



The Vouchers Privatization Process as a Price Discovery Mechanism

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Abstract. The privatization process through which governments transfer their holdings vary from one country to another. The coupon (or voucher) privatization process, which has been frequently utilized in Eastern Europe, is generally characterized by a transfer of government holdings to the public for less than their full economic value. The vouchers process in the Czech Republic, specifically, is a case in which the transfer was practically free and in which foreign participation was banned. As such, and in the absence of an actual flow of funds, the process constituted an interesting large-scale experiment of a price discovery mechanism whose empirical conclusions are inconclusive. On the one hand, the variance of the expected outcomes declines during this process, but on the other hand, the participants could obtain superior outcomes using public information, while some, who had access to private information, may performed even better. Thus, wondering whether the process in the Czech Republic served as an efficient price discovery mechanism, additional potential distortions should be investigated: (i) the specific rules of the process through which the public exchanged bidding points for shares, or (ii) the role that funds' managers played, in lieu of the potential conflict between their objective functions and those of the shareholders of these funds, and (iii) lack of uniformity in information reporting standards.

Generally, a failure to discover prices may lead to inefficiency in capital markets, because of the potential distortion of relative prices. If, in fact, the process in the Czech Republic, during the 'second wave', in which most of the shares of over 800 companies were transferred to the private sector, did not serve as an immediate price discovery mechanism, the 'damage', if any, was probably not significant, since it was not associated with a massive reallocation of funds, and the market could eventually correct itself once real funds started to pour in, in reaction to post-process relative prices.

1. Introduction

This paper focuses on the issue of whether the vouchers privatization process conducted in the Czech Republic was able to serve as an efficient price discovery mechanism, that is, whether shares previously owned by the government, that were transferred to the private sector, caused the least amount of distortion in relative prices. In general, if such a process fails to provide this kind of price discovery mechanism, a distortion in the relative costs of capital may, on the one hand, enhance the livelihood of firms that should have been doomed and may, on the other, doom firms that should have survived. Transferring shares to the public for

their full or partial price, or at no cost, is less of an issue as long as these shares are transferred in some denomination that reflects their true relative values.

It is the contention of this paper that this process may have caused some distortion. The argument was tested empirically with data from the vouchers privatization process in the Czech Republic. The paper hypothesizes that, if an 'abnormal' return could be obtained by the participants in the process, given ex-ante indications that were based on available public information, the reason for this was the specific set of rules of the process that may have led to a distortion in the relative costs of capital.

The findings of this paper confirm this hypothesis. Additionally, the paper finds that the objective function of one of the major players – the investment funds – namely, the objective to maximize the immediate post-privatization management fee, was not compatible with an efficient long-term price discovery mechanism. This conclusion may be supported by Claessens (1997), who found that the more concentrated ownership was, the higher were the prices that the bidders were willing to pay, and similarly, was the impact of an absolute ownership by a single domestic investor.

In addition to the issue raised by this paper, there exist other interrelated issues, some of which have been already discussed in the literature. The techniques through which the government transfers its asset holdings to the private sector vary in different countries and at different points in time. The common denominator, however, is that the move or intention to privatize the public sector is viewed, economically, as a positive one. A number of papers have been written on this topic, indicating that the issues are important or may still be unresolved. A thorough review of the issues is given in Bolton and Roland (1992). The debate in the literature encompasses four major interrelated issues:

1.1. SPEED AND SEQUENCING OF THE PRIVATIZATION PROCESS

This issue has attracted attention in view of the mass privatization recently conducted in Eastern Europe and in several other countries. Most academicians favor the simultaneous and rapid process, the "big-bang" approach, arguing, that it calls for a more efficient process, since it basically 'liberates' the economy faster from the distorting role that the state may have played. Additionally, these scholars realize that a continuous process may take more than a century to transpire (see Lipton and Sachs (1990), Blanchard et al. (1991), Frydman and Rapaczynski (1991), Boycko et al. (1993), Blanchard (1994)). Few authors argue for the gradual process, primarily to avoid the immediate counter-effect of reversal in the privatization policies (see Katz and Ownes (1993), Laban and Wolf (1993), Roland (1994)).

1.2. CURRENT REVENUES VS. FUTURE REVENUES

From a practical point of view, should a government sell shares for their 'full price', a partial price, or give away these shares? One could argue that the state trades future residual earnings for the sale price, which must be equal to the present value of future after-corporate-tax earnings. The issue remains whether those future earnings should reflect the firm's performance under government ownership, or, future earnings under a more efficient, privately owned, firm (recent literature supports the view that firms' performance improves after privatization). Additionally, as long as the flow of savings, or mechanisms ensuring a future inflow of funds into the privatized entities, would react to the true set of relative costs of capital, the present value of future corporate taxes could exceed the portion of the "full" price currently given away by the state. Thus, the main issue is, in fact, the impact of the process on the set of *relative* costs of capital implied from the sale prices. If this implied set resembles the efficient one, the issue of the *level* of prices is less important, especially if the participation of foreign investors is restricted.

Bolton and Roland (1992) favor the non-cash bids if the flow of savings can not absorb the massive stock of state assets. Maskin (1991) shows that the absence of wealth constraints, coupled with cash bid auctions, is an efficient mechanism. This is confirmed by Boyco, et al. (1994), who argue that in a full price auction the highest-value users should be those capable of reaping the largest efficiency gains from restructuring. However, in an environment with significant wealth constraints, assets may not end up in the hands of the highest-value users, and therefore the pattern of holding may be less concentrated. Laban (1991) argues that a lack of private capital reflow and a clear preference for extremely low-risk liquid assets may hamper the success of the process.

There are additional angles to this issue which are related, for instance, to the post-privatization pattern of ownership, the expertise of the management team, and the power vested in the hands of interest groups – political or financial – such as banks and investment funds.

1.3. CONTROL AND DEGREE OF CONCENTRATION IN THE NEWLY PRIVATIZED FIRMS AND THEIR RELATIONSHIP TO THE RESTRUCTURING OF THESE FIRMS AND THE RESUMPTION OF GROWTH

Some authors fear that a privatization scheme allowing for a dispersed post-privatization pattern of ownership would not lead to an efficient restructuring of the firms. A broadly dispersed pattern of ownership weakens the monitoring activity of the shareholders and strengthens the management position, thus ensuring that the firms will remain politicized (see Carlin and Mayer (1992) Boyco et al. (1994)). In an environment with significant wealth constraints, assets may not end up in the hands of the highest-value users, and hence the pattern of holding may be less concentrated. Begg (1991) and Roland (1994) have pointed out that the experience in the Czech Republic can not serve as a proof for this hypothesis. In Israel, for

example, the government conditions such sales on the existence of a controlling group that would presumably ensure future inflow of investment funds into the firms.

