all $\bar{N}$ firms in the first period (similar to equation (4)), is:

$$G'(\bar{N}) - \frac{\partial z(\bar{N})}{\partial N_1} < 0. \quad (8)$$

Equation (8) will hold and the government will not sell all the firms in the first period if the transaction cost of privatization rises sufficiently quickly and is larger than the marginal gain in public goodwill received in period 1 from selling the last firm. Again, this is likely to be the case in large-scale privatizations.

In the case of heterogeneous firms, the government will rank the SOEs in decreasing order of the discounted present value of the public goodwill that it receives from privatizing a firm in period *t*. The government will privatize the more profitable firms first, as the public is likely to value these firms more. Ranking the $\overline{N}$ firms from the most to least profitable, we redefine $G(N_t^*)$ and $z(N_t)$ for the case where the next firm to be privatized is the most profitable remaining firm. Again it is sensible to assume that $G'(N_t^*) > 0, G''(N_t^*) < 0$, where the second derivative is more negative with heterogeneous firms, since marginal public goodwill decreases as less profitable firms are privatized. As discussed in the previous section, transaction costs may increase at a faster rate as more profitable firms are privatized if the government is more likely to hire outside consultants for more valuable firms. On the other hand, transaction costs may be higher for less profitable firms if they require more costly pre-privatization restructuring. Thus it is reasonable to assume that the objective function remains concave and a redefined version of the first-order conditions in equation (6) determines the number of firms privatized in period *t*. The empirical prediction of this model is that more profitable

firms are more likely to be privatized first. Note that this is the opposite prediction from that obtained in Section 3.1.[21]

### 3.3 Minimizing political costs

In this section we analyze the sequencing decision of a government concerned about the political cost of layoffs and rising unemployment due to privatization. We consider the Central European setting where the governments freed prices, experienced a rapid rise in unemployment, and targeted remaining subsidies at keeping unprofitable firms afloat before launching privatization.[22] Since privatization involves restructuring and politically costly layoffs, a government will only continue with privatization if the unemployed workers are absorbed into the new private sector. In a similar context, Aghion and Blanchard (1994) develop a model where the optimal rate of privatization is determined by the rate at which new firms hire the laid off workers. We assume a similar equilibrating mechanism exists in the background of our model.

In our model, the rate of privatization in each period is again chosen to equate the marginal benefits and costs of privatizing an additional firm. To focus on political costs, we simplify the benefit side and assume that in any period *t* the government receives political goodwill from privatization equal to $\delta N_t^*$, where $\delta > 0$ and $N_t^*$ equals the total number of firms privatized up to and including period *t.* We again begin with the case of homogeneous firms and assume that in any period t there are political costs $C_{t,t}(N_t)$ of privatizing $N_t$ firms, where $C_{t,t}(0) = 0, C'_{t,t}(0) = 0$, $C'_{t,t}(N_t) > 0$ and $C''_{t,t}(N_t) > 0$ for all $N_t$. We also assume that the government incurs some future political costs stemming from privatizing $N_t$ firms in the present period, since some workers will remain unemployed beyond the current period. Specifically, next period these political costs will be $C_{t,t+1}(N_t)$ and *k* periods from now they will be

[21] Here we are ignoring the fact that some firms will have some monopoly power. This case is discussed in section 3.4 below.
[22] Between 1989 and 1992, subsidies to enterprises as a fraction of GDP fell from 25% to 5% in the Czech Republic and Slovakia.
[23] Their model does not allow for heterogeneous firms, and they are interested in the dynamics of private sector growth when the government is concerned about maximizing total output.

$C_{t,t+k}(N_t), C_{t,t+k}(0)=0, C'_{t,t+k}(0)=0, C'_{t,t+k}(N_t)>0$ and $C''_{t,t+k}(N_t)>0$.[24] Thus the present discounted political costs arising from privatizing $N_t$ firms today is

$\sum_{k=0}^{T-t} \rho^{t+k} C_{t,t+k}(N_t)$ where it is reasonable to expect that some workers laid-off due to privatization in period *t* will be absorbed in each of the later periods, so that political costs from privatization in period *t* diminishes over time:

$C_{t,t}(N_t) > C_{t,t+1}(N_t) > ... > C_{t,T}(N_t)$. The government's optimization problem is now

$$\max_{N_1,...,N_T} \tilde{V} = \sum_{t=1}^{T} \rho^t \delta N_t^* - \sum_{t=1}^{T}\sum_{l=t}^{T} \rho^l C_{t,l}(N_t) \quad \text{subject to } N_t \geq 0. \tag{9}$$

Since the objective function is concave (see Appendix A1), we focus on the following first order condition for maximization in period *t*:

$$\sum_{l=t}^{T} \rho^l \delta - \sum_{l=t}^{T} \rho^l \frac{\partial C_{t,l}(N_t)}{\partial N_t} \leq 0. \tag{10}$$

Assuming that $N_t$ is positive, the government will choose it to set the present discounted value of the marginal benefit from privatizing one more firm in this period equal to the present discounted value of the marginal political cost. Using the first-order conditions for $t = 2$ we investigate whether the government will sequence privatization. First, if the government sells $0 < N_1 < \bar{N}$ firms in the first period, it will continue to privatize in period 2 if

$$\delta - \sum_{l=2}^{T} \frac{\partial C_{2,l}(0)}{\partial N_2} > 0. \tag{11}$$

This condition is satisfied since $\delta > 0$ and $\frac{\partial C_{2,l}(0)}{\partial N_2} = 0$. Next we consider the corner solution where the government sells all $\bar{N}$ firms in the first period. A necessary condition for this to be optimal is

[24] Note that we make the simplifying assumption that $C_{t,t+k}(N_t)$ is independent of $N_{t+k}$.

[25] In the case of homogeneous firms, the model in this section and the models in the previous two sections can easily be combined. However, our focus is on heterogeneous firms (to explore which firms are privatized first) so we omit this to save space.

$$\delta - \sum_{l=1}^{T} \frac{\partial C_{1,l}\left(\bar{N}\right)}{\partial N_1} > 0 . \tag{12}$$

A sufficient condition is that the government cannot gain by switching the sale of one firm to period 2:

$$\partial \tilde{V}(\bar{N},0,...,0)/\partial N_1 - \partial \tilde{V}(\bar{N},0,...,0)/\partial N_2 < 0.$$

The condition for not sequencing in this case is given by

$$\left(\sum_{l=1}^{T} \rho^l \delta - \sum_{l=1}^{T} \rho^l \frac{\partial C_{1,l}\left(\bar{N}\right)}{\partial N_1}\right) - \left(\sum_{l=2}^{T} \rho^l \delta - \sum_{l=2}^{T} \rho^l \frac{\partial C_{2,l}(0)}{\partial N_2}\right)$$

$$= \rho\delta - \left(\sum_{l=1}^{T} \rho^l \frac{\partial C_{1,l}\left(\bar{N}\right)}{\partial N_1} - \sum_{l=2}^{T} \rho^l \frac{\partial C_{2,l}(0)}{\partial N_2}\right)$$

$$= \rho\delta - \sum_{l=1}^{T} \rho^l \frac{\partial C_{1,l}\left(\bar{N}\right)}{\partial N_1} > 0 . \tag{13}$$

The government will not sell all the firms in the first period if the marginal benefit in the first period from selling the last firm is less than the discounted marginal political cost of doing so. The condition in equation (13) will not hold if the marginal present discounted value of the political cost due to unemployment is sufficiently high.[26]

In the case of heterogeneous firms, since the discounted political costs incurred in period *t* accrue over the present period and the remaining *T-t* periods, the government prefers to privatize first those SOEs that will have the lowest layoffs. If political costs depend only on layoffs in the privatized firms, the government will privatize the more profitable and efficient firms first, since these firms will lay off the fewest workers. The government will order the firms in terms of decreasing profitability, and in each period will privatize the most profitable firms first. This ordering is the same as ordering for the case where the government focuses only on public goodwill (Section 3.2), and it is

[26] We also investigate whether the government has an incentive to delay privatization until period *T* in order to avoid the accumulated political costs of unemployment. Using conditions similar to equation (13) for periods *T* and *T-1*, it is straightforward to show that the government will not delay privatization until the last period.

opposite to that which occurs when the government focuses only on efficiency (Section 3.1). Since unprofitable firms that are likely to have more layoffs are privatized later, the political cost function will be more convex in this heterogeneous case, hence the objective function in (9) is expected to remain concave. Thus first-order conditions analogous to equation (10) determine the speed of privatization and the government privatizes the more profitable firms first.

