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Efficiency and market share in the Hungarian corporate sector[1]

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Abstract

This paper investigates the link between competition and efficiency for the Hungarian corporate sector during various phases of the transition process. We employ frontier production functions to explore differences among groups of firms, and to identify the typical adjustment process of each group separately throughout the transition period until 1997. The estimated production functions indicate a gradual improvement in efficiency and a shift from decreasing to increasing returns to scale due to the growing share of small firms. Market share can be explained by domestic and foreign competition and by the efficiency of the firm.

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1. Introduction

There is a general consensus that centrally-planned economies were highly inefficient. Inefficiencies stemmed from various sources: the idiosyncrasies of the macroeconomic planning process, the bureaucratic state-ownership stifling incentives, the highly concentrated enterprise structure paralyzing innovation, and the neglect of consumer preferences. When transition to the market economy started, all these constraints were suddenly removed. Privatization quickly turned most former state-owned enterprises into private companies, many new firms emerged either as small private enterprises, or through foreign direct investment, or from the break-up of former state-owned behemoths. Indeed, the corporate landscape was unrecognizably reshaped within a period of a few years. It was hoped that transition would quickly create more competitive economies.

Our major interest in this paper is in the evolution of corporate efficiency. Almost all theoretical models of transition assumed that private ownership is more efficient than state ownership by its nature. Indeed, this efficiency gap was the driving force of transition in many theoretical models. However, we found that efficiency gains are by no means uniform, and evenly spread over different types of companies. There are persistent efficiency differences among different groups of privately-owned firms, and not all forms of private ownership are more efficient than state ownership.

We also explore the relationship between efficiency and market structure. The causal relationship between corporate efficiency and market structure is far from obvious, even in a mature market economy (*cf.* Nickell, 1996, and Nickell *et al.*, 1997, vs. Hay and Liu, 1997). This relationship is even more complex in a transition economy where stable corporate behaviour has yet to emerge. It may happen that competitive pressure forces firms to improve efficiency faster. Alternatively, efficient firms may gain market share in the fast changing corporate environment. We explore both possibilities in this paper.

Hungarian firms have gone through different periods of economic transformation since the liberalization of prices and imports in 1988–89. Initially, the majority of firms just waited and did not adjust their capacities to the fall in internal and external demand. Although many (usually small) private firms were established in the period 1988–91, the privatization of state-owned enterprises (SOEs) was just beginning. The increased competition from both newly emerging firms and from liberalized imports, and more importantly, the loss of the former CMEA markets led to a severe recession and to a deep crisis of the banking sector in 1992–93. The adoption of new accounting standards and a tough bankruptcy law in 1992 contributed to the acceleration of restructuring, which was further enhanced by substantial foreign investment and the emergence of private firms. The March 1995 stabilization measures were intended to re-establish the macroeconomic equilibrium in the current account as well as in the general government budget, and also to shift revenues to the corporate sector. As

privatization progressed, helped by the inflow of foreign capital, it created a different environment for corporate performance. Markets have been heavily influenced by the penetration of foreign corporations and competition has become dependent on the evolving market structure.

This paper tries to assess the development of corporate performance between 1990 and 1997 using a large sample of Hungarian firms. Dynamic Cobb-Douglas frontier production functions are estimated. Our maintained hypothesis in this study is that most firms operate far away from the efficiency frontier during transition: first, because they underutilize existing capacities due to the lack of demand, and second, because many firms operate rather inefficiently during the reorganization period. Frontier production functions can directly take into account the above inefficiencies. Dynamic functions provide estimates to assess the speed of the adjustment process to the new, changed environment of the firms. The estimated inefficiencies were subsequently used to explain the development of market share, together with import penetration and concentration. For this purpose, balance sheet and profit and loss accounting data of a sample of several thousands of firms were used. Different sub-samples were defined and analyzed by sectors, size and ownership.