1.4. THE EMERGENCE OF EFFICIENT FINANCIAL MARKETS

This issue has been dealt with sporadically. Some authors have linked the issue solely to the role that the banks have played in the privatization process (see, for example, Sijlstra (1995)). Laban (1991) implied that the preferences of market participants were clearly biased towards highly low-risk liquid assets, while investment in equity did not seem to be attractive. Begg (1991), Frydman and Rapaczynski (1990), and Newbery (1991) suggested writing off debts placed during the pre-privatization era, since a competitive market does not price the debt instruments. The financial aspect of privatization techniques such as auctions has been mentioned in Bolton and Roland (1991) and many others, while Fluck et al. (1995) have discussed various mechanisms in the presence of corruptible state agents.

Forming a complete framework for this issue will require simultaneous answers to several questions. This paper, while analyzing the voucher privatization process in the Czech Republic, is concerned with the issue of whether the sale prices reflect or reveal the true efficient set of relative costs of capital. Collinge (1985) put it slightly differently, saying that the challenge is to provide incentives for allocative and technological efficiency, which is conditional upon knowledge of the complete schedule of benefits. Bolton and Roland (1992) have argued that in a market with wealth-constrained participants, non-cash bids can reveal willingness rather than ability to pay. This argument, however, serves only as a partial justification, since the objective function of the participants and the set of rules of the specific privatization technique must be considered.

This paper focuses on a single issue that might affect the answers to the other issues: does the voucher mechanism serve as an efficient price discovery mechanism? Section 2 of the paper will describe the second wave of voucher privatization in the Czech Republic. Section 3 will analyze the set of rules of the process and its impact on the efficiency of the process in tandem with an analysis of the set of information, which was made available to the various participants. Section 4 will describe the data set, Section 5 will describe the methodology and the hypotheses, and Section 6 will describe the results.

2. The 'Second Wave' in the Czech Republic

On February 15th, 1994, the '*second wave*' of privatization began in the Czech Republic when the government approved the privatization of 861 companies. The process ended in December of 1994. Newly privatized companies were listed for

trading on the local exchange in early 1995.* We bring here some additional crucial rules of the process during the 'second wave'.

Initially, the Ministry of Privatization set a nominal value for each firm. The nominal value was basically the balance sheet equity as of the end of December 1993, with some minor adjustments, divided by a factor of about 1.11. In some rare cases, the companies were allowed to reorganize the balance sheet reporting their equity at a more or less realistic value.

Up to 97% of the firms' shares was offered to the public. The remaining shares were offered to local municipalities, restitution funds, domestic or foreign investors, or were slated to be held by the government indefinitely or until a later sale. At the same time, each Czech citizen received a voucher book containing 1000 investment points. The citizens subsequently validated a total of 6.3 million books, each paying a registration fee of about 36 USD. The total number of shares offered for privatization was 155 million shares, with a total nominal value of 5.5 billion dollars. On the average, each voucher book of 1000 points was equivalent to about 24 shares. Thus, the Ministry set initial prices such that each 1000 point represented an entitlement to 20 shares of any company on the list.

Each citizen had a choice of allocating his 1000 investment points to any one company or to up to ten different companies, all of which had an initial denomination of 100 points for *two* shares. Alternatively, the citizen could assign his or her points to an investment fund. On 1 February, 1994, just before the process started, 3.9 million citizens (63.4%) assigned their shares to one of 349 previously established investment funds, and 2.2 million decided to invest their points on their own. Unlike the first wave, in which the investment funds promised a return of up to 10,000 Crowns (350 dollars) to each citizen for shares in the fund one year later, in the second wave, a few funds offered 3000 Crowns, while only one offered 8000 Crowns.

It was not mandatory to allocate all the points in the first round. In the first round, in which the denomination was pre-set as two shares for 100 points for any company on the list, 77% of the individual citizens actually allocated their points, while 23% waited for the second round. On the other hand, 98.9% of the investment funds actually allocated their points. Most of the points of all the participants were allocated to a small set of companies, thus, creating a situation in which these companies were 'over bought'; i.e., the number of points allocated (divided by 50) exceeded the number of shares offered. Any company that was 'overbought' by more than 125% was fully transferred to the second round, in which no bidder received any shares. For these companies, the denomination was set higher, in the range of 0.2 to 1.5 shares for 100 investment points.

For the companies which were overbought by up to 125%, the individual investors received their full bid, while the bid of the investment funds was satisfied

* The sources of information used for this paper are the local 1993-1994 FNM publications and local newspapers. A description of the first wave appears in Begg (1991), and in Grosfeld and Hare (1991).

on a pro-rated basis, such that exactly 100% of the offered shares were sold. If the demand was up to 100% of the shares, bidders received their entire subscription. These companies were not fully sold at the end of the first round. Thus, the denomination was generally set lower, in the range of 3 to 24 shares for 100 investment points. For companies which were almost fully sold, the denomination for the second round was generally set higher.

If S_j shares of company j are available to the private sector during a certain round, and N_{ij} is the subscription of individual i to company j , and p_j is the pre-set number of shares a bidder may receive in this round for each 100 points allocated to company j , the fraction q_i that a bidder i may receive out of S_j shares available at this round is:

$$q_i = \frac{\frac{N_{i,j}}{S_j} \left\{ \min \left[\frac{p_j \sum_i N_{i,j}/100}{S_i} - 1.25; 0 \right] / \left[\frac{p_j \sum_i N_{i,j}/100}{p_j S_i} - 1.25 \right] \right\}}{\max \left[1, \frac{p_j \sum_i N_{i,j}/100}{S_i} \right]}. \quad (1)$$

This satisfaction of the purchase order occurs as an irreversible single event. If the process, however, allows for a continuous bidding mechanism, the variance of the bidding results can be significantly lower. The continuous process is clearly advantageous because it minimizes the distortion of the relative values of the privatized firm.

2.1. DENOMINATION SETTING BY THE MINISTRY OF PRIVATIZATION

The Ministry set the denominations for the second round such that the total number of points remaining for the second round was approximately equal to the number of remaining shares. While in the first round,

$$p_j \cong \sum_j S_j / \left(\sum_i N_i / 100 \right), \quad (2a)$$

the goal in the second round was,

$$\left(\sum_i N_i / 100 \right) \cong \sum_j S_j / p_j, \quad (2b)$$

where N_i is the number of points remaining with individual i , S_j is the number of shares of firm j remaining for the second round, and p_j is the denomination, i.e., the number of shares per 100 investment points, set for the second round.

The Ministry's technique of setting the rules of the process, in general, and setting the denomination, in particular, is one of the main issues analyzed in this paper (see Section 3.2). In principle, the Ministry's goal was to assure a convergence of the process into equilibrium denominations such that all shares would be 'bought'

and no investment points would be 'used' within five rounds. (See also Svejnar and Singer (1994) and Hingorani et al. (1996).)