In our data we test whether the more profitable firms, and firms in which the difference between the marginal product of labor and the wage is higher, are more likely to be privatized first. Political costs of further layoffs are also likely to be higher in industries or regions with high layoffs and unemployment. As a result, we hypothesize that SOEs in industries or regions with poor demand conditions are likely to be privatized later, everything else held equal. This prediction is quite useful since it potentially allows us to distinguish between the political cost model and the models of public goodwill and revenue maximization.

### 3.4 Maximizing efficiency through informational gains of privatization

Glaeser and Scheinkman (GS) have been the only authors to theoretically address sequencing, and their paper examines sequencing strategies that would increase efficiency.[27] They argue that a primary advantage of private ownership is that it enhances efficiency by improving firms' acquisition of, and responsiveness to, information. In their model private firms respond to demand and cost shocks, but this information is unobserved or ignored by public firms.[28] In particular, GS assume that SOEs produce a fixed level of output based on the expected values of demand and cost, while private owners observe the actual values and adjust their production when demand and cost conditions change. Thus if the government is concerned about increasing efficiency in this sense, the GS model predicts that privatization should begin where demand or cost volatility is the greatest and where it maximizes the flow of information.

[27] Shleifer and Vishny (1994) provide an indirect recommendation for increasing efficiency by the choice of firms to be privatized – see section 3.6 below.

[28] Public firms may be less responsive because in centrally planned regimes SOEs fulfill a production plan that is not necessarily consistent with market conditions. However, it is not necessary to assume that they ignore these shocks as long as private firms observe these shocks with greater accuracy than the public firms.

In our analysis we test two predictions of the GS model pertaining to sequencing privatization across industries. First, GS argue that when demand uncertainty is greater than cost uncertainty, downstream industries should be privatized before upstream industries, because downstream industries are better positioned to transmit information between the retail and upstream sectors. When the retail sector is private, as in the Czech Republic where retail firms were privatized prior to large-scale privatization, GS show that privatizing downstream firms should occur before upstream privatization so that the flow of information between the private upstream and the private retail sectors is not disrupted by the intermediate state-owned downstream sector. Second, GS argue that industries that experienced the highest demand or cost volatility should be privatized first since firms in these industries need to respond to changing market conditions and hence are likely to benefit the most from privatization. Many transition economies, including the Czech Republic, faced a collapse in product markets due to the break-up of the Soviet-era trading system. Since demand fluctuations were the main source of volatility in these economies, GS's model predicts that industries which were most affected by the collapse of the Soviet common market should be privatized first.

GS also note that the informational gains from privatization may be offset by a loss of consumer surplus if firms with significant market power are privatized and allowed to engage in monopoly pricing.[30]

The GS model hence suggests that firms in downstream industries, firms facing demand or cost volatility, and firms with low monopoly power are the best candidates for privatization. This is a different set of predictions than have been obtained in the previous models. In the empirical section we test whether downstream industries and industries that faced the greatest demand shocks were privatized first. We also test if the market share of a firm affects the probability of it being privatized early. If the government maximizes public goodwill from vouchers (section 3.2) or maximizes privatization revenues (section 3.5), firms with high market share should be privatized first since this variable may also act as a proxy for profitability. Thus the market share variable also

[29] This prediction may not hold when the industry is upstream and faces high levels of both demand and cost volatility. However, due to the collapse of the Soviet-era common markets, demand volatility is considered to be the main source of uncertainty confronting firms in the transition economies.

[30] Many have investigated whether monopolies create inefficiencies; see, for example, Demsetz and Lehn

allows us to compare the relative priority placed on revenue and public goodwill objectives versus efficiency objectives.

### 3.5 Maximizing privatization revenues

This model assumes that the government's objective is to maximize privatization revenues and that there is an asymmetry of information between the government and the buyers. Firms chosen for privatization may have characteristics that are unobservable to buyers, but are correlated with the value or profitability of the firms. Since these characteristics also are likely to be unobservable to researchers, the model directly predicts the selection bias problem that occurs in evaluating the effect of privatization.

We assume that the government knows the true value or long-term profitability of the firm, but buyers do not. [31] This assumption may be justified on the basis that not much was known about these firms prior to the collapse of the Soviet bloc, and by investors' high level of uncertainty about the future of the reform process. Our assumption is also consistent with Perotti (1995) who assumes that buyers are less informed than the government because of uncertainty regarding future policies that may affect the value of the firm. In our model a unique pure strategy equilibrium exists in which the government sells the more profitable firm first.

We use a two-period setting with two firms A and B, many buyers, and one seller. The firms' long-term profits are given by $\theta_{A,B} \in \Theta = \{\underline{\theta}, \overline{\theta}\}$, and $\theta$ can take on either of the two values with $\overline{\theta} > \underline{\theta}$. The two firms can be of the same type or of different types; the type of the firm is denoted by its profit. We assume that all buyers have the same information about the distribution of types of firms, i.e. they all have public information about the average profitability of the firms. To simplify issues, we assume that different groups of buyers bid in each period, although second period buyers observe the quality of the first period firm. Since there is uncertainty about firm type, the value of the firm to all

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(1985).

[31] The main results of our model may be obtained even if both the government and buyers observe some (different) private information about the firms (Chakraborty, Gupta and Harbaugh, 2000). Unlike Chakraborty et al., we allow second period buyers to observe direct information about the value of the first period firm, since this case is more relevant for the Czech experience.

buyers is given by the expected profits of the firm. The government is able to extract all the rents from the informational asymmetry.

The timing of the game is as follows: the types (profits) $\theta_i$, of the firms are assigned by nature, the government observes the types and picks firm A or firm B to be sold in the first period, and the firm is sold at a price equal to its expected value; in the second period, buyers observe the type of the first firm and then bid for the second firm.

To simplify notation, let A be the firm being sold in the first period and B the firm sold second. We specify the following probability distribution for the firms' profits:

$p(\theta_A = \bar{\theta}, \theta_B = \bar{\theta}) = p(\theta_A = \underline{\theta}, \theta_B = \underline{\theta}) = \alpha$, and

$p(\theta_A = \bar{\theta}, \theta_B = \underline{\theta}) = p(\theta_A = \underline{\theta}, \theta_B = \bar{\theta}) = \beta$, where $\alpha, \beta \in (0,1)$ and $2\alpha + 2\beta = 1$.

Next we calculate the prices offered for each firm under the two sets of buyer beliefs about the government's sequencing strategy.

*a) Buyers believe that the government will sell the better firm first.*

The probability that the first firm will be of high value, given that buyers' believe that the government will sell the better firm first, is given by $\alpha + 2\beta$. The first period price (the price offered for the firm sold in the first period) is the expected value of the firm given these buyer beliefs and is equal to

$$E\left(\theta_A \middle| \theta_A \geq \theta_B\right) = p_1 = \bar{\theta}\left(\alpha + 2\beta\right) + \underline{\theta}\alpha, \tag{14}$$

where we use the fact that $2(\alpha + \beta) = 1$. Under these beliefs about the sequencing strategy, buyers will believe that the first firm will be of low value if and only if both firms are of low value, and the corresponding probability is equal to $\alpha$.

