The Two Waves of Voucher Privatization in the Czech Republic: A Model of Learning in Sequential Bidding

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Abstract

This study develops a dynamic model of bidding behavior to investigate the Czech voucher privatization process, which took place in two waves of bidding rounds, the first in 1992 and the second in 1994. It examines the voucher mechanism from the standpoint of investors and the pricing and allocation of shares. Investors could participate as independent individuals or by assigning some of all of their voucher points to investment privatization funds. Principle findings are that individual participants behaved quite differently from funds and could benefit by learning from one round to the next and from observing the behavior of the funds. An important collateral finding is that the market, though crude, behaved efficiently in the adjustment of share prices over the bidding rounds.

Abstrakt

V článku je studováno schéma českého modelu kupónové privatizace, jejíž první vlna proběhla v roce 1992 a druhá v roce 1994. V práci je navržen dynamický model poptávky po akciích, a spolu s tímto modelem je sledováno chování dvou kategorií investorů: DIKů a IPF. Základním výsledkem je, že DIKové se v procesu objednávání akcií výrazně lišili od IPF. Ukazuje se, že DIKové mohli využít informace o předchozích objednávkách IPF (model s učením), a tak zlepšit své výsledky v KP. Dalším zajímavým výsledkem je, že i schéma s cenami určovanými cenovou komisí se může za určitých podmínek chovat ve vyšších kolech eficientně.

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1. Motivation

Scarcely five years after the fall of the communist government, over 80 percent of the assets of the Czech state have been turned over to private hands. Apart from the unification of Germany, this transfer of public property amounts the largest of its kind ever.[1] It is at the heart of the transformation of the Czech Republic to a modern capitalist state. And its success may very well become a model for all of Eastern Europe.[2] Among the many dimensions of the Czech privatization program, by far the most important in terms of asset value has been the "large scale" voucher privatization scheme, which is responsible for transferring all or part of over 1650 large enterprises formerly owned by the state. In this process citizens were given voucher points that they could use to buy shares of designated firms in a series of price-administered bidding rounds.

As the principal instrument of ownership transfer, recent implementation of the voucher scheme offers a unique opportunity to study the privatization process and the behavior of new investors in an emerging capitalist state. The transition from a command economy to a market economy requires the establishment of private capital markets. In the Czech Republic these markets are being shaped as a direct consequence of manner in which the wealth of the state has been distributed to its citizenry. Voucher privatization not only determines market prices and allocates ownership shares of enterprises, but it establishes the relationships between the public and these new markets.[3]

This paper examines Czech large-scale voucher privatization, which took place in two waves of bidding rounds, the first in 1992 and the second 1994. It examines the voucher mechanism from the standpoint of investors, pricing, and the allocation of shares. Investors could participate as independent individuals (IIs) or by assigning some of all of their voucher points to investment privatization funds (IPFs). The focus of this study is on investor participation in the bidding process in order to understand whether individuals (IIs) behaved

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[1] See Kotrba (1994) for a thorough accounting of all aspects of Czech privatization.

[2] For example, Bulgaria just announced that it plans to implement the Czech model in the fall of this year; and Romania intends to study the Czech model. Poland wants to adapt the Czech model for its own mass privatization; and even Ukraine has shown interest in the Czech approach.

[3] In fact, the outcome of the first wave of bidding was used to set prices of shares on the Prague Stock Exchange, which explains why share prices in this start-up market were relatively stable at the beginning.

differently from funds (IPFs).[4] The principle hypothesis of this investigation is that IIs, in particular, could benefit by learning from one round to the next and by observing the behavior of others. An important collateral hypothesis is that the market, though crude, behaved efficiently in the adjustment of share prices over the bidding rounds.

2. Background

Czech privatization has proceeded on several fronts. In the early years of the transition (1990 and 1991) the former Czechoslovak parliament authorized the restitution of small properties to their former owners. Most of these were shops and restaurants, housing, and farm land, valued between 75 and 125 billion Czechoslovak Crowns (CsK). A second program followed in mid 1991 under the designation "small-scale" privatization. These were small enterprises that were offered in public auction, the last of which occurred in late 1993 and reached sales of 31 billion CsK.[5] Other programs during this period included the transformation of cooperatives (principally agricultural) and the transfer of about 350 billion CsK of property to about 6000 municipalities. But the bulk of the transfer has occurred under the "large-scale" privatization of state-owned enterprises worth almost 900 billion Czech Crowns (CzK) in the Czech Republic alone (Table 1). A large portion of the value of these enterprises have been transferred under the voucher privatization scheme in two separate waves of bidding rounds. The first wave involved 988 Czech enterprises and took place from May until December, 1992, before the Czecho-Slovak split in January, 1993; and the second wave (delayed largely because of the split) added another 676 firms and ended with the close of 1994.

The large-scale privatization program was charged with transferring most of the state-owned assets of industry, agriculture, and trade as quickly as possible and in a setting conducive to market competition. The program began late in 1990 by soliciting project proposals for the disposition of all or part of the assets of

[4] Many observers of this process suspect that while IIs were trying to maximize the value of their portfolio, IPFs were more interested in gaining control of targeted enterprises to change the way they do business.

[5] See Valbonesi (1995) for an overview of privatization by auction in the former Czechoslovakia.

some 4400 Czech enterprises that were eligible for privatization.[6] Firms could remain whole or be separated into subsidiaries. Each proposed unit could then be offered to the public in one of five ways: (1) transformation into a joint stock company with shares offered to voucher bidders, (2) direct sale to a designated buyer, (3) public auction, (4) public tender, and (5) transfer to a public institution. As shown in Table 1, over 86 percent of the large privatization projects (in terms of asset value) approved by the Czech Ministry of Privatization and the Federal Ministry of Finance by the end of 1993 were of the first type; and almost all (93.6%) of the 1774 joint stock companies participated in the voucher privatization scheme, offering almost half (45.5%) of their shares to voucher bidders. The book value of these shares was 343 CzK, hence making voucher privatization the most important single type of asset transfer.

3. Voucher Scheme

The voucher scheme provided for the allocation of shares of these firms under the following procedure: For each wave every adult citizen was entitled to buy a voucher book that contained 1000 investment "points" for 1000 crowns (about a week's wages). Seventy-five percent of those eligible participated (almost 6 million Czechs in the first wave and over 6 million in the second), which (as a result of dividing total book value by the number of participants) gave each voucher book an accounting value of about 35,000 crowns in the first wave and about 25,000 crowns in the second wave. Citizens used these voucher points to buy shares of eligible enterprises in a series of bidding rounds. Before the bidding began individual had the opportunity to allocate some or all of their points to any of over 400 investment privatization funds (IPFs). For the first wave about 72 percent of all voucher points were deposited into these private funds, but for the second wave that share dropped to under 64 percent. For many individuals these funds were a means to tap into professional investment expertise, as well as a way to diversify their portfolios.