2.2. THE OUTCOMES OF THE PROCESS

91.1% of the overall number of points were actually allocated in the first round, of which 18.7% were satisfied. The 18.7% of the points was equivalent to 13.5% of the total number of shares. Interestingly, the public (on its own) managed to satisfy 15.8% of its subscription, while the funds managed to satisfy 20%. Presumably, since the companies which were the favorites in the first round were ostensibly the blue chips, the above figures indicate better performance on the part of the funds. Ex-post, however, the public performed better than the funds did in the first round by having a lower rate of participation in this round.

Since the range of prices for the second round was 0.2 to 24 shares per 100 investment points, it meant that some companies were 120 times more expensive than others, as opposed to having equal prices in the first round. The allocation in the second round was naturally biased towards the least expensive shares. These observations are summarized in Table 1 for all five rounds.

At the end of the fourth round, just before the scheduled fifth and final one, 32.03 million shares remained unsold (21% of the shares), and only 710 million points have not been allocated. This was probably a result of a miscalculation on the part of the Ministry while setting the prices for each round, since its goal had been to reach the fifth round with very few shares. Due to the large number of shares and points left at the end of the fifth round, the Ministry decided to set a sixth round. On the average, each 1000 investment points for the fifth round commanded about 50 shares, as opposed to 20 shares in the first round. At the end of the fifth round, total number of points remaining was about 200 million and the number of shares was about 4.4 million. Thus, the final ratio of unsold shares was, on the average, 2.2 shares for 100 investment points. In the sixth round, most of the shares cleared the market and most of the investment points were used.

The process lasted for 11 months, during which time the government raised 229 million dollars and transferred free to the public a balance sheet equity of 5.3 billion dollars. On the average each citizen received free transfer worth about \$800 of a balance-sheet-value (about 24,000 Crowns).

3. The Voucher Privatization Process as a Price Discovery Mechanism

This section will analyze two major weaknesses in the Czech-type vouchers privatization process that could have lead to some distortion with respect to price discovery. The goal of the process is to provide a mechanism for revealing the true relative prices of the privatized entities, whereby the true prices are the ones, which reflect all available information. If the process fails to provide such a mechanism, it will lead to a distortion in the relative costs of capital, and may thereby enhance the

Table 1. The official results of the five rounds of the voucher privatization

Initial	First round				Second round			
	Points allocated (in billions)	Fraction satisfied (in %)	Fraction of initial hold (%)		Points left for round	Points allocated (in billions)	Fraction satisfied (in %)	Fraction of initial hold (%)
Total # of points (in billions)	6.16	5.61	20.94	18.70	5.11	4.57	35.85	13.30
Citizens	2.25	1.74	5.50	15.80	1.97	1.64	11.91	8.70
Funds	3.91	3.87	15.44	20.00	3.14	2.93	23.94	17.90
	Third round				Fourth round			
	Points left for round	Points allocated (in billions)	Fraction satisfied (in %)	Fraction of initial hold (%)	Points left for round	Points allocated (in billions)	Fraction satisfied (in %)	Fraction of initial hold (%)
Total # of points (in billions)	2.99	2.79	29.72	15.2	1.97	1.80	37.31	34.09
Citizens	1.50	1.34	17.72	14.3	1.07	0.91	22.99	42.32
Funds	1.49	1.45	12.0	17.0	0.90	0.89	14.32	28.64
	Fifth round							
	Points left for round	Points allocated (in billions)	Fraction satisfied (in %)	Fraction of initial hold (%)				
Total # of points (in billions)	0.71	0.66	77.80	72.32				
Citizens	0.39	0.34	50.53	85.51				
Funds	0.32	0.32	27.27	56.24				

Source: National Assets Fund (FNM) Czech Republic; Official Notification.

livelihood of firms that should have been doomed, while possibly dooming firms that should have survived.

If it is believed that the process provides such a mechanism, it involves two simultaneous hypotheses, first, that the voucher process is efficient and that the final process denomination, p shares per 100 investment point, reflects the true costs of capital, and second, that the final process denomination is highly correlated (negatively) with the first post-process trading price (keeping in mind that the first post-process trading took place only few months after the final process price was set).

Formally, we make the following three assumptions:

ASSUMPTION A. During the process, there was a vector of expected post-privatization prices, $\bar{P}_j$, $j = 1, T$, which denotes the prices at which shares are expected to be traded, matched with the expected earnings per share, or E_j , $j = 1, T$.

ASSUMPTION B. The only change in the set of information during the process was the results of the interim round-bidding, $1, 2, \dots, r$, $r \leq 5$, given the pre-set denominations, $p_j^1, p_j^2, \dots, p_j^r$. Information arrived, after the final process price p_j^r was set, and before the first post-process trading, was random, and it affected the price of a share j by an amount ϵ_j . It is assumed that ϵ_j was normally distributed with a zero mean.

ASSUMPTION C. There exists a constant market-uniform λ representing the expected monetary value of one investment point (alternatively, the risk-adjusted expected earnings times p is a constant over all firms equals $100\lambda \cdot r^f$, where r^f is the riskfree rate of return), so that,

$$\delta_j = E_j / \bar{P}_j \quad \forall j \quad \text{and} \quad \delta_j^* = p_j E_j / 100\lambda \quad \forall j. \quad (3)$$

Hence, efficiency implies $\delta_j / \delta_i = \delta_j^* / \delta_i^* \quad \forall i, j$, where δ is the growth-adjusted costs of capital. Moreover (3) implies,

$$\bar{P}_1 p_1 = \bar{P}_j p_j = \dots = \bar{P}_T p_T \quad j = 1, T. \quad (4)$$

The Ministry of Privatization set a goal, namely, obtaining an equitable distribution among all the participating citizens within five rounds. In other words, setting p_j^r so that,

$$\bar{P}_j p_j^r = \text{constant} \quad \forall j, \quad (4a)$$

which is equivalent to (4).

Under Assumption B, the relationship between the expected price $\bar{P}_j$ and the actual post-process trading price is,

$$\bar{P}_j = \gamma \cdot P_j + \epsilon_j, \quad (5)$$

where new information is reflected in γ (representing market wide information), which is assumed to be unity,* and firm specific information ϵ_j with a zero mean across firms. Hence, it follows that,

$$\bar{P}_j p_j^r = \frac{1}{T} \sum_j P_j p_j^r. \quad (5a)$$

* The assumption of $\gamma \neq 1$ would change the analysis as long as γ is constant across all firms, since a constant γ means that relative expected price are equal to relative actual prices. Additionally, the following must be true: $\bar{\lambda} = \gamma \lambda$ where $\bar{\lambda}$, λ are the "expected" and "actual monetary value of one investment point, respectively.

The testable implications of this model will be discussed in Section 4, in which we verify as to whether the voucher privatization process, which was described in Section 2, served as an efficient price discovery mechanism. In the next step we will introduce arguments that may support the view that the voucher privatization in the Czech Republic was likely to distort relative prices, partially because of specific rules which were governing the process, and partially because of the objective functions of the managers of the investment funds. If we demonstrate, however, that the process failed to discover the true relative prices it does not necessarily indicate that the capital market in the Czech Republic has subsequently become inefficient.