In the second period buyers will observe the quality of the first firm. Correspondingly, the price for the second firm conditional on the value of the first firm is given by

$$p_2 = \begin{cases} \dfrac{\bar{\theta}\alpha + 2\beta\underline{\theta}}{\alpha + 2\beta} & \text{if the buyer observes } \theta_A = \bar{\theta} \\ \underline{\theta} & \text{if the buyer observes } \theta_A = \underline{\theta}. \end{cases} \tag{15}$$

When the second period buyers observe a high value first firm, conditional on their beliefs that the best firm is sold first, they will believe that the probability of the second firm being high value as well equals $\alpha$, while the probability of the second firm being low

value equals $2\beta$. However, if they observe that the first firm is of low value, given that they expect the government to sell the best firm first, they will conclude that the second firm must be low value. We use these prices to check whether it is an equilibrium strategy for the government to sell the better firm first under these buyer beliefs. Under these buyer beliefs, the respective payoffs in present value over both periods to the government from i) selling the better firm first or ii) deviating and selling the worse firm first, are given by

$$V^S = \begin{cases} \rho p_1 + \rho^2 \left( \dfrac{\bar{\theta}\alpha + 2\beta\underline{\theta}}{\alpha + 2\beta} \right) & \textit{if it follows and sells the good firm first,} \\ \rho p_1 + \rho^2 \underline{\theta} & \textit{if it deviates and sells the bad firm first,} \end{cases} \tag{16}$$

where $\rho$ is the discount factor. Using equation (16) it is straightforward to show that the payoff from selling the good firm first is greater than the payoff from deviating; hence the optimal strategy for the government, given that the buyers believe that it will sell the best firm first, is to follow.[32] To see the intuition behind this result, suppose that the buyers believe that the government will lead with the better firm, and the government deviates and sells the worse firm first. Given their beliefs, the buyers in the second period will then observe the low quality of the first firm and conclude that the second firm is of equal or lower quality. As a result, the second period price will be lower than if the government had kept to the strategy of selling the better firm first.

When the buyers believe that the better firm will be sold first, it is an equilibrium strategy for the government to lead with the best firm. We now show that this argument does not extend to the case where buyers believe that the government will sell the worst firm first.

b) *Buyers believe that the government will sell the worse firm first.*

As in the previous case, the first period price is the expected value of the firm given buyers' beliefs and is equal to

$$E\left(\theta_A \mid \theta_A \le \theta_B\right) = \bar{\theta}\alpha + \left(\alpha + 2\beta\right)\underline{\theta}\,. \tag{17}$$

The second period price depends on the realization of $\theta_A$ (the observed value of the first period firm) and is given by

[32] For an explicit expression of the difference in revenue, set $\gamma$ equal to 1 in Appendix B.1.

$$p_2 = \begin{cases} \bar{\theta} & \text{if the buyer observes } \theta_A = \bar{\theta}, \\ \dfrac{2\beta\bar{\theta} + \alpha\underline{\theta}}{\alpha + 2\beta} & \text{if the buyer observes } \theta_A = \underline{\theta}. \end{cases} \tag{18}$$

If the buyers believe the government will sell the worse firm first, the respective payoffs to the government from the two strategies are given by

$$V^S = \begin{cases} \rho p_1 + \rho^2 \left( \dfrac{2\beta\bar{\theta} + \alpha\underline{\theta}}{\alpha + 2\beta} \right) & \text{if it follows and sells the bad firm first,} \\ \rho p_1 + \rho^2 \bar{\theta} & \text{if it deviates and sells the good firm first.} \end{cases} \tag{19}$$

Equation (19) implies that the payoff from deviating is higher than the payoff from following, and the government will always choose to deviate when the buyers believe that it will sell the worst firm first. Hence, it cannot be equilibrium for the buyers to believe that the government will sell the worst firm first. To see this, suppose that buyers believe that the government will lead with the worst firm, and instead the government deviates and sells the better firm first. In this case, second period buyers observe the high quality of the first firm, and given their beliefs about the government's strategy, they conclude that the second firm is of equal quality. Thus second period buyers pay a higher price than they would if the government had sold the worse firm first; therefore when buyers believe that the government will sell the best firm last, it is always better for the government to deviate. The pure strategy equilibrium in this model is for the government to lead with the more profitable firm. **(**In our empirical work we use several measures of firm profitability to test whether the government in the Czech Republic privatized more profitable firms first.**)** We note that sequencing in this model arises due to the asymmetric information between the government and the buyers. A revenue maximizing government gains nothing from sequencing in this model if buyers are also fully informed about the value of the firms.

The analysis in this section may seem overly simple for two reasons. First, the Czech government held onto some of the shares of companies privatized in the first round to sell to investors at a later date, and this is not captured in our model. In Appendix B.1 we show that allowing the government to save a fraction of the first period firm to sell at its realization in the second period will not change the equilibrium result. Second, for simplicity we have ignored the profits received by the government during the first period

from the firm it does not sell. We show in Appendix B.2 that selling the best firm first will be the unique pure strategy equilibrium under reasonable parameter values.

### 3.6 Issues relevant to privatization in other countries

We now consider four aspects of sequencing that distinguish the Czech Republic from some other transition economies. First, consider the case of manager and worker buyouts. Most managers in the Czech Republic wanted their firms to be privatized in the first wave. Faced with this excess demand, the government decided how many firms, and which ones, would be privatized in the first and second wave, respectively. Moreover, firms' participation in the government-decreed privatization process was not voluntary. The government also sent a clear and early signal that management and employee buyouts were undesirable forms of privatization, and consequently few such buyouts took place. In Russia and the Ukraine, however, managers and worker buyouts were much more common.[33] In these cases it may not be easy to identify the government's sequencing decision, since privatization could be an outcome of joint bargaining between the government, managers, and workers.

Second, if capital markets are underdeveloped, governments may be unwilling to sell profitable firms in the initial stages of privatization because of the low purchasing power of domestic buyers. Voucher privatization was introduced in the Czech Republic in part to address this issue. The government could sell some shares of a firm for cash, distribute some through vouchers, and keep some for a later sale. In countries where voucher privatization is not favored, however, governments might privatize less profitable firms first.

Third, in some transition economies, governments sold particular firms to extend patronage to politically connected buyers. This occurred, for instance, in the second wave of privatization in Slovakia. There is little evidence to suggest that this was a widespread phenomenon in the Czech privatization program. In fact, the process was deliberately public to limit such outcomes.

[33] Around 55% of firms in Russia were sold through management and employee buyouts (World Bank, 1996).

Finally, Shleifer and Vishny (1994) observe that in a Russian-type institutional setting, both potentially profitable and loss-making firms receive government subsidies before privatization. Moreover, the government cannot avoid providing subsidies to unprofitable firms after privatization and these firms hence do not restructure. On the other hand, an implicit "decency constraint" ensures that profitable firms that are privatized can be cut off from subsidies and they are hence more likely to lay off surplus workers after privatization. As Shleifer and Vishny (1994, p.1023) point out, "potentially profitable firms are the best candidates for privatization, since they refuse to dissipate their profits on excess employment, whereas the hopeless firms continue getting subsidized." An implication of their model is that more profitable firms are the best candidates for early privatization in terms of improving efficiency. While this conclusion is similar to the prediction obtained in some of the models developed above, note that the Russian mechanism is very different from that in the Czech Republic, where government subsidies to firms declined dramatically from 25% to 5% of GDP between 1989 and 1992 and most firms started relying on bank loans.

## 4. Data, Specification, and Empirical Results

### 4.1 Our data and comparison to other studies

We use a large data set of firms sold in the Czech large-scale privatization program. The data have several notable advantages. First, they capture the important large-scale privatization program that was clearly divided into two non-overlapping waves. Second, they cover the population of medium and large industrial firms rather than a smaller (possibly non-random) subsample. Third, the data permit a clear identification of which firms were privatized early and which ones later. Fourth, the Czech data are of relatively good quality - a feature that is important since it is often difficult to obtain dependable firm-level data in transition economies.

Our original data set contains quarterly and annual observations, starting in 1992, on the population of all industrial firms with 25 or more workers, or approximately 2,500 firms. The data were reported by firms to the Czech Statistical Office and contain information from balance sheets and profit and loss statements. The reported variables

include sales, production, employment, average wages, total wage expenditures, accounting profits, and two-digit industry classification. Regional identification is not available.