At the start of the process the public was given basic financial information about each enterprise to be transferred. At the beginning of each round participants were told the *administered* price of the shares of each firm and the number of shares offered. For example, the first round of Wave 1 started on May 18, and

[6] Because the first wave of voucher privatization occurred before the Czecho-Slovak split at the beginning of 1993, it included approximately 1600 Slovak firms as well. This study focuses exclusively on the Czech firms, in part because Slovakia did not continue with privatization after 1992.

ended on June 8, 1992. During that time participants submitted written bids in voucher points for the number of shares desired of any firm. For that first round the share price was set uniformly across firms at 3 shares per 100 points (2 shares per 100 in Wave 2), since the number of shares assigned to each firm was based on accounting valuation of the firm, so that each share represented the same book value (about 1200 crowns for both waves) for every enterprise.

The process was by no means a standard auction, since investors bids were *quantities* and the prices were in fact administered by the privatization authority. The rules for awarding shares in any round were as follows: If bids for a firm did not exceed its supply of shares, these demands were satisfied and the remaining shares were deferred to the next round. But if the demand exceeded supply, then no bids were accepted and all shares were deferred to the next round.[7]

The privatization authority never revealed its algorithm for adjusting share prices between rounds, but it was generally observed that prices would rise for shares in excess demand and fall for shares in excess supply.[8] The authority appeared to use the rule of thumb of unitary price elasticity, which assumes that price adjustment does not change the number of voucher points bid--only the number of shares demanded (in inverse proportion to the price change). For example, if a firm faced a 20% excess demand, raising the share price by 20% would eliminate the shortage, because share demand would fall by 20% as investors collectively bid the same total number of points. Indeed, at the end of the first wave when the fifth round was announced as the final round, the authority acted on the assumption of unitary elasticity to clear the market. The authority exhorted investors that were thwarted by excess demand in round 4 not to change their bids in round 5, saying it would simply adjust prices to bring share demand in line with the remaining supply. The authority pursued the same strategy at the end of the second wave when it announced that the sixth round of bidding would be the last round.

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[7] There was one other wrinkle: if demand exceeded supply by less than 25%, then the shares would be allocated by an equi-proportional cut in shares to IPFs, provided that this cut in the IPF allocation was no more than 20%. This gave a noteworthy advantage to individual bidders, who would receive the full amount of shares demanded at the offer price.

[8] More precisely, it is *relative* excess supply and demand that would guide price adjustment, since this market is closed off from the rest of the economy and only relative prices matter. (Voucher points had no other use and could not even be carried over from Wave 1 to Wave 2.) In particular, prices would be increased in some cases for those shares whose excess supply is small relative to a market that exhibits excess supply on the average.

4. Approach and Methods

The basic approach is to develop an econometric model of bidding suitable to analyze the both waves of voucher privatization in the Czech Republic. As shown in Table 1, Wave 1 involved 988 enterprises and shares valued at 212.5 billion CzK and Wave 2 involved 861 enterprises and shares valued at 154.9 billion CzK. Separate analysis of two waves provides an opportunity to compare and double check findings from each wave and a powerful way to test for the robustness of these findings. The central working hypothesis is that individuals investors (IIs) take into account the previous bidding behavior of investment privatization funds (IPFs). The implicit claim is that IPFs had more (possibly inside) information than IIs.

The first task is to set up a simple econometric model of share demand by individual investors (IIs) across rounds of bidding, which takes into account the past behavior of investment privatization funds (IPFs). Observations entail the total bid for each firm in each round. The model must take into consideration the dynamic effects of bidding from one round to the next, including share price and availability, as well as the fixed effects of each individual firm. We cannot ignore fixed effects in this study (in favor of the simpler random-effects model), because we know that firms selected for each of the two waves of voucher privatization are not a random sample of Czech enterprises. A simple dynamic model with fixed firm effects (η_i) has the following form:

$$d_{i,t}^{II} = \rho_t d_{i,t-1}^{II} + \beta_t d_{i,t-1}^{IPF} + \gamma_t p_{i,t} + \delta_t s_{i,t} + \eta_i + u_{i,t} \qquad (4.1)$$

where lower case letters indicate logarithms.[9]

$d_{i,t}^{II}$ and $d_{i,t}^{IPF}$ denote demands of II (individuals) and IPF (privatization funds), respectively, corresponding to the i^{th} firm at round t;
$p_{i,t}$ is the price of one share and $s_{i,t}$ is the supply of shares of the i^{th} firm at round t.

[9] The logarithmic transformation of the data is useful here for a number of reasons, including correction for heteroscedasticity and allowing the option of interpreting demand behavior in terms of either shares or points bid (since shares=points/price). The one drawback is that for certain firms in certain rounds IPF demand is zero, even though II demand is nonzero for all available firms. In order to keep these firms in the sample, we set the log of IPF demand to zero in these cases.

The first term is the autoregressive term, accounting for the influence (ρ) of past information; the second term reflects the extent that IIs learn from or follow the IPFs (β); the third term is the price effect (price elasticity γ); and the fourth term accounts for the number of outstanding shares in the bidding strategy (δ). By working with first differences and allowing variation across rounds, we eliminate the firm level nuisance variables (η_i) and get

$$\Delta d_{i,t}^{II} = \rho_t \Delta d_{i,t-1}^{II} + \beta_t \Delta d_{i,t-1}^{IPF} + \gamma_t \Delta p_{i,t} + \delta_t \Delta s_{i,t} + \Delta u_{i,t} \qquad (4.2)$$

In a dynamic model such as this with fixed effects, classical estimation techniques yield biased (inconsistent) estimates, as demonstrated by Nerlove (1967, 1971) and Nickel (1981). The magnitude of bias can be quite large for short time series with strong dynamic effects.[10] The solution is to use an instrumental variable estimator. Specification of instruments in a dynamic model with a large number of fixed effects (988 firms in this case) is crucial, especially when we have predetermined variables that are not strictly exogenous.[11] In the voucher process such predetermined variables for each round are the prices and outstanding supply of the shares of each firm. Prices are preset by the authority at the beginning of each round, but we know that they are adjusted for the next round in response to excess supply or excess demand; so although predetermined, they are not even weakly exogenous. Similarly the supply of shares is (identically) determined by the difference between supply at the beginning of the round and the number of shares allocated in that round [$S_{i,t} = S_{i,t-1}$ - $sales_{i,t-1}$]; so it, too, cannot be characterized as exogenous. Hence, with the understanding that investors have rational expectations, it can be shown that predetermined variables from the twice lagged round (*t-2)* are valid instruments. Therefore, we have (beyond the second round):

$t = 3$ $d_{i,1}^{II}$, $d_{i,1}^{IPF}$, $p_{i,1}$, $s_{i,1}$ and all "static" variables ($\boldsymbol{z}_i$) characterizing the firm (profit, sales, debt, etc.);

$t = 4$ $d_{i,1}^{II}$, $d_{i,1}^{IPF}$, $p_{i,1}$, $s_{i,1}$, $d_{i,2}^{II}$, $d_{i,2}^{IPF}$, $p_{i,2}$, $s_{i,2}$ and $\boldsymbol{z}_i$;

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[10] Nickel(1981) showed that the bias is approximately equal to

$$\underset{N\to\infty}{plim}\ (\rho - \hat{\rho}) \simeq \frac{-(1+\rho)}{T-1},$$

and for short time series (small T) is quite substantial.