3.1. THE OBJECTIVE FUNCTION OF THE INVESTMENT FUNDS' MANAGERS

The most powerful bidders in this process were the managers of the investment funds. Most of the funds being so heavily in debt due to the recruiting costs, had a very short horizon, i.e., maximizing the first official market value of the funds, based on which they recouped some of the costs and obtained their first proportional management fee. Under the assumption that these managers were concerned with the immediate reward, rather than maximizing, on behalf of the citizens who pledged their investment points to the fund, the risk-adjusted, expected long-term rate of return, this could exacerbate the inefficiency of the process. If, to begin with, the set of rules of the process failed to reveal the true post-process prices, then the managers of these funds would favor the shares of firms with the *lowest* long-term expected rates of return. This is simple to demonstrate: Assume that the objective function of the managers is to maximize the first post-processes value of their total number of points, i.e.,

$$\begin{aligned} \max_j \sum_j \left\{ \frac{N_{ij}}{100} p_j \bar{P}_j \right\} \\ \text{s.t. } \frac{N_{ij}}{100} p_j \bar{P} \leq S_j \bar{P}_j, \end{aligned} \quad (6)$$

where N_{ij} is the number of points of fund i invested in firm j , and S_j is the number of shares of firm j to be privatized. If (4) is violated in the short run, *given* p , the higher $\bar{P}$, the higher this firm would be ranked by the manager. But if it is believed that (4) will prevail in the long run, it implies a relatively higher initial price but lower long term rates of returns. In other words, if $\bar{P}$ in (4) represents the long term expected prices, managers would intentionally pick the firms that, in the short run, violate (4), specifically, firms with higher relative $\bar{P}$. Thus, if the process does not serve as mechanism for price discovery, fund managers are likely to exacerbate the distortion. Note that if (4) holds in the short run as well, then all firms would be equally ranked, irrespective of the manager's objective function.

Additionally, note that solving (6) also requires knowledge of the probability that the fund which allocates N_{ij} would actually receive $N_{ij}p_j/100$ shares. In fact, the fund could receive any number of shares between zero and $N_{ij}p_j/100$ shares. The closer this bid is to S_j , the lower the probability of getting the full amount. Thus, given the optimization tactic of the manager, his ranking may have little resemblance to the ranking of expected long-term rates of return. Moreover, the rules of the process, while disregarding this probability, are not able to assure convergence to the relationship in (4).

3.2. THE RULES OF THE PROCESS

In a two-bidders, two-firms game, where there are four possible outcomes only if the players agree beforehand to take a different strategy will they be able to obtain the best results. In the absence of a side bet mechanism, there is no reason to assume that the best outcome can be achieved. This is true even if the game is repeated again and again. Ironically, the more information the bidders have about the outcomes and their opponents, the less likely it is that a clearing solution will be obtained.

An example will suffice to illustrate that the following rules should have been applied to the voucher process:

1. All bidders must be compelled to allocate all their remaining points in each round.
2. It should be made known that the market will clear at the end of the fifth round, i.e. no points and no unsold shares can remain.
3. After one or two rounds, in which the prices p are readjusted, the remaining rounds should be at the same price.
4. At the end of the fifth round, all unused points should be randomly assigned to unsold shares at the last round p .

In order to show that, consider the following example:

Initially, there were a total of $\bar{N}$ voucher points to be allocated among the privatized companies. Each bidder may allocate N_i , $i = 1, K$ among any number of companies.

Assume that there are two companies, each with 20 shares to be privatized, or $S_1 = 20$, $S_2 = 20$. Expected post-process prices are, $\bar{P}_1 = 1500$ and $\bar{P}_2 = 500$. There are two bidders, each with 1000 points to be allocated.

Assume now that for some reason, the initial risk-adjusted expected returns on equity are 10% and 10.01%, respectively. Obviously, the second security should be favored. We will show that the first security may be consistently favored and that the Ministry of Privatization has no way of correcting this inefficiency under the actual set of rules of the process.

The Ministry did not know the set of the bidders' expected post-privatization prices, otherwise it could have set the initial voucher prices to remain the same for all rounds. Since the Ministry needs to learn about the bidders' expectations, the

following arbitrary initial prices are set: $p_1 = 20$ shares per 1000 points, $p_2 = 20$ shares per 1000 points.

The results are surely going to be as follows:

Both bidders will bid the entire 2000 points on the first company since if they get the shares:

$$\bar{P}_1 p_1 = 1500 \times 20 > \bar{P}_2 p_2 = 500 \times 20. \quad (7)$$

Even if both bidders know that this would be the result, they would not bid for the second company since there are still four rounds to be repeated.

As of the second round, if the government had known the expected prices of the bidders, the prices, p_1 , p_2 for the second round would have been set as follows:

$$\bar{P}_1 p_1 = \bar{P}_2 p_2. \quad (8)$$

Additionally, it must be true that

$$p_1 \left(\frac{N_1}{100} \right) = S_1, \text{ and simultaneously } p_2 \left\{ \frac{(\bar{N} - N_1)}{100} \right\} = S_2, \quad (9)$$

i.e. that the number of points allocated for the first and second companies will exactly match the availability of shares.

Given Equations (8) and (9), and $N = 2000$, the only simultaneous solution for these equations is:

$$p_1 = 13.333 \quad \text{and} \quad p_2 = 40. \quad (10)$$

The only problem is that even if the Ministry had known the expected prices, N_1 and therefore $\bar{N} - N_1$ can not be controlled by Ministry. In other words, in order to conclude the bidding process in the second round, the two bidders must, based on Equation (9), allocate:

$$N_1 = 1500 \quad \text{and} \quad N_2 = \bar{N} - N_1 = 500. \quad (11)$$

However, since the bidders (from (10)) are indifferent with respect to the companies, there is no reason to believe that the allocation would be different than 1000 for each company. In fact, any pair of numbers we choose other than $\{1500, 500\}$, including allocations of less than the full 2000 available points, would prevent the conclusion of the process.

In the event that the allocation is $\{1000, 1000\}$, the results would be as follows, even under the best case scenario, in which the results of the first round would give the Ministry true indications about expected post-process prices:

1000 points allocated for the first company will receive 13.333 shares, while the 1000 points allocated to the second company will create excess demand. Thus, no shares of the second company will be sold.

The third round will start with

$$S_1 = 6.666 \quad \text{and} \quad S_2 = 20 \quad \text{and} \quad \bar{N} = 1000.$$

Once again, Equation (9) must be satisfied. The solution is: $p_1 = 13.333$, $p_2 = 40$, and the desired allocations are,

$$N_1 = 500 \quad \text{and} \quad N_2 = \bar{N} - N_1 = 500.$$

In practice, the rule was that the government would set the prices as follows:

$$p_1 \geq 13.333 \quad \text{and} \quad p_2 \leq 40.$$

Additionally, total actual points allocation was generally less than 1000. The process could have been concluded only if all 1000 points were allocated, 500 to each company, and the prices p_1 , p_2 should have been left unchanged.