From this data set we exclude approximately 750 firms that were either restituted to previous owners or privatized in the small-scale privatization program. Restitutions could be claimed during a period of several years, and the government allowed considerable latitude for the prior owners to submit their claims. Unlike the large-scale program, there was no explicit sequencing or waves in the small-scale privatization effort. Small-scale privatization was a continuous process, and its timing reflected the diverse capabilities of local government units more than sequencing. The small-scale firms are also not comparable to the firms privatized in the two waves of the large-scale program because they have significantly smaller asset size, employment, and output.[34] Since $30 billion worth of assets were privatized in the large-scale program, compared with $1 billion in the small-scale program, by focusing on the former program we are analyzing the privatization of the bulk of the property in the Czech Republic. [35]

We also exclude about 250 cooperatives and 37 electric and water utility companies. Cooperatives were not privatized in the large-scale privatization. Electric and water utilities were considered strategic and retained under state ownership at this stage of the privatization process. These exclusions yield data on 1,470 firms that went through the large-scale privatization program. For the purposes of our analysis, we need annual and first quarter 1992 values for sales, value of output, average wages, labor force, accounting profits, and industry classification for each firm. After deleting firms with missing values, we obtain our group of 1,121 firms. Of these firms, 664 were privatized in the first wave of the large-scale privatization process and 457 were privatized in the second wave.

In comparison, published studies of the effect of privatization on firm behavior in transition economies tend to use survey data on relatively small samples of firms. For example: Frydman, Gray, Hessel and Rapaczynski (1999) use a sample of about 200

[34] The value of output for the excluded firms is on average one-fifth that of the joint stock companies in the data.

firms; Barberis, Boycko, Shleifer**,** and Tsukanova (1996) use a similar size sample in their study of Russian shops; Bilsen and Konings (1998) use survey data on about 400 firms divided among Bulgaria, Romania, and Hungary; Grosfeld and Nivet (1997) use a sample of 173 of the largest 500 companies in Poland; and Claessens and Djankov (1999) use data on approximately 700 manufacturing firms from the Czech Republic.

### 4.2 Empirical specification

In section 3 we consider five possible government objectives that would determine the sequencing of firms for privatization. Of course, the government may care about several or all of these objectives. In this case a government will have to weigh the different objectives when sequencing privatization. We can think of the government as having a weighting function over the objectives or over the observable variables that reflect or capture these objectives. The probit equations that we estimate below may be interpreted as estimating such a weighting function over the observable variables. Alternatively, government decisions may be viewed as the result of bargaining between competing groups. In this case the government may be thought of as having an overall objective function that weighs the utility of competing groups. The weights depend on the bargaining power of the individual groups and the utility of each group depends on some or all of the explanatory variables that we use (Svejnar, 1982 and Prasnikar, Svejnar, Mihlajek, and Prasnikar 1994).

We estimate probit equations where the dependent variable is coded one if a firm is privatized in the first wave and zero if it is privatized in the second wave. We choose our explanatory variables to reflect the five theories summarized in Table 1. The revenue maximization and public goodwill models predict that the government will want to sell the more profitable firms first. To test the predictions of these models, we use (separately) annual 1992 values of three alternative variables as indicators of profitability: *PROFIT* (accounting profits); $(Q-W)$ (difference between the value of total output and the total wage bill); and $(Q/L-W/L)$ (difference between the value of average

[35] One could arguably include some of the firms privatized through auctions in the small-scale privatization program, but many of these firms were transferred to their new owners between 1990 and 1991, before our data begin.

product and the average wage) where $L$ is employment.[36] The three profitability variables complement one another. Accounting profit captures all input costs but may be subject to reporting error, while $(Q-W)$ and $(Q/L-W/L)$ underestimate total cost (because they ignore other inputs) but get directly at the relationship between revenues and labor cost.[37] The revenue maximization and public goodwill models both predict that these variables should have positive coefficients.

We also use an explanatory variable *MKSHARE* measuring the firm's market share in the industry (ratio of firm sales to industry sales) as a proxy for profitability. As noted above, the public goodwill and revenue maximization models predict that, as an indicator of profitability, *MKSHARE* should have a positive coefficient.

The Pareto efficiency model predicts that the estimated coefficient of $(Q/L-W/L)$ should be negative since firms in which wages most exceed the marginal product of labor are likely to benefit the most from restructuring. In this prediction we use the average product, $Q/L$ as a proxy for the marginal product. Alternatively, one can view the efficiency model as predicting that firms with the largest (negative) difference between the value of output and the total wage bill, or the greatest dollar losses, should be privatized first. The efficiency model thus has exactly the opposite predictions for our three profitability variables than the revenue maximization and public goodwill models.

We test the Glaeser and Scheinkman (GS) predictions regarding which industries should be privatized early to reap the informational gains from privatization by creating two dummy variables. The first dummy variable is *CMEA*, which is coded one for industries most affected by the break-up of the Soviet common trading area known as the CMEA and zero otherwise. Analyzing the effect of demand uncertainty is relevant because of what is known as the CMEA shock. The trading system of the Soviet bloc countries began disintegrating in 1990 and was dismantled in 1991, resulting in a collapse of trade. Exports between Central European countries fell 25% between 1989 and 1990 and were still 13% lower than the previous year in 1993. Similarly, imports from other

[36] We could probably increase the explanatory power of the equation by simultaneously including all three measures of profit in the specification. However, since this is likely to lead to multicollinearity problems, we do not estimate such an equation.

[37] Assets are reported only for a small number of firms in the data and including them would greatly reduce our sample size.

Central European countries to Czechoslovakia fell over 25% in 1991 and continued to fall through 1993. The trend is similar for exports between Central European countries and the former Soviet Union. Industries that relied heavily on exports to these other markets experienced considerable demand uncertainty after the collapse of the CMEA.

To identify industries that faced demand uncertainty because of the collapse of the CMEA, we selected industries that experienced declining exports and output after 1991, using evidence from the statistical yearbooks of the Czech Republic and the detailed discussion of this issue in Bohata, Hanel, and Fischer (1995). The industries included in this category are mining of non-energy materials, mining of metal ores, other mining, textiles, wood products, pulp and paper products, and other non-metallic mineral products.

Our second dummy variable, *DOWN*, is coded one for downstream (processed goods) industries and zero otherwise. The *DOWN* category includes food, tobacco, textiles, leather, footwear, paper, publishing, electronic machinery and equipment, and transportation.[38] GS show that privatizing downstream will be more efficient than upstream privatization if the retail sector is private. In the Czech Republic, retail and other service-oriented firms were privatized in the small-scale program prior to the start of large-scale privatization. The GS model suggests that firms in the *CMEA* and *DOWN* industries should be privatized first, since these firms are likely to benefit the most from increased responsiveness to information about demand conditions after privatization.[39] To test the proposition that firms with greater monopoly power should not be privatized early since they offer lower efficiency gains from privatization, we use *MKSHARE* as an explanatory variable. According to the GS model, the coefficients of *CMEA* and *DOWN* should be positive and that of *MKSHARE* should be negative. Since the public goodwill and revenue maximization models predict the opposite sign of the *MKSHARE* coefficient than the GS model, we can investigate the relative priority placed on efficiency by the government.

[38] We choose these firms following the discussion in GS.

[39] We wanted to include a variable for industries facing cost uncertainty, since GS recommend that these firms are good candidates for early privatization, but we could not obtain statistical evidence and the anecdotal evidence was inconsistent. The primary source of uncertainty facing firms in transition economies has been fluctuating demand conditions. Therefore, both the CMEA and DOWN variables capture one of the most significant sources of uncertainty affecting these firms.