[11] Keane and Runkie (1992) suggest how to create instruments in such a setting.

$t = 5$ $d_{i,1}^{II}$, $d_{i,1}^{IPF}$, $p_{i,1}$, $s_{i,1}$, $d_{i,2}^{II}$, $d_{i,2}^{IPF}$, $p_{i,2}$, $s_{i,2}$, $d_{i,3}^{II}$, $d_{i,3}^{IPF}$, $p_{i,3}$, $s_{i,3}$ and $\mathbf{z}_i$.

and for Wave 2

$t = 6$ $d_{i,1}^{II}$, $d_{i,1}^{IPF}$, $p_{i,1}$, $s_{i,1}$, $d_{i,2}^{II}$, $d_{i,2}^{IPF}$, $p_{i,2}$, $s_{i,2}$, $d_{i,3}^{II}$, $d_{i,3}^{IPF}$, $p_{i,3}$, $s_{i,3}$, $d_{i,4}^{II}$, $d_{i,4}^{IPF}$, $p_{i,4}$, $s_{i,4}$ and $\mathbf{z}_i$.

As part of the task of specifying instruments, this study will test for weak and strong exogeneity of price and supply using the standard Chi-squared test. The most efficient estimator for this system of equations is "generalized method of moments" (GMM), which can handle the appropriate set of instruments and impose the proper orthogonality conditions for the system.

The method just described (we shall call it Model 1) is the standard efficient model. But here there are two problems with its application. One is that we lose observations over the bidding rounds because some firms are sold out before the final round. The bottom of Table 2(a) indicates that 166 firms, whose shares represent over 20 percent of the total, disappear before the final round; and the bottom of Table 2(b) shows that 244 firms, whose shares represent over 42 percent of the total, disappear before the final round. The other is that the firms that sell out may not be fully representative of the entire sample, hence causing selection bias in our estimates. This bias would tend to increase as the bidding rounds proceed and more firms sell out. One way to handle the first problem is to estimate the model separately for each round, which we call Model 2.[12] Single equation estimation is typically not efficient, but in this case the loss of efficiency is offset by the increase in the effective sample size. To deal with the second problem (selection bias) we implement the Heckman (1979) two-step procedure, where the selection bias correction term (λ) is based on the static firm characteristics (listed in Appendix Table A-1) that are the regressors in the probit selection equation of the first step. The selection bias correction can be applied to the system (Model 1) as well as to round-by-round estimation (Model 2), but in order to maximize the sample size we implement the sample selection correction separately for each round and designate it Model 3.

A second task is to identify firm-specific effects and to test for market efficiency. The idea is to try to relate the fundamental (static) characteristics of

[12] Another possible solution is to work with an unbalanced panel, but this would be hard to implement given the dimension of the model with its instrument structure.

firms to the demand for their shares as revealed in the bidding process. All bidders had access to information on the financial characteristics and performance of all participating enterprises for the three years before the first wave (1989 to 1991) and for the four years before the second wave (1990 to 1993). As listed in Appendix Table A-1, public information included the number of employees, sales, debt, and profitability, as well as industry, location, and ownership structure. One would expect that these firm fundamentals would affect bidding in the early rounds.[13] But if markets are acting efficiently, these factors should play no systematic role in later rounds, because by then all relevant information should be incorporated in the share prices. Hence, testing for statistically significant firm effects beyond the first two rounds of biding is a way to test for market efficiency.

An immediate obstacle to accomplishing this second task is that our fixed-effects model does not generate estimates of the influence of time-invariant variables, because they are masked by the firm-specific shift parameter, η_i. These fixed factors correspond to the firm-level information described in the Appendix Table A-1 and made available to the public before the bidding process began. Nevertheless, by applying a two-step procedure developed by Hausman and Taylor (1981) these firm-level effects can be recovered easily. The first step is to apply the model corrected for selectivity bias (Model 3) to equation 4.2 to get consistent estimates of ρ_t, β_t, γ_t and δ_t in each bidding round. These estimates are then applied to equation 4.1 to take out all influences except the firm effects (and random error), leaving firm-level residuals. In the second step these firm-level residuals become the dependent variable in a regression with firm characteristics on the right-hand side.

In this manner it is possible to relate static firm characteristics to the bidding for each round. Moreover, it is possible to test to see if these firm effects are constant across rounds. If the market is behaving efficiently we would expect to find no systematic or constant firm effects across rounds. Because of the large number of potential firm variables (about 40 in Wave 1 and 50 in Wave 2), this study uses principle components to consolidate and reduce the number of factors to a manageable dimensionality (say, about 10 or 12).[14]

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[13] In order to capture significant information about firms we used factor analysis. See for instance Harman (1967). The factors can be understood as linear transformations of principal components that explain most of total variation.

[14] The actual number of relevant factors has been chosen based on eigenvalues. Many empirical studies on factor analysis recommend to have number of principal components equal to number of eigenvalues greater than 1.

5. Results

Data for this project comes directly from the Czech Ministry of Privatization and the Czech Ministry of Finance. They include all firm level data, as well as the bids, prices, and outcomes of each bidding round by firm and by type of bidder (II or IPF). Our current estimates are based on the five rounds of bidding of the first wave and on the six rounds of the second wave.

The most obvious way to compare the behavior of IIs and IPFs is to look at the outcomes of their bidding round by round. Table 2(a) tracks the bidding rounds for Wave 1 and Table 2(b) tracks Wave 2. The first observation is that IPFs spent their voucher points more quickly than IIs. By the end of the second round of Wave 1, IPFs allocated virtually 80 percent of their points, while IIs spent less than two-thirds. Investors learned to proceed more slowly in Wave 2 (for reasons discussed below) with IPFs spending 62 percent of their points and IIs spending less than one-third. In each of the first three rounds of both waves the IPFs had a substantially higher proportion of their bids accepted.

It appears from the downward trend of prices over the rounds that IPFs paid a premium for the shares they received. Table 2 confirms this impression, showing that round by round the mean price that IPFs paid for accepted bids was about 45 percent higher than the mean price paid by IIs in Wave 1 and about 75 percent higher in Wave 2. This observation strengthens the suspicion that either (1) IPF bidding was motivated by other considerations than price or (2) that IPFs had better information than IIs and could assume the leadership in bidding. In fact, by waiting until the later rounds the typical investor could expect to pay less for shares. The advantage to waiting stems from the asymmetry of the bidding process, described in Section 3. In almost all cases where bids are accepted, shares are in excess supply and so are generally offered at lower prices in the next bidding round. In practice this meant that after the first two rounds of bidding in each wave, over 80 percent of bids to firms in excess supply would have been accepted at a *lower* price in the subsequent round (Appendix Table A-2). This lesson was not lost on bidders, as evidenced by the slower rate of point allocation in Wave 2 for IIs and IPFs alike.