The process continues, such that by the fifth round it must be true that $p_1 = 13.333$, $p_2 = 40$, and all available points must have been allocated in equal amounts and used, thereby leaving no shares unsold.

The likelihood that this would materialize under the actual set of rules is nil.

Once the prices had been changed or not all M available points had been allocated, the process could have continued indefinitely. More importantly, the first firm was consistently favored or equally favored over the second firm, whereas the latter should have been favored.

4. Methodology

The basic hypothesis, as per Equation (4), is,

$$\bar{P}_j \cdot p_j^f = \text{constant} \forall j, \quad (12)$$

where p_j^f is the final process denomination and $\bar{P}_j$ is the expected price just prior to the end of the process. Equation (5a) states that,

$$\bar{P}_j p_j^f = \frac{1}{T} \sum_j P_j p_j^f. \quad (12a)$$

That is, the final round, expected value of, say, 100 investment points, is equal to a fixed number, namely, the average post-process value of these 100 points.

Using, therefore, the expected prices derived by (5a) for the final round, we can form the first hypothesis.

HYPOTHESIS A. The process is an efficient price discovery mechanism since,

$$\lim_{r \rightarrow \infty} Va[\bar{P}_j p_j] \rightarrow 0. \quad (13)$$

That is, as the rounds continue, the variance of the expected outcomes must decline to zero as r , or the number of rounds, increases (it is zero by definition in the final round).

Alternatively, we can rank all firms in each round by the expected outcome and by using the expected prices derived from (5a).

HYPOTHESIS B. The process is an efficient price discovery mechanism since, given the total number of firms, T' in a certain round, $T' \subset T$,

1. The T'' -highest-ranked firms will be overbought (in a manner explained in Section 2), and
2. The T''' -lowest-ranked firms will attract no points.

Our tests, however, may reject the hypothesis, without being able to prove that the alternative hypothesis is valid:

Given p , $\bar{P}$ is not an efficient estimate of P since,

- (i) Some participants in the process possessed insider information (though non-public information could have been self-revealing through the bidding process), and/or
- (ii) Some of the small firms attracted the attention of participants who wanted to obtain control, and hence the outcomes reflect some sort of control premiums, and/or
- (iii) The major players in the process – the investment funds – had a very short horizon while trying to maximize the initial value of the fund.

These arguments could explain why the process failed to demonstrate price discovery. On the other hand, given p , $\bar{P}$ was an efficient estimate of P , but,

- (i) The final denomination was not the equilibrium one, since a small fraction of the shares were actually allocated during the final round for a particular firm, and
- (ii) The initial trading prices of the shares on the Prague Stock Exchange, or on the RMS, reflected massive dumping by small participants who would sell at almost any price in order to obtain some cash.

The Ministry of Privatization's lack of knowledge with respect to price expectations of the participants in the process is not included in the arguments above. The purpose of the process, as we analyze it in this paper, has been to discover price expectations. Hence, we do not view prior knowledge of price expectations as a necessary condition. If the Ministry had set the denominations too high, presumably the participants could expect that these firms would be 'overbought'. On the other hand, if the Ministry had set the denominations too low, the participants could simply avoid these firms.

HYPOTHESIS C. There is no consistent trading rule based on publicly known information, under which an individual or a fund can extract more than the average actual outcome, as in Equation (5a).

5. The Data

The government made available some information at no costs to all bidders. Apart from this basic information that was released to the public, the management of the privatized firms could have potentially supplied any additional information. In actuality, the firms' management were cooperative in supplying information only to the extent that their interests could have been served. Management had no incentive to glorify the actual performance of their companies. In fact, one may argue that they wanted to attract as little attention as possible.

The data included all publicly available information, just prior to the beginning of the process, or that has become available during the process.

The data, which was public information prior to the beginning of the process, included the following:

- Company name, line of business, location and size.
- Profits, sales and depreciation rates for 1991–1993.
- Debts for 1991–1993
- Number of employees.
- Patterns of holding of the shares excluded from the process.
- About 10% of the companies have already been partially privatized during the first wave in 1992, thus, market prices were available.

Subsequently, additional information has become available:

- The bidding outcomes for each round.
- The public demand and the demand of the investment funds for specific firms.
- The new denominations set by the Ministry of Privatization for each round.

The data was 'complete' for 802 privatized firms. The Ministry eliminated 58 companies from the sample due to erroneous official notification of the results. Additionally, few companies, that have not reached the national stock exchange or the regional over-the-counter exchanges (RMS) subsequent to the process, were eliminated.

Post-privatization prices were defined in two ways: $P(M)$, initial prices during the first month of trading on the Prague Stock Exchange or on the RMS. $P(A)$, the prices, three months after trading was initiated, on the Prague Stock Exchange (April 1995).

Accordingly, market value is defined as the price, multiplied by the number of outstanding shares, $V(M)$ and $V(A)$ respectively.

Other variables were defined as follows:

Profits. Most recent three years of net profits before tax, just prior to the beginning of the privatization process. The figures were adjusted upward by an amount reflecting the allowable accounting depreciation. The weights for the average profits were chosen in two different ways; first, equal weights for each year, or increasing weights of 20% for 1991, 30% for 1992, and 50% for 1993. Alternatively, the weight for 1993 was determined based on the number of employees;

any company in which the number of employees declined by more than 50%, the weights were set as: {25%, 25%, 50%}.

Debts. Initially it was hypothesized that the debt figures reported in the balance sheets, which happened to be fairly accurate, did not matter since the Czech Privatization Law protected the companies, which were undergoing privatization through the voucher process. Under the Czech Law, a bank can not force this type of company into a bankruptcy. Moreover, a significant portion of the debt was issued by the State or by State-owned banks. However, this was not the case with respect to debt collateralized by real estate, generally, a post-1991 debt.

Since the rate of interest during the process was between 14 to 18 percents, while the US-dollar exchange rate was fairly stable, finance charges carried by these companies were a major factor in their profit performance.

Location. Most companies were endowed with real estate, the value of which was shown in the balance sheet by an extremely low, already depreciated, historical value. It is hypothesized that companies located in major real estate markets, such as in Prague or Brno, will command a premium.

Size. The size of the privatized companies, measured in terms of the initial equity (ranged from 65,000 dollars to 120 million dollars). It is hypothesized that the large companies were more viable from an economic point of view, but the small companies have commanded a premium due to the relative ease of obtaining control of a firm which will eventually be a publicly traded company.

Industry. The Czech Republic, enjoying a pre-Second-World-War reputation for its heavy industry, has shifted towards light industrial plants, services and trading. Moreover, the technology possessed by the industrial plants was old, inefficient and fully depreciated economically. Agriculture was the least favorable industry.