Finally, consider the political cost model. This model predicts that the government will privatize more profitable firms first. We expect that the profitability variables will have positive coefficients, as in the public goodwill and revenue maximization models. The political cost model also predicts that the government will privatize firms in industries with strong labor demand first. We use the industry employment growth rate to proxy current labor market conditions in the industry. We expect the coefficient on this variable to be positive (stronger labor demand in an industry lowers the political cost of privatizing firms in that industry). If demand conditions are not important in determining the probability of privatization, this casts doubt on the political costs model, and allows one to distinguish it from the public goodwill model and the revenue maximization model. However, we should note that it might be hard to identify the effects of demand conditions on privatization for two reasons. First, we do not have regional data and must use industry-level data instead. Specifically, we use the difference between 1991 and 1992 industry employment rates, *EMPGR*, since these are not affected by the first wave of large-scale privatization. Second, although employment fell by an average of 11% between 1992 and 1991, there may be insufficient variation in employment growth across industries to precisely estimate the effect of labor market conditions. (The standard deviation of employment growth is 4.1% in our data.)

We start by estimating the parameters of the following probit equation:

$$y_i^* = \alpha_0 + \alpha_1 (Q/L - W/L)_i + \alpha_2 MKSHARE_i + \alpha_3 CMEA + \alpha_4 DOWN + \alpha_5 EMPGR + u_i, \quad (20)$$

where $u_i$ has a standard normal distribution and $y_i^*$ is a latent index. A firm is privatized if $y_i^*$ is greater than zero. To test the sensitivity of our results to the measure used for profits (or the degree of inefficiency), we replace $(Q/L - W/L)_i$ with $(Q - W)_i$ in equation (20) while retaining $MKSHARE_i$:

$$y_i^* = \beta_0 + \beta_1 (Q - W)_i + \beta_2 MKSHARE_i + \beta_3 CMEA + \beta_4 DOWN + \beta_5 EMPGR + \varepsilon_i. \quad (21)$$

Finally, to investigate further the sensitivity of our results to the choice of profit variables, we replace $(Q - W)_i$ with accounting profits $PROFIT_i$ and estimate:

$$y_i^* = \gamma_0 + \gamma_1 PROFIT_i + \gamma_2 MKSHARE_i + \gamma_3 CMEA + \gamma_4 DOWN + \gamma_5 EMPGR + v_i. \quad (22)$$

Table 1 contains a summary of the predictions of the theoretical models developed in section 3 and it also lists the variables used to capture these predictions.

### 4.3 Econometric issues

In order to ensure that the explanatory variables capture firm performance before the firms were turned over to new owners starting in the spring of 1993, we use 1992 annual values for the firm-specific independent variables: $(Q/L - W/L)_i$, $(Q - W)_i$, $PROFIT_i$ and $MKSHARE_i$. (We do not have data prior to the first quarter of 1992.) There may be an endogeneity problem for some of these variables if their values were affected by the knowledge of whether the firm would be privatized in the first wave. This information became available at the end of April 1992 and thus the values from May to December 1992 could be affected by whether the firm was chosen for privatization. However, the future owners could not affect the values of these variables since the actual transfer of shares to new owners did not occur until May 1993 or later. Existing evidence suggests that little restructuring occurred in the second half of 1992. Thus we do not expect this endogeneity issue to be serious, but we cannot rule it out.

To investigate this issue, we test for the endogeneity of the annual 1992 firm-specific values using the test outlined in Rivers and Vuong (1988). Specifically, we estimate first stage equations for each of the annual 1992 firm-specific variables using all of the 1992 first quarter values of the firm-specific variables as instruments. The model is well identified in the sense that the p-values for the F test on the excluded explanatory variables in the first stage equations are always below 0.01.[40] Under the assumption of multivariate normality, we then enter both the respective 1992 annual values and their residuals from the first-stage into the relevant probit equation. We test the null hypothesis that the annual values are exogenous using Wald tests for whether the coefficients on the residuals are significantly different from zero, either individually or jointly. We find that the null hypothesis of exogeneity is rejected only for accounting profits. Thus when we estimate equation (22), we also enter a fitted value for accounting profits and adjust the standard errors to account for this fitted value (Amemiya 1978).

[40] The first stage results are reported in the Appendix Table A1.

While studies in the transition and development literatures commonly use data reported by firms in balance sheets and income statements, the variable measuring accounting profits may arguably be affected by inappropriate accounting methods. We address this issue by using (as proxies for profitability) other variables such as the difference between total output and the wage bill, the firm's market share, and the difference between the average product of labor and the average wage. (However, one advantage of the accounting profit variable is that it nets out the cost of raw materials and energy.) There also may be concerns that our explanatory variables are based on prices from the Communist era and hence are largely irrelevant in predicting firms' performance in a market economy. Fortunately, most prices were liberalized on January 1, 1991, the 20 percent temporary import surcharge was eliminated at the end of 1991, and the average import tariff was set at a mere 5%. Therefore, our 1992 data already reflect world prices in the context of modest inflation. Finally, the question arises as to whether stock market prices could be used to measure profitability. However, these prices report post- rather than pre-privatization performance of firms and hence cannot be used to predict whether a firm is privatized in the first wave. Moreover, this variable is not even available in 1993 for firms not privatized in the first wave.

### 4.4 Empirical results

In Table 2 we presents the mean 1992 values of the explanatory variables. Column 1 contains the values for all firms, while columns 2 and 3 contain the values for the firms privatized during the first wave and the second wave, respectively. Column 4 contains the t-statistic for the null hypothesis that the mean values in columns 2 and 3 are equal. Note that firms privatized in the first wave are, on average, more likely to be in downstream industries and have higher average values of profits, average product minus average wage, value of output minus wage bill, and market share. These firms are also more likely to have been affected by the collapse of the CMEA, but the difference between the first and second wave firms for this variable is not statistically significant. Finally, there is very little difference in mean industrial employment growth between the two types of firms.

Table 3 presents our results for the specifications given by equations (20), (21), and (22). In the first three columns of Table 3, we report our results using annual 1992 values for the firm-specific variables. We also report the Wald and likelihood-ratio test statistics from the Rivers and Vuong (1988) exogeneity tests for each of the annual firm-specific variables in each specification. As mentioned earlier, we reject the null hypothesis of exogeneity for the accounting profits variable only. In column 4 we treat accounting profits as endogenous. (First stage estimates are provided in Table A1.)

In column 1 of Table 3, both *CMEA* and *DOWN* have positive and statistically significant coefficients (at the 10 percent and 1 percent levels respectively), as predicted by the GS model. The coefficient of the variable measuring the difference between the value of average product of labor and the average wage, $(Q/L - W/L)_i$, has a positive sign and is also statistically significant. This result is consistent with the government minimizing political cost and maximizing privatization revenues and public goodwill; it is inconsistent with the government maximizing Pareto efficiency.

The coefficient on the market share variable captures two effects. While dead-weight loss may be lower if firms with monopoly power are not privatized early (as recommended by GS), this variable may also proxy profitability. If the first effect dominates, we expect the coefficient to be negative. If the second effect dominates, we expect the coefficient to be positive. We find a positive and statistically significant coefficient on market share, suggesting that the profit effect dominates. Finally, the coefficient on the industry employment growth variable, which measures labor demand conditions affecting political costs, is not statistically significant at standard confidence levels casting doubt on the political costs model. As a result, we attribute the positive coefficients on the profit variables to the government maximizing revenue and/or public goodwill.

In column 2 of Table 3 we use market share and the difference between the value of total output and the wage bill as proxies for profitability. These results are quite similar to those in column 1. In column 3 we replace the difference between the value of total output and the wage bill with accounting profits. The results are similar to those in columns 1 and 2 except that the coefficient on accounting profits has a statistically insignificant coefficient. However, the null hypothesis that this variable is exogenous is

rejected. Thus, in column 4 we treat accounting profits as endogenous. The results are similar to those in columns 1 through 3, although treating accounting profits as endogenous substantially increases its coefficient and statistical significance.[41]

Finally, to examine the possibility that equations (20), (21) and (22) are too rich to identify the effect of the employment growth variable, we consider a narrower specification that eliminates the industry dummy variables *CMEA* and *DOWN*. These results are quite similar to those in Table 3, and the coefficient of the employment growth variable remains statistically insignificant.[42] As noted earlier, one possible explanation is that the relatively low level of variation in this variable across industries leads to an insignificant coefficient on this variable.