This leadership role of the IPFs appears to be recognized in the bidding behavior of the IIs, according to our three estimated dynamic models, tabulated in Table 3. The three models give similar results. Model 2 closely resembles Model 3, even though the selectivity parameter in Model 3 is statistically significant in the last two rounds of both waves. Most striking is that the learning parameter (β) is significant in every round of Wave 1 (and dominates round 3 where $\beta>\rho$) but is significantly positive only in round 3 and 4 of Wave 2. In both waves β falls

abruptly from the third to the fourth round. Not coincidentally it is in the fourth round of Wave 1 that the autoregressive parameter (ρ) is significant and larger than the learning parameter (β). In Wave 2, ρ is larger than β in every round. The weakening of learning in the later rounds and especially in the second wave indicates that IIs took their cues directly from IPFs much less as time passed.[15] The learning trajectory appears to be "S-shaped;" with each successive round more and more information is embodied in the model's autoregressive term, whereby past learning is incorporated into the most recent bids of individual investors. Moreover, as the market for shares becomes more efficient over time, we would expect that individual investors would pay less and less attention to IPF bids.

The price elasticity (γ) is quite large in both waves, but falls by the final rounds toward unity, reflecting the narrowing of choices and the fact that voucher points are useless after the final round of bidding. In this respect, as well, the results from Models 2 and 3 are more plausible, since we would expect that in the final rounds bidders would display unitary elasticity if they follow the authority's exhortation to resubmit identical bids from the previous round's excess demand firms.[16]

The standard χ^2 test can be applied to look for overidentifying restrictions under GMM in Model 1. For Models 2 and 3 we apply the single-equation version of the standard Hausman test devised by Spencer and Berk (1981).[17] The exogeneity tests presented in Appendix Table A-3 document that both weak and strong exogeneity are rejected in both price and the supply for both waves. These results confirm the structure of instruments, twice lagged in price and

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[15] Note that by 1994 when Wave 2 took place the Prague Stock Exchange had been in operation for almost a year, providing market information of the value of Czech firms, especially for the 185 firms that carried over from Wave 1.

[16] We have tested the applicability of this model to the bidding behavior of mutual funds. The model was estimated symmetrically for IPF demand. The results turned out to be quite different, indicating that the IPFs did not appear to learn from IIs. Moreover, IPF demand is relatively insensitive to share prices, since it is presumably more motivated by attempting to gain control of certain enterprises than by looking for the best bargains. That this model fits IPF demand relatively poorly (when compared to II demand) would lend support to the hypothesis that IPFs have very different objectives than individual investors.

[17] For the single equation methods of Models 2 and 3 we conduct the exogeneity tests separately for each round, which means that we have no way test for strong exogeneity. Since we reject weak exogeneity in every case, we have no need to conduct the strong exogeneity tests.

supply, and the orthogonality conditions that were presented in Section 4.[18] In other words, investors do behave rationally.

The results from Task II support the efficient market hypothesis. Using the derived factors to conduct the Hausman-Taylor two-step estimation of firm-level (fixed) effects, we see few systematic effects. The factor analysis of the almost 50 variables described in the Appendix Table A-1 yielded four ownership factors for Wave 1 and five for Wave 2;[19] ten industrial and regional factors for Wave 1 and twelve for Wave 2;[20] and three firm description factors for each wave.[21]

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[18] Looking for symmetric behavior of IPF share demand, we found that the bidding behavior of IPFs does not follow IIs. The model fit is poor and many of the parameter estimates for IPF demand do not make much sense.

[19] Ownership factors:

For Wave 1, O1-O4 explain about 55% of all variation with the following loadings:

O1 = .822*FNTP + .599*EMPL,
O2 = .846*DOMESTIC
O3 = .688*INTERM + .651*MUNIC - .686*FNPU
O4 = .608*RESTIT - .771*FOREIGN

For Wave 2, O1-O5 explain about 75% of all variation with the following loadings:

O1 = .715*FOREIGN + .665*RESTIT
O2 = .843*INTERM - .577*FNTP
O3 = .885*DOMESTIC
O4 = .911*MUNIC
O5 = .967*FNPU

[20] Industrial and regional factors:

For Wave 1, D1-D10 explain about 76% of all variation with the following loadings:

D1 = .810*INDTRADE + .739*REGPR
D2 = .920*INDLIGHT - .648*INDHEAVY
D3 = .978*INDCONST
D4 = .756*REGWB + .649*INDSERV
D5 = .557*INDTRANS - .834*REGEB
D6 = .806*REGCB
D7 = .935*REGNB
D8 = .778*INDFIN
D9 = .872*REGSB
D10 = .935*INDAGR

For Wave 2, D1-D12 explain about 77% of all variation with the following loadings:

D1 = -.762*INDAGR + .698*WAVE1 + .612*INDHEAVY
D2 = .912*INDHEAV6Y
D3 = -.893*REGEB
D4 = .940*REGNB
D5 = .887*REGWB
D6 = .662*CAPITAL - .580*INDFIN + .574*HOLDING
D7 = .881*INDTRADE
D8 = .754*INDSERV +.565*REGPR
D9 = .835*REGCB - 566*REGSM
D10 = -.926*REGSB
D11 = -.934*INDCONST
D12 = -.889*INDTRANS

The results tabulated in the Appendix (Tables A-4 (a) and (b)) show that no factor was statistically significant across rounds for either Wave 1 or Wave 2. Tables 4(a) and 4(b) show that the fit was very poor in both waves with R^2s no greater than five percent. Finally, these tables report the results of constraining the coefficients to be equal over the rounds of each wave. These results can be used to construct likelihood ratio tests for constancy of coefficients over rounds. The hypothesis of constancy is rejected in the second wave and not rejected in the first wave.[22] But even where constancy is not rejected, the factors have so little influence that we must conclude that by the third round the static firm-level factors have already been incorporated into the prices of shares. Such evidence that is consistent with emerging market efficiency, especially noting that it is even stronger for the second wave.

6. Conclusions

Voucher privatization in the Czech Republic was remarkably successful in allocating shares of targeted state enterprises quickly and efficiently. The bidding process was crude in many ways, especially in the administration of share prices and in the attempts by the privatization authority to artificially speed the process by over adjusting prices. But in spite of the artificial price jolts, the market reacted logically, even predictably. In five or six short rounds over a few months almost all shares were allocated and almost all voucher points were spent. Individual investors, taking their cues from the mutual funds (to whom they attributed better information), tried to get the most value for their vouchers. But these individuals paid less attention to the IPFs in the second wave than in the first, indicating growing investor self-confidence. The IPFs, guided by considerations other than short-term portfolio maximization, tried to acquire shares even at premium prices.