Pattern of holding. The percentage of the company's shares, which was privatized and offered to the public, varied. It is hypothesized that companies, in which 51% of its shares were promised to a certain group of investors, were negatively assessed. Companies, of which the government retained a significant portion for a future sale, have offered a higher likelihood for obtaining control.

Restrictions and reorganization. Some companies had restrictions on sale of assets, changes in the lines of activity, or an outright disallowance of some specific major reorganization. The water supply companies, for examples, were highly endowed with real estate and other valuable assets, hence, the Government retained the control.

Several companies were allowed to re-evaluate their balance sheet to more realistic figures. These companies reported a higher equity, relatively to other companies.

Market prices. Information, such as market prices, for companies which have been privatized in the first wave, while some small portion of the shares remained for the current second wave, could provide a testable control group.

Foreign participation. Direct or indirect purchases of vouchers were prohibited. However, foreigners could make agreements with funds that they will purchase

from their actual shares (not vouchers) which have been allocated to them. Companies, which were known to have a major foreign shareholder or were about to be purchased by a foreign entity commanded a premium. Interestingly, conveying control to a local group could have been perceived as a negative factor, while conveying control to a foreign entity could have been perceived as a positive signal.

6. Results

The purpose of the empirical tests, as described in Section 4, is to test the three hypotheses. The first one tests the variability of the expected outcomes over the rounds. The second one tests the participants in the process acted rationally. The third one attempts to identify a consistent strategy which could earn a post-privatization value per 1000 investment points that could be higher than a randomly allocated 1000 investment points. As we shall see, the average value of 1000 investment points allocated in the first round to a single company was 22,128 Crowns (about 820 US dollars).

Prior to the beginning of the process, there was an unofficial secondary market for investment points. If a buyer, including any foreign entity, wanted to make an agreement with an investment fund, such that the fund would allocate points to a pre-designated firm, while the buyer would make a commitment to purchase whatever number of shares resulted from this allocation, the quoted price was surprisingly uniform at 22,500 Crowns for the 1000 points that would actually be used. As pointed out above, the average actual post-process value of 1000 points was 22,128 Crowns.

6.1. THE VARIABILITY OVER ROUNDS

The null hypothesis is that the variability of the expected outcomes of allocating, say, 100 investment points to a certain firm, decreases as the rounds continue, provided that the expected prices are revealed in the final round. Hence, using the extrapolated expected prices, the sample for each round includes all the firms for which that round was *not* the final one. A final round for a certain firm is a round in which more than 95% of the privatized shares of this firm have been sold during that or prior rounds.

The results clearly demonstrate that the variability of the expected outcomes decreased consistently over the rounds. The variability, based on trading prices three months after the end of the process, exhibits, as expected, a higher magnitude than that of the initial trading, but both show a consistent decreasing pattern (the variance rate decreased from 98.7% to 6.9% – as seen in Table 2).

We should note that, according to our assumption, the variability of the final round is nil. It is likely, however, that the final round has still not reflected the true equilibrium denominations, even though we believe that the variability has

Table II. The variances of the expected value of 100 investment points based on $P(M)$ – the initial actual trading price, and $P(A)$ – actual trading price three month later. The numbers in parenthesis are the rate of the variance to the squared actual average value of 100 investment points. By our definition the variance of the final round is zero

	First round	Second round	Third round	Fourth round
Variance of the expected value of 100 investment points based on $P(M)$	1858344 (37.8%)	673781 (13.7%)	262814 (5.3%)	140903 (2.7%)
Variance of the expected value of 100 investment points based on $P(A)$	4854398 (98.7%)	1239013 (25.2%)	423254 (8.6%)	340925 (6.9%)

been consistently declining over the rounds. Hence, this tends to support the null hypothesis.

6.2. PREDICTED 'OVERBOUGHT' SITUATIONS

Under the second hypothesis, we would like to test whether the participants in the process acted rationally, namely, if they allocated their points to firms whose expected value of 100 investment points were the highest.

Surprisingly, even during the first round, during which the denominations were uniformly set as two shares per 100 investment points, we could not trace any evidence of a consistent pattern. We found that the denominations set by the Ministry were, in fact, highly negatively correlated with 'overbought' firms, but overall there was no relationship between the expected outcome of 100 investment points and the number of points allocated to any particular firm.

Before we rush to discard the null hypothesis, perhaps a possible explanation could be related to the risk of remaining with unused points. The rule of the process was that if a participant did not managed to allocate all his points until the final round, these points would become worthless. In other words, the Ministry did not provide a mechanism for a final clearing, such as a sixth round in which a lottery would allocate all unused points to unsold shares. Thus, due to the risk of remaining with unused points, the participants assessed, in addition to the expected outcome, the likelihood that allocated points would, in fact, win targeted shares. In this scenario, a safer bet could have been to allocate points to a firm which, given the pre-set denomination, exhibited a potential below the highest expected outcome.

Table III. Industry effect. Average post-privatization prices on the Prague stock exchange and average value of 1000 investment points. (PM) , $B(M)$, initial trading. $PA()$, $B(A)$, three months later. Kc, crowns. The sample did not include firms that are labeled as 'other industries'

Industry	Average price per share, $P(M)$ for 1000Kc balance sheet equity	Average price per share, $P(A)$ for 1000Kc balance sheet equity	Average value of 1000 investment points, $B(M)$	Average value of 1000 investment points, $B(A)$
Light industry	2212	1295	29960	17170
Food and beverages	1065	240	20950	10475
Utilities	817	404	18950	5503
Construction	479	259	20600	11260
Trading	447	337	18030	12750
Services	415	215	29355	11303
Heavy industry	257	204	31870	25175
Agriculture	144	107	16800	11950
Average	698	350	23314	13198

6.3. CONSISTENT INVESTMENT STRATEGY

Perhaps the most conclusive test would be the one that can identify a trading strategy which could earn a post-process value higher than 22,128 Crowns per 1000 investment points. Using the data set described in Section 5, we need to identify a set of consistent rules, that is, a set of rules that could have been used by the market participants to allocate their points by using a consistent trading strategy. Subsequently, we would like to test whether this trading strategy can ensure a superior outcome.

6.3.1. Step 1 – Identifying the Rules

Several indicators can be enumerated and examined. First, we suspect that, both, funds and citizens made their selections, categorizing firms by 'Industry'. Table 3 demonstrates a definite industry effect with respect to the post-process trading prices; for example, basic industries commanded higher share prices. On the other hand, the value of 1000 investment points was hardly correlated with industry ranking.