For the sake of completeness, we also estimated probit equations using the first quarter 1992 data, rather than annual 1992 data, for the firm-specific variables. These estimates are similar to those based on annual data and we report them in Appendix Table A2. The only difference is that the coefficient on accounting profits is not statistically significant, perhaps because this variable is subject to seasonal fluctuations.

## 5. Conclusion

In the numerous privatization programs around the world, governments have virtually never privatized all firms simultaneously. This raises the issue of whether governments sequence privatizations strategically on the basis of their objectives. We first present five theoretical models of privatization that relate to alternative government objectives as seen by economists, political scientists and sociologists: maximizing Pareto efficiency, maximizing public goodwill, minimizing political cost, maximizing economic efficiency through informational gains of privatization, and maximizing privatization revenues. The models provide concrete predictions about the sequencing of privatization and we test these predictions using micro data from the Czech large-scale privatization program.

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[41] One could argue that variables such as $PROFIT_i$ or $(Q-W)_i$ may simply be picking up a size effect, although there is no theoretical reason to include size. Our results, however, are very similar when we use $(Q/L-W/L)_i$, which is independent of firm size.

[42] The results are available from the authors upon request.

Our empirical evidence suggests that governments sequence the privatization of firms strategically rather than randomly. We find strong evidence that the Czech government privatized first firms that were more profitable, firms in downstream industries, and firms in industries subject to greater demand uncertainty. Privatizing more profitable firms first is inconsistent with maximizing Pareto efficiency but it is consistent with maximizing privatization revenues, maximizing public goodwill and minimizing the political cost of unemployment. However, the implication of the political cost model that employment growth in the firm's industry should affect sequencing is not supported by our data. Our finding that firms in downstream industries and in industries with greater demand uncertainty were more likely to be privatized early suggests that the government placed emphasis on efficiency in the Glaeser and Scheinkman (1996) sense, namely by privatizing first firms that required flexible management. However, in contrast to the GS recommendation, but consistent with the general evidence regarding profitability, firms with higher market share were more likely to be privatized first.

In future work it will be important to use data from economies with more variable employment growth to assess the role of political costs in these economies. It may also be possible to distinguish between the revenue maximization and public good will models if we can determine the information sets of the government and the buyers at the time of first period sales. Our revenue maximization model depends on a difference in these information sets, while our public goodwill model does not.

In addition to providing key evidence on the nature of the privatization process, our results have important implications for studies evaluating the effect of privatization. Many of these studies measure gains from privatization by comparing the performance of privatized firms to firms that are still in the public sector.[43] Such comparisons are valid only if firms are randomly chosen for privatization. For example, if the government selectively privatizes better firms (as our results suggest), it would not be surprising to see these privatized firms perform better than firms that remain public, even if privatization had no effect on firm performance. Thus our results suggest that it is

[43] For an earlier survey see Vining and Boardman (1992). Studies investigating the effects of privatization include Galal et al. (1994), Estrin (1994), Kikeri, Nellis, and Shirley (1992), Megginson, Nash and van Randenborgh (1994), Gordon and Li (1995), Boubakri and Cosset (1997), Claessens and Djankov (1999), and Gray and Holle (1997).

necessary to investigate the possibility of selection bias in such an evaluation. A similar statistical problem arises in studies examining the effect on firm performance of the length of time since privatization. Our result that more profitable firms are likely to be privatized early implies that unobserved characteristics that make the firms more profitable may be correlated with the length of time they have been privatized.

A few studies have considered selection bias in privatization. LaPorta and Lopez de Silanes (1999) address this problem by using SOEs in the same sector as a comparison group, but this method does not account for selection biases from firm-specific characteristics. In their analysis of the restructuring of Russian shops after privatization, Barberis, Boycko, Shleifer, and Tsukanova (1996) allow for the possibility that the new ownership structure is endogenous, but they assume that privatization is exogenous.[44] Frydman, Gray, Hessel, and Rapaczynski (1999) estimate the effects of privatization on performance and control for selectivity in privatization using fixed effects methods. This approach provides unbiased estimates if the selection effect is time invariant. Time changing selection effects can be controlled for by combining our modeling approach with that of Heckman (1979) and Lee (1978).[45] Both the fixed effects approach of Frydman et al. (1999) and the selection method using our modeling approach have advantages and disadvantages and thus may be viewed as complementary (Heckman and Robb, 1985 and Vella, 1998). In future work it will be interesting to use both methods in evaluating the effect of privatization.

[44] In choosing their sample they stratify on privatization status. They later analyze only privatized firms without correcting for selection bias.

[45] Frydman et al. (1999) also consider time changing factors, but they assume that the timing of privatization, conditional on being chosen for privatization, is exogenous.

**Table 1**

**Theoretical Predictions of Models of Privatization**

| Theory | Variable[a] | Definition | Sign |
|---|---|---|---|
| **1) Maximizing Pareto Efficiency** | $(Q/L - W/L)_i$ | Value of Average Product – Average Wage | - |
| | $(Q - W)_i$ | Value of Output - Total Wage bill | - |
| | $PROFIT_i$ | Accounting Profit | - |
| | $MKSHARE_i$ | Market Share | - |
| **2) Maximizing Public Goodwill** | $(Q/L - W/L)_i$ | | + |
| | $(Q - W)_i$ | | + |
| | $PROFIT_i$ | | + |
| | $MKSHARE_i$ | | + |
| **3) Minimizing Political Cost** | $(Q/L - W/L)_i$ | | + |
| | $(Q - W)_i$ | | + |
| | $PROFIT_i$ | | + |
| | EMPGR | Employment growth rate in industry between 1991 and 1992 | + |
| **4) Maximizing Efficiency Through Informational Gains[b]** | CMEA | Demand shock industry dummy | + |
| | DOWN | Downstream industry dummy | + |
| | $MKSHARE_i$ | | - |
| **5) Maximizing Privatization Revenues** | $(Q/L - W/L)_i$ | | + |
| | $(Q - W)_i$ | | + |
| | $PROFIT_i$ | | + |
| | $MKSHARE_i$ | | + |

[a] An i subscript denotes a firm specific variable.
[b] This is the Glaeser and Scheinkman (1996) model.

**Table 2**
**Means of Principal Variables in 1992 By Privatization Status of Firms**
(Standard deviations of means are in parentheses.)

| Variable | Values for All firms | Firms privatized in Wave 1 | Firms privatized in Wave 2 | Normal Statistic $H_o$: (2) = (3) |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| CMEA | 0.255<br>(0.013) | 0.267<br>(0.017) | 0.239<br>(0.020) | 1.06 |
| DOWN | 0.678<br>(0.014) | 0.702<br>(0.018) | 0.643<br>(0.022) | 2.06** |
| $PROFIT_i$ | 37.9<br>(5.42) | 47.2<br>(8.31) | 24.5<br>(5.53) | 2.06** |
| $(Q/L-W/L)_i$ | 0.505<br>(0.016) | 0.542<br>(0.022) | 0.452<br>(0.021) | 2.78*** |
| $(Q-W)_I$ | 396.8<br>(37.62) | 505.4<br>(61.07) | 238.9<br>(23.63) | 3.50*** |
| $MKSHARE_i$ | 0.020<br>(0.002) | 0.024<br>(0.002) | 0.013<br>(0.002) | 3.53*** |
| EMPGR | -11.14<br>(0.124) | -11.11<br>(0.160) | -11.18<br>(0.195) | -0.286 |
| Number of observations | 1,121 | 664 | 457 | - |

*Note 1* - Profits, value of total output, wage bill, firm sales, and industry sales are measured in millions of Czech crowns, where 1 U.S. dollar was equal to about 30 Czech crowns at the time. The firm-specific variables are calculated using annual 1992 observations and are denoted by an i subscript.
*Note 2* - * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.