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[21] Firm characteristic factors:

For Wave 1, S1-S3 explain about 79% of all variation with the following loadings:

S1 = .995*P90 + .992*S91 + .990*S90 + .990*S89 + .829*P91
S2 = .953*D89 + .948*D91 + .943*D90
S3 = .955*E90 + .903*E91 + .879*E89

For Wave 2, S1-S3 explain about 80% of all variation with the following loadings:

S1 = .965*P91 + .960*P92 + .940*P93 + .889*D93 + .817*D90 + .802*S92 + .767*D91
S2 = .953*E92 + .951*E91 + .928*E93 + .896*E90
S3 = .807* DEP_R93

[22] In Wave 1 LR=25.63, which for 34 degrees of freedom at 5% is less than the critical value of 48.60. In Wave 2 LR=182.78, which for 60 degrees of freedom at 1% is greater than the critical value of 88.38.

The openly public way in which shares were transferred from the state to private hands ensured that no individual or group of investors could reap windfall gains at the expense of the general populace. The experience convinced many skeptics that even in a country unaccustomed to free enterprise, the market is a powerful force that can be more equitable than other paternalistic restitutions. For this reason many other Central and Eastern European countries, such as Romania, Bulgaria, Poland, and Ukraine, are examining the Czech model very seriously to adapt it to their own privatization plans.

Table 1: Large Scale Privatization

Approved method of privatization	Number of units	percent	Property bill. CzK	percent
Public Auctions	514	6.8	5.8	0.7
Public Tenders	502	6.7	19.2	2.2
Direct Sales	1680	22.3	46.3	5.3
Joint Stock Co.	1777	23.6	754.3	86.5
Free Transfers to Municipalities	2318	30.8	30	3.4
Restitutions	613	8.1	6.5	0.7
Restitutions with buy in	129	1.7	9.5	1.1
Total	7533	100	871.6	100

Ownership allocation of joint stock companies*

Vouchers		1664	93.6	343	45.5
Foreign Investors		92	5.2	14.02	1.9
Domestic Investors		148	8.3	13.52	1.8
Restitutions		192	10.8	2.54	0.3
Fund of National Property	Temporary	602	33.9	139.01	18.4
	Permanent	49	2.8	0.65	0.1
Financial Intermediaries		103	5.8	12.04	1.6
Municipalities		416	23.4	96.78	12.8
Other		NA	NA	130.9	17.4
Total joint stock co.		1777		754.3	100

Waves of voucher privatization**

Total	1664	22.1	343	39.4
First Wave	988	13.1	212.5	24.4
Second Wave	861	11.4	154.9	17.8
-- new	676	9	130.5	15
-- from the first	185	2.5	24.4	2.8

Source: Ministry of Privatization, C.R., August and December, 1993

* The first two columns can not be summed because company ownership can be distributed across a number of alternatives.

** Percentages are with respect to total large scale privatization.

Table 2a: Comparisons of Individual Investors (II) and Investment Privatization Funds (IPF), Wave 1 (based on **voucher points** allocated in each round to Czech enterprises)[*]

round	1	2	3	4	5
Mean price weighted by supply					
total	33.33	34.38	23.78	17.91	19.35
Mean price weighted by demand					
IPF	33.33	20.73	13.01	5.20	6.37
II	33.33	26.11	5.50	9.47	11.64
Mean price weighted by accepted bids[**]					
IPF	33.33	53.06	44.59	17.38	17.87
II	33.33	35.07	29.61	13.93	12.73
Percentage of shares demanded that are actually allocated by round					
IPF	39.0	53.9	17.2	37.4	87.9
II	26.4	46.9	7.8	39.7	84.0
Voucher point allocation by round (millions)					
IPF	1877 (38.01%)	2142 (41.44%)	573 (11.58%)	199 (4.24%)	180 (4.34%)
II	392 (27.08%)	661 (36.25%)	233 (12.5%)	196 (10.42%)	183 (12.92%)
Percentage of available points bid					
IPF	95.3	92.4	99.2	100.0	100.0
II	84.2	78.3	84.1	77.6	81.8
Sold out units by round					
No. of units	30	55	24	57	26
Shares in sold out units (in millions)	9.92 (4.7%)	12.99 (6.1%)	3.28 (1.5%)	16.85 (7.9%)	4.87 (2.3%)

[*] Using the regional distribution of investment points, one can estimate the number of disposable points for the Czech Republic, alone, as the weighted average of Czech and Slovak IPFs and individual investors, respectively. Note that weighted average corresponds to the conditional mean of the regional distribution of shares:

$$II = II_{Cz} \cdot Pr(II_{Cz} \text{ invest in } CR) + II_{Sl} \cdot Pr(II_{Sl} \text{ invest in } CR)$$

$$IPF = IPF_{Cz} \cdot Pr(IPF_{Cz} \text{ invest in } CR) + IPF_{Sl} \cdot Pr(IPF_{Sl} \text{ invest in } CR)$$

[**] The total mean price weighted by accepted bids was 41.33 for IPFs and was 28.54 for II.

Table 2b: Comparisons of Individual Investors (II) and Investment Privatization Funds (IPF) Wave 2 (based on **voucher points** allocated in each round)

round	1	2	3	4	5	6
Mean price weighted by supply						
total	50.00	42.59	35.83	37.18	29.74	26.44
Mean price weighted by demand						
IPF	50.00	77.58	57.58	70.75	70.18	55.18
II	50.00	50.23	40.55	50.49	46.05	44.76
Mean price weighted by accepted bids*						
IPF	50.00	118.07	101.98	74.89	71.06	57.34
II	50.00	138.43	88.20	55.62	42.91	45.67
Percentage of shares demanded that are actually allocated by round						
IPF	20.0	17.9	17.0	53.5	80.0	83.8
II	15.8	8.7	14.3	54.0	76.7	82.6
Voucher point allocation by round (millions)						
IPF	772 (19.74%)	1651 (42.23%)	590 (15.09%)	575 (14.71%)	257 (6.58%)	62 (1.58%)
II	275 (12.21%)	470 (20.91%)	434 (19.29%)	681 (30.27%)	254 (11.27%)	102 (4.51%)
Percentage of available points bid						
IPF	99.0	93.5	97.6	98.9	100.0	100.0
II	77.4	83.0	88.8	84.8	87.6	85.8
Sold out units by round						
No. of units	15	59	60	59	51	24
Shares in sold out units (in millions)	2.61 (1.68%)	14.75 (9.5%)	24.56 (15.85%)	12.87 (8.31%)	11.57 (7.47%)	5.71 (3.69%)

* The total mean price weighted by accepted bids was 91.78 for IPFs and was 43.65 for II.