There exists a strong negative relationship between P_j , the post-process market price, and p_j , the number of shares allocated for 100 investment points, as shown in Table 4. As was already hypothesized, the final round denominations and the actual trading prices demonstrate a strong negative relationship, one which stems from Equation (5a); the higher the expected market price $\bar{P}$, the lower the process denomination p . Interestingly, only the denominations for the second round

Table IV. The relationships between the initial trading prices, ($P(M)$), and three months later ($P(A)$) and the denominations set for the various rounds. $p2$ and $p5$ are the denominations set for the 2nd and 5th rounds of the process

Dependent variable	Constant	Slope	Explanatory variable	t	RSQ	F
$P(M)$	-99.39	1234	$p5$	36.18	0.349	425
$P(A)$	-46.8	629	$P5$	29.82	0.255	271
$P(M)$	-40.03	1028	$p2$	31.05	0.199	196
$P(A)$	-19.34	508	$p2$	27.01	0.152	142

demonstrate a similar relationship. Note that the final denominations include the ones for the fifth round, or for earlier rounds for companies which were fully sold prior to the fifth round.

Most of the variables in the data set, namely, the set of information which was known before the process started, show a relatively low level of correlation with the post-process market prices, or the post-process value of 1000 investment points. Only a few variables could be viewed as leading indicators (see Table 5). These weak relationships could be explained by the fact that the process participants had little trust in the figures released by the firms before the process began.

The regression results presented in Table 5 demonstrate that we did not manage to capture systematic effects that were believed to have been taken into consideration by the participants in the process. For example, the effect of the location of the company had little relationship to the expected price. However, it is clear that location was an important variable, since the average price of all privatized firms was 698 Crowns per share, while the average price of all companies located in Prague itself was 953 Crowns per share, and 656 Crowns for firms outside of Prague.

Similarly, if we divide the sample into four groups, which were sorted by,

- (i) Firms with a low post-process market price, below average, above average, and high prices, and by
- (ii) Firms with low value of 1000 investment points, below average, above average, and high values,

then the average values of the explanatory variables, which were known prior to the process, were significantly different from each other. Tables 6 and 7 present these results.

Table 6 shows, for example, that profits, as a proportion of the balance sheet equity, increase monotonically from -2.2% to 16.2%. We could, perhaps, suspect that the variability within each group is high, yet the averages across groups are different. Additionally, we did expect that the ratio, of profits to market value

Table V. The relationships between the initial and three months later trading prices, ($P(M)$, $P(A)$), and the post-process values of 1000 investment points, ($B(M)$, $B(A)$), as the dependent variables, and (1) ratio of 1993 profits to book equity, (2) ratio of average 1991–1993 profits to book equity, (3) ratio of bank credit to total book assets, (4) sales in 1993, (5) profits in 1993

Dependent variable	Constant	$b1(t)$	$b2(t)$	$b3(t)$	RSQ	F
$P(M)$	643.62	-125.09 (-0.068)	-487.85 (-5.46)	2071.85 (12.85)	0.181	58
$P(A)$	330.8	-149.11 (-1.42)	-197.08 (-3.96)	1300.88 (12.34)	0.173	55
Dependent variable	Constant	$b4(t)$	$b5(t)$		RSQ	F
Value $B(M)$	40633	3.99 (20.23)	0.24 (4.47)		0.82	1905
Value $B(M)$	53484	3.45 (19.81)	0.23 (4.43)		0.83	1903

(market price times the number of shares) would be distributed uniformly over the various groups. We would not expect the same results with respect to the ratio of 'profits to the balance sheet equity'. Surprisingly, the results for both ratios are not conclusive. Since we did not have a way to adjust for risk, this could be a possible explanation, though it is unlikely that the level of risk is correlated with the price of a single share (which is the variable according to which the groups were sorted).

It is interesting to observe the behavior of the non-funds participants. In the third round, for example, the public made a bid 409% of the available shares of companies which belonged to the low post-process price group, and a bid of only 140% for the high-price-group. This observation by itself is not sufficient to determine that the public was wrong in assessing the available information, but it seems as if the funds' managers were better informed than the public was.

While the ratios of 'profits to equity' do not show a clear pattern for each group, the ratios of 'sales to equity' do. Additionally, the average value of 1000 investment points varies from one round to another, with the highest value obtained in the second round (about 30,000 Crowns). This indication may not necessarily be used as a strategy, since it does not take into consideration that the allocation of points to a specific company did not guarantee that the bid would be satisfied.

The size of a firm is a key variable with respect to the final value of 1000 investment points. No matter how 'size' is measured, the larger a company the larger the actual final value of 1000 investment points.

Table VI. Firms were sorted by the post-process market price of one share: average, 698 crowns; low, 174 crowns; below, 461 crowns; above, 1084 crowns; high, 2548 crowns

Groups were sorted by the price of one share	Balance sheet equity	Sales (1993)	Profits (1991)	Profits (1993)	Portion of shares that have been retained by the government	Portion of shares that have not been privatized
Average	709304	512992	87266	52964	7.08	22.56
Low	383477	231666	17387	-1015	5.46	17.92
Below	663448	323546	53662	7683	5.33	21.43
Above	633492	562852	87032	45824	8.88	26.24
High	2320459	2188143	484099	456238	15.17	34.12

Groups were sorted by the price of one share	Portion of demand by the citizens in first round	Denomination for the second round	Denomination for the third round	Portion of demand by the citizens in third round	Denomination for the first round	Market value of equity
Average	34.56	8.20	8.69	202.33	6.00	355000
Low	2.92	12.88	17.92	409.06	10.49	53960
Below	8.54	9.22	6.51	156.32	5.40	140961
Above	56.51	3.01	2.42	63.26	2.46	294696
High	185.47	0.87	0.64	14.79	1.35	2505940

Groups were sorted by the price of one share	Value of 1000 points	Portion of foreign shareholders	Ratio of sales (1993) to market equity	Ratio of profits (1993) to book equity	Ratio of bank loans to total book assets	Market price of one share
Average	22844	0.57	8.76	0.027	0.140	698
Low	17409	0.00	14.24	-0.022	0.164	174
Below	23589	0.71	7.72	0.006	0.130	461
Above	25496	0.52	5.30	0.075	0.122	1084
High	32875	2.28	2.00	0.162	0.138	2548

6.3.2. Step 2 – Trading Strategy

The results reported in Tables 3–7 form a set of rules that can be used for a consistent trading strategy. The set of information contains the data set which has been known prior to the process and the outcome of the bidding during the various rounds. We apply the results and form two kinds of rules: binary rules (namely, “yes or no”), and continuous rules.