**Table 3**
**Estimates of the Probability of A Firm Being Privatized**
Dependent variable equals one if the firm is privatized in the First Wave.
Firm-specific RHS variables are annual 1992 observations.
(Standard errors are in parentheses.)

| Variable | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| CMEA | 0.164* | 0.186** | 0.159* | 0.167* |
| | (0.092) | (0.092) | (0.092) | (0.092) |
| DOWN | 0.236*** | 0.268*** | 0.265*** | 0.265*** |
| | (0.086) | (0.086) | (0.086) | (0.086) |
| $MKSHARE_i$ | 3.229*** | 1.892* | 3.157*** | 2.763** |
| | (0.933) | (1.027) | (0.973) | (1.203) |
| EMPGR | -0.001 | 0.004 | 0.010 | 0.008 |
| | (0.011) | (0.010) | (0.009) | (0.010) |
| $(Q/L - W/L)_i \times 10^{-4}$ | 2.012** | - | - | - |
| | (0.860) | | | |
| $(Q - W)_i \times 10^{-7}$ | - | 2.701*** | - | - |
| | | (0.814) | | |
| $PROFIT_i \times 10^{-7}$ | - | - | 4.722 | 8.304* |
| | | | (3.363) | (4.763) |
| Rivers and Vuong LR joint test for exogeneity of firm-specific variables: $\chi^2_{(2)}$ (Prob > $\chi^2_{(2)}$) | 0.43 | 0.80 | 3.49 | |
| | (0.806) | (0.671) | (0.175) | |
| Rivers and Vuong Wald individual tests for exogeneity $\chi^2_{(1)}$ (Prob > $\chi^2_{(1)}$) | $(Q/L - W/L)_i$: | $(Q - W)_i$: | $PROFIT_i$:: | |
| | 0.32 | 0.59 | 3.10*** | |
| | (0.573) | (0.442) | (0.078) | |
| | $MKSHARE_i$: | $MKSHARE_i$: | $MKSHARE_i$: | |
| | 0.06 | 0.01 | 0.43 | |
| | (0.799) | (0.937) | (0.512) | |

*Note* - In columns 1 - 3 the firm-specific variables (denoted by an i subscript) are treated as exogenous. In column 4, annual profit is treated as endogenous. The first stage results are reported in Appendix Table A1. A constant is included but not reported. The sample contains 1,121 firms. See notes to Table 2.

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# Priorities and Sequencing in Privatization:
## Theory and Evidence from the Czech Republic

**by**

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# Additional Results Appendix[46]

[46] To be made available to readers on the University of Michigan

**Appendix Table A1**
**First Stage Estimates of the Annual 1992 Firm-Specific Variables**
(Standard errors are in parentheses.)

| | Dependent variables using annual 1992 observations | | | |
|---|---|---|---|---|
| | $(Q/L - W/L)_i \times 10^{-4}$ | $(Q-W)_i \times 10^{-7}$ | $MKSHARE_i$ | $PROFIT_i \times 10^{-7}$ |
| **Explanatory variables using quarter 1, 1992 observations for firm-specific variables** | | | | |
| $CMEA \times 10^{-3}$ | 0.280<br>(1.091) | -0.075<br>(1.91) | -0.148<br>(0.754) | 0.477<br>(0.843) |
| $DOWN \times 10^{-3}$ | 0.083<br>(1.030) | -1.852<br>(0.181) | -0.730<br>(0.711) | -0.017<br>(0.795) |
| $MKSHARE_i$ | 0.003<br>(0.011) | -0.017<br>(0.019) | 0.958***<br>(0.008) | -0.027***<br>(0.008) |
| $EMPGR \times 10^{-4}$ | 9.156***<br>(1.226) | 2.196<br>(2.150) | -0.525<br>(0.847) | 0.157<br>(0.947) |
| $(Q/L - W/L)_i \times 10^{-4}$ | 3.665***<br>(0.038) | -0.015<br>(0.066) | -0.020<br>(0.026) | -0.009<br>(0.029) |
| $(Q - W)_i \times 10^{-7}$ | 0.021<br>(0.020) | 4.075***<br>(0.034) | 0.048***<br>(0.014) | 0.384***<br>(0.015) |
| $PROFIT_i \times 10^{-7}$ | -0.285**<br>(0.124) | -2.156***<br>(0.218) | -0.312***<br>(0.086) | 1.030***<br>(0.096) |
| $R^2$ | 0.919 | 0.956 | 0.958 | 0.585 |
| Number of observations | 1121 | 1121 | 1121 | 1121 |

*Note* - Dependent variables are the annual observations from 1992. The right-hand side firm-specific variables, denoted by an *i* subscript, are observations from the first quarter of 1992. See notes to Table 2.

**Appendix Table A2**
**Estimates of the Full Model Using First Quarter 1992 Data**
(Standard errors are in parentheses.)

| Variable | 1 | 2 | 3 |
|---|---|---|---|
| CMEA | 0.164* | 0.182** | 0.151* |
| | (0.092) | (0.092) | (0.092) |
| DOWN | 0.234*** | 0.262*** | 0.253*** |
| | (0.086) | (0.086) | (0.086) |
| $MKSHARE_i$ | 3.007*** | 1.892** | 3.191*** |
| | (0.902) | (0.999) | (0.933) |
| EMPGR | 0.001 | 0.006 | 0.010 |
| | (0.010) | (0.009) | (0.009) |
| $(Q/L - W/L)_i \times 10^{-4}$ | 6.683** | - | - |
| | (3.313) | | |
| $(Q - W)_i \times 10^{-7}$ | - | 8.151*** | - |
| | | (2.939) | |
| $PROFIT_i \times 10^{-7}$ | - | - | 3.811 |
| | | | (9.515) |

*Note* - Firm-specific variables are observations from the first quarter of 1992. See notes to Table 2.

## Appendix - Additional Results

### *A Concavity of the Objective Functions in Sections 3.1 – 3.3*

### *A.1 Concavity of the Objective Function in Section 3.1 and 3.2*

Consider the objective function in 3.1. We need to show that the function $H(N_1,...,N_T)=\sum_{t=1}^{T}\rho^t\left(\theta\left(N_t^*\right)-z\left(N_t\right)\right)$ is concave. It is simpler to consider the terms

$H_1(N_1,...,N_T)=\sum_{t=1}^{T}\rho^t\theta\left(N_t^*\right)$ *and* $H_2(N_1,...,N_T)=-\sum_{t=1}^{T}\rho^t z\left(N_t\right)$, where

$H(\bullet)=H_1(\bullet)+H_2(\bullet)$, since the sum of concave functions is a concave function.

Considering $H_2(\bullet)$ first, note that $\partial^2 H_2(N_1,...,N_T)/\partial N_t\partial N_\tau=0$ *for* $t\neq\tau$. Further,

$\partial^2 H_2(N_1,...,N_T)/\partial N_t^2=-\dfrac{\partial^2 z\left(N_t\right)/\partial N_t^2}{\left(1+\rho\right)^t}<0$, given our assumptions concerning $z\left(N_t\right)$.

Again using the fact that the sum of concave functions is also concave, $H_2(\bullet)$ is concave.

Now consider the term $H_1(N_1,...,N_T)$. It is sufficient to investigate the concavity of the function $\tilde{\theta}_\tau\left(N_1,....,N_t,....,N_T\right)=\theta\left(\sum_{r=1}^{\tau}N_r\right)=\theta\left(N_\tau^*\right),\tau=1,...,T.$ Define the terms $N_T^{*1}=\left(N_1^1,N_2^1,....,N_T^1\right)$ and $N_T^{*2}=\left(N_1^2,N_2^2,....,N_T^2\right)$ and consider $\tau=T$.