Table 3a: Dynamic model with fixed effects, Wave 1
(GMM for Model 1 and IV for Models 2 & 3*)

Parameter	t	Model 1	Model 2	Model 3
ρ_t autoregressive parameter	3	-0.098 (.014)	-0.058 (.029)	-0.071 (.033)
	4	0.069 (.010)	0.108 (.019)	0.103 (.018)
	5	-0.015 (.023)	0.044 (.050)	0.034 (.043)
β_t learning coefficient	3	0.053 (.004)	0.089 (.016)	0.087 (.017)
	4	0.026 (.004)	0.020 (.007)	0.017 (.006)
	5	0.011 (.006)	0.022 (.009)	0.025 (.008)
γ_t price elasticity	3	-1.604 (.021)	-1.460 (.066)	-1.467 (.070)
	4	-1.765 (.063)	-1.807 (.104)	-1.609 (.113)
	5	-1.219 (.027)	-0.813 (.070)	-0.844 (.061)
δ_t supply coefficient	3	0.740 (.025)	0.957 (.043)	1.033 (.097)
	4	0.443 (.036)	0.463 (.056)	0.357 (.061)
	5	0.647 (.029)	0.786 (.054)	0.615 (.063)
λ_t selection bias (mills ratio coefficient)	3			0.316 (.358)
	4			-0.459 (.132)
	5			-0.421 (.104)
R^2	3	0.880	0.810	0.795
	4	0.691	0.676	0.678
	5	0.817	0.722	0.763

* Standard errors computed from heteroscedastic-consistent matrix (Robust-White) are shown in parentheses beneath parameter estimates.

Parameter	t	Model 1	Model 2	Model 3
Std. error of regression	3	0.643	0.790	0.829
	4	0.392	0.400	0.375
	5	0.428	0.515	0.443
Std. dev. of dependent variable	3	1.767	1.780	1.780
	4	0.668	0.654	0.654
	5	0.903	0.903	0.903

Table 3b: Dynamic model with fixed effects, Wave 2
(GMM for Model 1, IV for Models 2 & 3)*

	t	Model 1	Model 2	Model 3
ρ_t autoregressive parameter	3	0.413 (.008)	0.449 (.025)	0.447 (.024)
	4	0.162 (.014)	0.182 (.028)	0.181 (.028)
	5	0.286 (.027)	0.103 (.075)	0.073 (.060)
	6	0.432 (.025)	0.265 (.056)	0.197 (.057)
β_t learning coefficient	3	0.058 (.004)	0.069 (.011)	0.071 (.011)
	4	0.015 (.003)	0.016 (.006)	0.016 (.006)
	5	-0.006 (.004)	0.001 (.011)	-0.001 (.009)
	6	-0.028 (.004)	-0.019 (.008)	-0.014 (.008)
γ_t price elasticity	3	-3.529 (.038)	-3.340 (.103)	-3.372 (.104)
	4	-2.308 (.029)	-2.106 (.079)	-2.112 (.084)
	5	-0.905 (.063)	-1.188 (.137)	-1.450 (.114)
	6	-1.405 (.052)	-1.152 (.156)	-1.332 (.157)
δ_t supply coefficient	3	-0.199 (.019)	-0.171 (.095)	-0.051 (.123)
	4	0.305 (.011)	0.410 (.061)	0.418 (.071)
	5	0.774 (.009)	1.139 (.056)	0.837 (.059)
	6	0.650 (.029)	0.911 (.075)	0.788 (.081)

* Standard errors computed from heteroscedastic-consistent matrix (Robust-White) are shown in parentheses.

	t	Model 1	Model 2	Model 3
λ_t selection bias (mills ratio	3			0.394 (.261)
	4			0.030 (.135)
	5			-1.049 (.133)
	6			-0.465 (.164)
R^2	3	0.753	0.712	0.720
	4	0.523	0.487	0.487
	5	0.267	0.410	0.467
	6	0.288	0.310	0.357
Std.error of regression	3	0.707	0.753	0.742
	4	0.599	0.622	0.623
	5	0.857	0.858	0.713
	6	0.795	0.820	0.752
Std. dev. of dependent variable	3	1.406	1.398	1.398
	4	0.868	0.865	0.865
	5	0.863	0.893	0.858
	6	0.842	0.842	0.842

Table 4a: Summary statistics for equations run separately across rounds, Wave 1.

	round 3	round 4	round 5
R^2	.018	.046	.021
Adj. R^2	-.002	.027	.002
Log L	-985.501	-349.476	-482.560
Std. error of regression	.816	.375	.441
Mean of dependent var.	-.024	-.004	-.014
Std. dev of dependent var.	.815	.380	.441

Summary statistics, constraining coefficients to be equal across rounds, Wave 1.

	round 3	round 4	round 5
R^2	.004	.035	.001
Log L	-1804.72		
Std. error of regression	.813	.373	.440

Table 4b: Summary statistics for equations run separately across rounds, Wave 2.

	round 3	round 4	round 5	round 6
R^2	.032	.040	.050	.041
Adj. R^2	.001	.010	.020	.10
Log L	-675.741	-576.519	-657.729	-684.174
Std. error of regression	.735	.626	.714	.746
Mean of dependent var.	.058	-.022	-.067	-.045
Std. dev of dependent var.	.734	.629	.719	.748

Summary statistics, constraining coefficients to be equal across rounds, Wave 2.

	round 3	round 4	round 5	round 6
R^2	.000	.004	.01	.01
Log L	-2502.77			
Std. error of regression	.737	.628	.718	.746

References

Amemiya, T., and T. E. McCurdy. "Instrumental-Variables Estimation of an Error-Components Model," *Econometrica* 54, (1986), 869–880.

Anderson, T. W. and C. Hsiao. "Estimation of Dynamics Models with Error Components," *Journal of the American Statistical Association* 76 (1981), 598–606.

Anderson, T. W. and C. Hsiao. "Formulation and Estimation of Dynamic Models Using Panel Data," *Journal of Econometrics* 18 (1982), 47–82.

Arellano, M. "Some Tests of Specification for Panel Data: MonteCarlo Evidence and an Application to Employment Equations," *Review of Economic Studies* 58, (1991), 277–297.

Ashenfelter, O. "Estimating the Effects of Training Programs on Earnings," *Review of Economics and Statistics* 60 (1978), 47–57.

Balestra, P. and M. Nerlove. "The demand for Natural Gas," *Econometrica* 34 (1966), 585–612.

Bhargava, A. and J. D. Sargan. "Estimating Dynamic Random Effects Models from Panel Data Covering Short Time Periods," *Econometrica* 51 (1983), 1635–1659.

Engle, R. F, D. F. Hendry, and J. F. Richard. "Exogeneity", *Econometrica* 51, (1983), 277–304.

Filer, R. and J. Hanousek. "Efficiency in an Emerging Capital Market: The Case of Czech Voucher Privatization," unpublished.

Hanousek, J. and R. Laštovička. "Incorporating Information into Models: A Methodology and an Estimation Using Czech Voucher Privatization Data," *CERGE-EI Discussion Paper* 72, 1994.

Hanousek, J. and E. Kroch. "Voucher Privatization in the Czech Republic," *EAST: Economies and Societies in Transition*, University of Pennsylvania, **1**, 2 (March), 1995, 6–13.