The binary rules are used for elimination. That is, 1000 investment points are allocated equally to all firms, except those, which are eliminated under the following categories:

Table VII. Firms were sorted by the post-process value of 1000 investment points: average, 22,128 crowns; low, 13,088 crowns; below, 20,281 crowns; above, 25,104 crowns; high, 37,982 crowns

Groups sorted by post process value of 1000 investment points	Balance sheet equity	Sales (1993)	Profits (1991)	Profits (1993)	Assets already depreciated as of 1993	Employees (1991)	Employees (1993)	Ratio of foreign share-holders
Average	709304	512992	87266	52964	48.06	1232	907	0.44
Low	479676	400141	41100	21434	49.54	761	619	0.00
Below	440479	391353	52604	14933	48.73	1113	714	0.87
Above	811454	490859	72000	62131	47.86	1385	1057	1.17
High	883558	562920	76830	42452	45.24	1797	1350	0.38

Groups sorted by post process value of 1000 investment points	Portion of shares which were not privatized	Portion of demand by the citizens in first round	Denomination for the second round	Denomination for the third round	Number of shares left for the round	Portion of demand by the citizens in third round	Denomination for the fourth round	Portion of demand by the citizens in fourth round
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Table 7. Continued

Average	22.56	34.56	8	9	128982	202	4.64	89.43
Low	27.41	31.95	8.75	9.33	54536	237.53	5.16	116.99
Below	18.88	29.03	9.63	10.34	116896	249.17	5.18	62.22
Above	20.62	34.41	7.47	8.06	159732	137.17	4.33	53.03
High	23.41	45.99	6.05	5.83	220101	140.11	3.39	41.36
Groups sorted by post process value of 1000 investment points	Denomination for the fifth round	Market equity value	Ratio of sales to market equity	Ratio of profits-1993 to book equity	Ratio of average profits 1991-1993 to market equity value	Ratio of liabilities to total assets	Market price of a share	Value of 1000 investment points
Average	6.00	355000	8.759	0.027	0.067	0.305	698	22128
Low	5.59	169835	11.392	0.031	0.063	0.329	453	13088
Below	6.84	170201	10.116	0.005	0.057	0.303	591	20281
Above	5.83	539320	6.863	0.038	0.059	0.291	699	25104
High	5.48	346096	4.968	0.046	0.093	0.290	1179	37982

- (i) Utilities (transportation, water, electricity) since the government retained control in this firms.
- (ii) Firms that have already depreciated over 90% of their assets, so the number of shares was unusually low.
- (iii) Small firms with less than 25,000 shares, for the same reason as in (ii).
- (iv) Firms with book-equity under 80-150 million Crowns, for the same reason as in (ii).
- (v) Any firm that the number of privatized shares were less than 25,000.

The outcome is calculated in terms of the denominations for the final round of each firm and the post-process trading prices. The justification for this approach is that, in any round prior to the final one, there is no guarantee that points allocated to a certain firm will actually materialize into shares. Under the assumption that our strategy will not trigger an 'overbought' situation, then the final round represents a sure satisfaction of our bid. The outcome could be even better if we attempted to capture higher denominations in rounds prior to the final one. The results are shown in Table 8, which demonstrates that the elimination rules could yield superior performance.

The second approach was a bit more ambitious. We started the process with 1000 investment points, but waited for the results of the first round. Subsequently, we ranked all firms which had not been fully bought in the first round (780 firms), using the results in Table 3, in order to predict the expected value of 1000 investment points. We compare two outcomes:

1. Ranking is entirely based entirely on the results of the first round, assuming that the selected firms can be purchased at the denominations set for the second round. It is clear that the Ministry mis-priced the denominations for the second round, but, interestingly, taking advantage of that mis-pricing by the Ministry could yield outcomes contrary to our prediction rule. Our goal, nevertheless, is to reject the null hypothesis that this mis-pricing has been corrected as we approach the fifth round.
2. Ranking is based on the results of the first round, jointly with the elimination rule 5 in Table 8. The worst sets of firms were selected using the entire remaining sample of 780 firms.

The results demonstrate that a superior performance can be obtained using public information. The actual outcome of a strategy based on these rules depends, however, on the actual fraction of the bid that could be satisfied in each round. It is believed that a dynamic strategy, using the information on a round-by-round basis, could lead to even more superior performance.

7. Conclusion

This paper, while examining a narrow aspect of the privatization process in the Czech Republic, found several grounds that may be suspected as causes for an inefficient price discovery mechanism; on the one hand, it found that the rules of

Table 8. The upper part demonstrates the results of selecting firms by elimination. The lower part demonstrates the results based on ranking of firms using a predictor for the expected value of 1000 investment points. The left column indicates the effect of mis-pricing by the Ministry. The right column indicates that the process did not manage to serve as a price discovery

Elimination rule	Elimination method					
	1	2	3	4	5	6
Non agricultural and utilities:	Yes	Yes	Yes	Yes	Yes	All
Depreciated portion over:	29%	29%	29%	29%	50%	All
Book equity under:	150	100	100	80	All	All
	millions	millions	millions	millions		
1993 profits to book equity under:	0.037	0.037	0.03	0.02	0	All
Value of 1000 investment points	36,617	32,869	31,535	29,320	24,297	22,128
Number of firms	10	16	20	26	277	796
Ranking method						
Average value of 1000 investment points, ranked by the bidding outcome of the first round and purchased in the second round. Sample: all 780 remaining firms for the second round.	Average value of 1000 investment points, ranked by the bidding outcome of the first round and purchased in the final round. Sample: 277 firms which have not been eliminated by rule 5 above			Selection		
7999	31163			Best 10 firms		
7497	28211			Best 20 firms		
7109	33314			Best 30 firms		
7568	36478			Best 40 firms		
9762	30389			Best 100 firms		
14465	29500			Best 200 firms		
31014	22246			All firms		
49438	24475			Worst 200 firms		
64135	21066			Worst 100 firms		
72670	23370			Worst 40 firms		
88569	23016			Worst 30 firms		
111628	23417			Worst 40 firms		
140775	22035			Worst 30 firms		

the process do not align with market clearing along with significant information asymmetry and non-uniform information reporting standards, but, on the other hand, the variability of the expected outcomes declined as the process approached the final round.

The mass privatization in the Czech Republic will probably serve as a case study for a *successful* rapid transfer of assets from the public sector to the private sector. This paper, however, wishes to point out that specific rules of the process should have been altered in order to provide a more efficient price discovery mechanism. The paper shows, theoretically and empirically, that coupon privatization must follow a certain set of rules, during the transfer of assets owned by the government to the private sector, so that their true relative prices are revealed. First and foremost, the objective function of the investment funds, which is to maximize their immediate post-privatization management fee, is not compatible with a long term price discovery mechanism. Second, the Ministry of Privatization should have announced that any unused points would be subject to a final lottery during, say, a sixth round of the process. Finally, the denominations set, say, in the third round, should have been kept constant for several more rounds.

The paper, however, concludes that the privatization process was not crucial in establishing the true relative prices or costs of capital. That is, the process in the Czech Republic did not trigger a misallocation of funds since the transfer was free. Thus, if it triggered an initial distortion, market forces could have corrected it when real funds would have reacted subsequently to actual market prices. This may not be the case in other countries, where coupon privatization is associated with simultaneous inflows of funds originating from, both, domestic or foreign participants.

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