Then

$$\tilde{\theta}\left(\lambda N_1^1+(1-\lambda)N_1^2,...,\lambda N_t^1+(1-\lambda)N_t^2,...,\lambda N_T^1+(1-\lambda)N_T^2\right)$$

$$=\theta\left(\sum_{r=1}^{T}\lambda N_r^1+\sum_{r=1}^{T}(1-\lambda)N_r^2\right)=\theta\left(\lambda\sum_{r=1}^{T}N_r^1+(1-\lambda)\sum_{r=1}^{T}N_r^2\right)$$

$$=\ \theta\left(\lambda N_T^{*1}+(1-\lambda)N_T^{*2}\right)$$

$$>\lambda\theta\left(N_t^{*1}\right)+(1-\lambda)\theta\left(N_t^{*2}\right)\ =\lambda\theta\left(\sum_{r=1}^{T}N_r^1\right)+(1-\lambda)\theta\left(\sum_{r=1}^{T}N_r^2\right)$$

$$=\ \lambda\tilde{\theta}_T\left(N_1^1,...,N_t^1,...,N_T^1\right)+\ (1-\lambda)\tilde{\theta}_T\left(N_1^2,...,N_t^2,...,N_T^2\right),$$

where the strict inequality arises from the fact that $\theta(\cdot)$ is concave. Thus

$\tilde{\theta}_T\left(N_1,...,N_t,...,N_T\right)$ is concave. A similar argument holds for $\tilde{\theta}_\tau\left(N_1,...,N_t,...,N_T\right), \tau = 1,...,T-1$. Thus $H_1(\bullet)$ is concave, implying that $H(\bullet)$ is also concave. The argument for equation (5) for section 3.2 is identical.

### A.2 Concavity of the Objective Function in Section 3.3

We want to show that the following function is concave

$h(N_1,...,N_T) = \sum_{t=1}^{T} \rho^t \delta N_t^* - \sum_{t=1}^{T}\sum_{l=t}^{T} \rho^l C_{t,l}\left(N_t\right)$. Note that

$\partial^2 h(N_1,...,N_T)/\partial N_t \partial N_\tau = 0 \quad for\ t \neq \tau$. Further,

$$\partial^2 h(N_1,...,N_T)/\partial N_t^2 = -\sum_{l=t}^{T} \rho^l \frac{\partial^2 C_{t,l}\left(N_t\right)/\partial N_t^2}{\left(1+\rho\right)^l} \quad < \quad 0, \text{ since } C''_{t,l}(\bullet) > 0.$$

Hence the objective function is concave.

## B. Extensions of the Asymmetric Information Model in Section 3.5

### *B.1 Allowing the Government to Keep a Fraction 1-$\gamma$ of the Shares of Firms Sold in the First Round*

The Czech government often held on to some shares of the companies privatized in the first round for the explicit purpose of selling the shares later. In terms of the model in section 3.5, we assume that for the firms privatized in the first round, the government sells a fraction $\gamma$ of the shares in the first round, and receives $\gamma P_1$ revenue in the first round. In the second round it sells the remaining 1-$\gamma$ of the shares. Since the value of the firm is revealed in the first round it receives (1-$\gamma$) $\bar{\theta}$ if the firm is revealed to be a good firm, and (1-$\gamma$) $\underline{\theta}$ if the firm is observed to be bad firm. We show that the best foot forward is still the unique pure strategy equilibrium.

If the government announces best foot forward and does indeed sell the best firm first, its revenue is

$$V_g = \rho\gamma p_1 + \rho^2\left[\frac{\theta\alpha + 2\beta\underline{\theta}}{\alpha + 2\beta}\right] + \rho^2(1-\gamma)\bar{\theta}\ .$$

If it deviates and sells the bad firm first, it receives

$$V_b = \rho\gamma p_1 + \rho^2\underline{\theta} + \rho^2(1-\gamma)\underline{\theta}\ .$$

Since

$$V_g - V_b = \rho^2\left\{\left[\frac{\bar{\theta}\ \alpha + 2\beta\underline{\theta}}{\alpha + 2\beta}\right] - \underline{\theta} + (1-\gamma)\left(\bar{\theta} - \underline{\theta}\right)\right\} > 0\,,$$

it pays to follow.

If the government announces that it will sell the worst firm first and follows it obtains,

$$V_b = \rho\gamma p_1 + \rho^2\left[\frac{2\beta\bar{\theta} + \alpha\underline{\theta}}{\alpha + 2\beta}\right] - \rho^2(1-\gamma)\underline{\theta}\ .$$

If it deviates and sells the best firm first, its revenue stream is

$$V_g = \rho\gamma p_1 + \rho^2\bar{\theta} + \rho^2(1-\gamma)\bar{\theta}\ .$$

It will deviate from its announced strategy because

$$V_b - V_g = \rho^2\left\{\left[\frac{2\beta\bar{\theta} + 2\underline{\theta}}{2+2\beta}\right] - \bar{\theta} + (1-\gamma)\ (\underline{\theta} - \bar{\theta})\right\} < 0\,.$$

### B.2 Accounting for Current Period Profits

In section 3.5 we ignored the fact that the government will receive profits in the first period from whichever firm it sells in the second period. Denote the per period profit from a good firm by $\bar{\mu}$. Assuming that the present discounted value of the stream of profits equals the firm value, we have[47]

$$\bar{\theta} = \frac{\rho}{1-\rho}\bar{\mu} \ \text{ or } \bar{\mu} = \frac{(1-\rho)\bar{\theta}}{\rho}\,.$$

A bad firm produces profit $\underline{\mu}$ each period, where

$$\underline{\theta} = \frac{\rho}{1\text{-}\rho}\underline{\mu} \ \text{ or } \ \underline{\mu} = \frac{(1-\rho)\,\bar{\theta}}{\rho}\,.$$

[47] Thus we assume that privatization takes place in the first two periods of an infinite horizon economy.

If the government announces best foot forward and follows, its revenue stream is

$$V_g = \rho p_1 + \rho\underline{\mu} + \rho^2\left(\frac{\bar{\theta}\alpha + 2\beta\underline{\theta}}{\alpha+2\beta}\right)$$

$$= \rho p_1 + (1-\rho)\underline{\theta} + \rho^2\left(\frac{\bar{\theta}\alpha + 2\beta\underline{\theta}}{\alpha + 2\beta}\right).$$

If the government announces best foot forward and deviates by selling the bad firm first, its revenue stream is

$$V_b = \rho P_1 + (1-\rho)\bar{\theta} + \rho^2\underline{\theta}$$

The government will follow if $V_g > V_b$ or if

$$V_b - V_g = (1\text{-}\rho)(\underline{\theta} - \bar{\theta}) + \rho^2\left\{\left(\frac{\bar{\theta}\alpha + 2\beta\underline{\theta}}{\alpha + 2\beta}\right) - \underline{\theta}\right\}$$

$$= \left(\frac{\rho^2\alpha}{\alpha + 2\beta} - (1\text{-}\rho)\right)(\bar{\theta} - \underline{\theta}) > 0.$$

The term $\rho$ is the discount factor, and a reasonable parameter value for it is 0.97. The term $\alpha$ is the probability the firms are the same type. A sufficient condition for the government to follow best foot forward is $\alpha > .04$. (Note that under independence, $\alpha = \beta = .25$ and A.12 is certainly satisfied.)

Next consider whether the government will deviate or follow if it announces worst foot forward. Its revenue stream if it follows is

$$V_b = \rho p_1 + (1\text{-}\rho)\bar{\theta} + \rho^2\left(\frac{2\beta\bar{\theta} + \alpha\underline{\theta}}{\alpha + 2\beta}\right).$$

Its revenue stream if it deviates is

$$V_g = \rho p_1 + (1\text{-}\rho)\underline{\theta} + \rho^2\bar{\theta}.$$

It will deviate if the revenue from selling the good firm first is greater than the revenue from selling the bad firm first, or if

$$V_g - V_b = -(1-\rho)(\bar{\theta} - \underline{\theta}) + \rho^2\bar{\theta} - \rho^2\left(\frac{2\beta\bar{\theta} + \alpha\underline{\theta}}{\alpha + 2\beta}\right)$$

$$= \left(\bar{\theta} - \underline{\theta}\right)\left\{\frac{\rho^2\alpha}{\alpha + 2\beta} - \left(1 - \rho\right)\right\} > 0 .$$

This is exactly the same condition considered immediately above; thus under reasonable parameter values the government will deviate if it announces worst foot forward, and under these parameter values, best foot forward is the only pure strategy equilibrium.