Hansen, L. P. "Large Sample Properties of Generalized Method of Moments Estimation," *Econometrica* 50, 1982, 1029-1054.

Harman, H. H. *Modern Factor Analysis*, Second Edition, Chicago University Press, 1967.

Hausman, J. A. "Specification Tests in Econometrics," *Econometrica* 46 (1978), 1251–1273.

Hausman, J. A. and W. E. Taylor. "Panel Data and Unobservable Individual Effects," *Econometrica* 49 (1981), 1377–98.

Heckman, J. "Sample Selection Bias as a Specification Error," *Econometrica* 47 (1979), 153–161.

Hoch, I. "Estimation of Production Function Parameters Combining Time-Series and Cross-Section Data," *Econometrica* 30 (1962), 34–53.

Jacobs, R. L., E. E. Leamer, and M. P. Ward. "Difficulties with Testing for Causation," *Economic Inquiry*, 1979, 401–313.

Keane, P. and D. E. Runkie. "On the Estimation of Panel-Data Models With Serial Correlation When Instruments Are Not Strictly Exogenous," *Journal of Business & Economic Statistics* 10 (1992), 1, 1–9.

Kotrba, J. "Czech Privatization: Players and Winners," *CERGE-EI Working Paper* No. 58, April, 1994.

Lahiri, K. and P. Schmidt. "On the Estimation of Triangular Structural Systems," *Econometrica* 46 (1978), 1217–22.

Leamer, E. E. "Vector Autoregressions for Causal Inference," in K.Brunner and A. Meltzer (eds.), *Understanding Monetary Regimes* (supplement to *Journal of Monetary economics*), 1985, 255–304.

Maddala, G. S. "The Use of Variance Components Models in Pooling Cross Section and Time Series Data," *Econometrica* 39 (1971), 341–58.

Mundlak, Y. "Empirical Productions Free of Management Bias," *Journal of Farm Economics* 43, (1961), 44–56.

Nerlove, M. "Experimental Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross-Sections," *Economic Studies Quarterly* 18 (1967), 42–74.

Nerlove, M. "Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross-Sections," *Econometrica* 39 (1971), 359–387.

Nickel, S. "Biases in Dynamic Models with Fixed Effects," *Econometrica* 49 (1981), 1417–1426.

Revankar, N. S. "Asymptotic Relative Efficiency Analysis of Certain Tests of Independence in Structural Systems," *International Economic Review* 19, 1978, 165–179.

Spencer, D. and K. Berk. "A Limited Information Specification Test," *Econometrica* 49 (1981), 1079–1085.

Svejnar, J. and M. Singer M. "Using Vouchers to Privatize an Economy: The Czech and Slovak Case," *CERGE Working Paper* No. 36, 1993.

Valbonesi, P. "Privatizing by Auction in the Eastern European Transition Countries: The Czechoslovak experience," *MOCT-MOST* 5 (1995), 101–131.

Wu, D. "Alternative Tests of Independence between Stochastic Regressor and Disturbances," *Econometrica* 41 (1973), 733–750.

APPENDIX

Appendix Table A-1 Firm Characteristics

Name	Description of the variable
TNS	The total number of shares of a firm
E89 - E91	The number of employees in 1989 - 1990, 1991 (wave 1) divided by TNS
E90 - E93	The number of employees in 1990 - 1993 (wave 2) divided by TNS
P89 - P91	The profit in 1989, 1990, 1991 (wave 1) divided by TNS
P90 - P93	The profit in 1990, 1991, 1992, 1993 (wave 2) divided by TNS
S89 - S91	Sales in 1989, 1990, 1991 (wave 1) divided by TNS
S90 - S93	Sales in 1990, 1991, 1992, 1993 (wave 2) divided by TNS
D89 - D91	The debt in 1989, 1990, 1991 (wave 1) divided by TNS
D90 - D93	The debt in 1990, 1991, 1992, 1993 (wave 2) divided by TNS
DEP_R93	The depreciation rate in 1993 (wave 2).

Ownership structure:

FOREIGN	The percentage of shares for the direct sale to predetermined foreign owners
DOMESTIC	The percentage of shares for the direct sale to predetermined domestic owners
FNPT	The percentage of shares for the transfer to The Fund of National Property for temporary period
FNPU	The percentage of shares for the transfer to The Fund of National Property for undetermined period
RESTIT	The percentage of shares for the transfer to restituents
INTERM	The percentage of shares for the transfer to an intermediator (usually a bank) which will sell it later
MUNIC	The percentage of shares for the free transfer to municipalities
EMPL	The percentage of shares for the sale to employees

Industries:

IND 1	Agriculture
IND 2	Heavy industry and mining
IND 3	Light industry
IND 4	Construction
IND 5	Transportation and telecommunication
IND 6	Trade
IND 7	R & D
IND 8	Services, culture and education
IND 9	Financial and state institution
IND 0	Unspecified

Regions:

REGPR	Prague (Capital)
REGCB	Central Bohemia
REGSB	Southern Bohemia
REGWB	Western Bohemia
REGNB	Northern Bohemia
REGEB	Eastern Bohemia
REGSM	Southern Moravia
REGNM	Northern Moravia

Other dummy variables: (Wave 2)

WAVE1	1 if the firm is a carry-over from the first wave
HOLDING	1 if the firm is a holding company
CAPITAL	1 if the board decided to increased capital from other sources (changes not registered in current data base) and/or if an increase of capital is related to the privatization project (a change of ownership structure).

Appendix Table A-2 Price adjustment for enterprises with accepted bids (percents are in parentheses)

Pairs of Adjacent rounds	Number of enterprises with excess supply	Number of enterprises by price change (percent of total)		
		decline	no change	increase
First wave				
1-2	668	616 (92.2)	24 (3.6)	28 (4.2)
2-3	672	471 (70.1)	54 (8.0)	147 (21.9)
3-4	539	107 (19.9)	379 (70.3)	53 (9.8)
4-5	636	241 (37.9)	209 (32.9)	186 (29.2)
Second wave				
1-2	732	673 (91.9)	33 (4.5)	26 (3.6)
2-3	456	289 (63.4)	83 (18.2)	84 (18.4)
3-4	299	102 (34.1)	92 (30.8)	105 (35.1)
4-5	491	437 (89.0)	17 (3.5)	37 (7.5)
5-6	499	427 (85.6)	17 (3.4)	55 (11.0)

Bidding success for firms whose **price fell or stayed the same** between rounds

	Numbers of firms (percent) whose bids would have been accepted				
Rounds	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
First wave					
Firms	370	126	405	385	
Percent	57.8	24.0	83.3	85.6	
Second wave					
Firms	390	189	154	342	376
Percent	55.2	50.8	79.4	75.3	84.7

Appendix Table A-3(a) Tests for Exogeneity, Wave 1

Test χ^2 Test statistic (degrees of freedom and p-value)	Model 1	t	Model 2 (df=1)	Model 3 (df=1)
Weak supply exogeneity	140.7 (df=6) (p=.000)	3	157.4 (p=.000)	64.9 (p=.000)
		4	66.6 (p=.000)	14.0 (p=.000)
		5	34.9 (p=.000)	28.3 (p=.000)
Weak price exogeneity	33.3 (df=6) (p=.000)	3	10.8 (p=.001)	9.9 (p=.002)
		4	77.6 (p=.000)	58.1 (p=.000)
		5	26.7 (p=.000)	52.3 (p=.000)
Weak price and supply exogeneity	165.9 (df=12) (p=.000)	3	164.4 (p=.000)	78.6 (p=.000)
		4	83.9 (p=.000)	60.1 (p=.000)
		5	100.8 (p=.000)	91.0 (p=.000)
Strong price and supply exogeneity	177.6 (df=18) (p=.000)		NA	NA

Appendix Table A-3(b) Tests for Exogeneity, Wave 2

Test χ^2 Test statistic (degrees of freedom and p-value)	Model 1	t	Model 2 (df=1)	Model 3 (df=1)
Weak supply exogeneity	26.2 (df=6) (p=.000)	3	7.5 (p=.006)	7.0 (p=.008)
		4	10.3 (p=.001)	9.1 (p=.003)
		5	65.5 (p=.000)	28.3 (p=.000)
		6	21.6 (p=.000)	16.4 (p=.000)
Weak price exogeneity	32.0 (df=6) (p=.000)	3	21.7 (p=.000)	12.4 (p=.002)
		4	69.3 (p=.000)	58.8 (p=.000)
		5	5.0 (p=.025)	8.0 (p=.005)
		6	78.5 (p=.000)	43.6 (p=.000)
Weak price and supply exogeneity	50.5 (df=12) (p=.000)	3	30.4 (p=.000)	29.7 (p=.000)
		4	93.7 (p=.000)	91.9 (p=.000)
		5	138.6 (p=.000)	75.5 (p=.000)
		6	107.2 (p=.000)	57.5 (p=.000)
Strong price and supply exogeneity	60.8 (df=18) (p=.000)		NA	NA

Appendix Table A-4(a) Hausman-Taylor two-step estimation of fixed effects*, Wave 1.

	round 3	round 4	round 5	all rounds
OWNERSHIP FACTORS				
O1	-0.034 (0.029)	-0.018 (0.013)	0.024 (0.016)	-0.004 (0.008)
O2	0.012 (0.031)	0.012 (0.014)	-0.010 (0.017)	0.003 (0.009)
O3	-0.001 (0.030)	0.016 (0.014)	0.002 (0.016)	0.009 (0.009)
O4	0.027 (0.029)	0.032* (0.013)	0.014 (0.015)	0.025* (0.008)
INDUSTRIAL AND REGIONAL FACTORS				
D1	0.025 (0.032)	0.007 (0.015)	0.019 (0.017)	0.013 (0.009)
D2	-0.005 (0.029)	0.012 (0.013)	0.006 (0.015)	0.008 (0.008)
D3	-0.018 (0.031)	0.030* (0.014)	-0.022 (0.017)	0.006 (0.009)
D4	0.055 (0.029)	0.035* (0.013)	0.015 (0.016)	0.029* (0.009)
D5	-0.007 (0.029)	0.038* (0.013)	0.010 (0.015)	0.023* (0.008)
D6	0.036 (0.029)	0.001 (0.013)	-0.001 (0.015)	0.003 (0.008)
D7	0.059* (0.029)	0.004 (0.013)	0.020 (0.016)	0.015 (0.008)
D8	-0.032 (0.030)	0.030* (0.014)	-0.002 (0.016)	0.013 (0.009)
D9	-0.013 (0.030)	0.015 (0.014)	0.039* (0.016)	0.022* (0.009)
D10	0.008 (0.029)	0.015 (0.013)	0.002 (0.016)	0.009 (0.008)
FIRM DESCRIPTION FACTORS				
S1	-0.003 (0.026)	0.009 (0.012)	-0.011 (0.014)	0.000 (0.008)
S2	-0.004 (0.036)	0.013 (0.016)	0.018 (0.019)	0.014 (0.010)
S3	-0.017 (0.032)	0.009 (0.015)	0.018 (0.017)	0.010 (0.009)

* Significant at 5% (two tailed)

*Standard errors are in parentheses below the coefficient estimates.

Appendix Table A-4(b) Hausman-Taylor two-step estimation of fixed effects*, Wave 2.

	round 3	round 4	round 5	round 6	all rounds
OWNERSHIP FACTORS					
O1	.003 (.028)	.011 (.024)	.020 (.027)	-.005 (.028)	.009 (.009)
O2	-.004 (.033)	.012 (.028)	-.054 (.032)	-.003 (.033)	-.011 (.011)
O3	.002 (.030)	.005 (.026)	-.048 (.029)	.033 (.031)	-.005 (.010)
O4	-.044 (.031)	.018 (.027)	-.038 (.031)	-.021 (.032)	-.017 (.011)
O5	-.012 (.041)	.010 (.035)	-.029 (.040)	-.003 (.042)	-.007 (.014)
INDUSTRIAL AND REGIONAL FACTORS					
D1	.042 (.031)	-.091* (.026)	.019 (.030)	-.006 (.032)	-.019 (.011)
D2	-.010 (.030)	-.032 (.026)	-.012 (.029)	.076* (.031)	-.005 (.010)
D3	.041 (.030)	-.003 (.025)	.013 (.029)	.033 (.030)	.017 (.010)
D4	.025 (.031)	-.019 (.026)	-.024 (.030)	-.032 (.031)	-.013 (.010)
D5	.041 (.031)	-.011 (.026)	.033 (.030)	.016 (.031)	.016 (.010)
D6	-.028 (.034)	-.016 (.029)	.016 (.033)	-.015 (.035)	-.010 (.012)
D7	-.018 (.032)	.041 (.027)	-.040 (.031)	.033 (.033)	.005 (.011)
D8	.013 (.029)	-.005 (.025)	-.020 (.028)	-.026 (.030)	-.009 (.010)
D9	.006 (.030)	.041 (.026)	-.088* (.029)	-.009 (.030)	-.008 (.010)
D10	-.015 (.030)	.034 (.025)	-.010 (.029)	.063* (.030)	.017 (.010)
D11	-.026 (.032)	.004 (.027)	.005 (.031)	-.014 (.032)	-.006 (.011)
D12	-.043 (.030)	-.017 (.025)	.043 (.029)	.067* (.030)	.006 (.010)

*Standard errors are in parentheses below the coefficient estimates.

FIRM DESCRIPTION FACTORS					
S1	.012 (.038)	.016 (.032)	.006 (.037)	.022 (.038)	.013 (.013)
S2	-.164* (.059)	.123* (.050)	.083 (.057)	-.003 (.060)	.028 (.020)
S3	-.004 (.030)	.024 (.026)	-.042 (.029)	-.045 (.031)	-.010 (.010)

* Significant at 5% (two tailed)