The remainder of the paper is organized as follows. Section 2 provides some background on previous studies of corporate performance. The framework of our empirical analysis is set out in Section 3. Empirical findings are analyzed in Section 4. Finally, conclusions are drawn. Appendices summarize the characteristic features of the dataset, definitions, and most of the important estimation results.[2]

2. Corporate performance in transition economies

It is assumed that corporate efficiency is closely related to the structure of the market. Prices, firms' costs, and hence profits may depend on the degree of competition. In this respect one can distinguish two approaches. In the first one, the corporate cost level is outside the control of firms. Their survival depends on the degree of competition and on the cost level of their rivals. According to the second interpretation, the cost level is a negative function of efforts, managerial and investment activities. Adopting the second approach, the results of the effort of each firm can be compared with that of the best-practice firm and the relative efficiency can be assessed. According to the assumptions, this (in)efficiency affects the market share and can be related to other performance indicators. It is, however, obvious that the relation between efficiency and market share is simultaneous. The relation between efficiency and profitability, or investment

[2] Additional tables, summarizing all relevant estimation results, are available in Halpern and Kőrösi (2000).

activity may also be simultaneous, and only an empirical investigation may shed light on its nature.

In principle one can distinguish between short- and long-run efficiencies. Long-run efficiency can be influenced by the adoption of new technologies, and investment, while short-run efficiency depends on the ability of the management to allocate the existing resources optimally according to market conditions. If the dynamics of efficiencies can be assessed, then the time profile of performance indicators can be separated too.

It is important to take into account the basic market characteristics. The more competitive the market, the stronger the link between efficiency and market share, i.e., in a very competitive market only the efficient firms have a good chance for survival. In a less competitive environment less efficient firms can also survive, and the relationship between efficiency and market shares will be weaker.

The few early theoretical models of enterprise performance and transition – Aghion *et al.* (1994a) and (1994b), Estrin and Hare (1992), Katsoulacos (1994) – are now complemented with more detailed and more transition-specific models, like Aghion and Schankerman (1999), Commander *et al.* (1999), Ghosh and Whalley (2000), Meyer (2000) and Xu (2000). This paper concentrates on empirical evidence. Theoretical aspects of the issue are beyond the scope of this paper.

Our knowledge of the initial conditions of markets and corporate performance in transition countries is rather limited.[3] The development of markets in transition economies is influenced by the speed and degree of price and foreign trade liberalization, and by the rules and costs of entry and exit for domestic and foreign participants. These factors are substantially different across countries. However, low capacity utilization, the increasingly large number of market participants, the lack of legal, behavioural and institutional stability and of transparency can be regarded as common characteristics of transition economies. These conditions are very different from those in mature market economies.

The Hungarian corporate sector attracted substantial foreign direct investment in a relatively early phase of transition compared to other transition economies. Large numbers of new firms were created, partly as spin-offs of liquidated firms. Some of these new domestic and foreign firms are widely thought to be leaders of the competition, and to be more efficient than the others. These assumptions will be investigated.

Similar investigations were made by Brada *et al.* (1997) for Hungary for 1991 and for Czechoslovakia for 1990, and by Konings and Repkin (1998) for Bulgaria for 1993–95 and Romania for 1994–95 and recently by Brown and Earle (2000) for Russia. Our results, however, are not directly comparable to these studies. There are major differences in the model specification, and also in the sample period. Nevertheless, the main direction of these studies is similar to ours as far as the

[3] Both Brada *et al.* (1997) and Konings and Repkin (1998) offer some evidence supporting the hypothesis of Ickes and Ryterman (1992) that the larger the firm the higher the allocative efficiency prior to transition.

estimation of frontier production function is concerned. This paper goes beyond the scope of those listed above in investigating the relationship between efficiency and market share. The behaviour of Hungarian firms, the link between performance and ownership have been analyzed by other studies (*cf.* Major, 1999 and Tóth, 1999), but our study is more extensive, and none of them aims at assessing the link between performance and market power.

3. Estimated models

The starting point of our analysis is the traditional Cobb-Douglas production function in its linearized form. We assume that the production function describes the potential production of the firm. Thus, we use frontier production functions and follow the traditional approach first suggested by Aigner *et al.* (1977):

$$log\left(Y_{t,i}\right) = c + \alpha\, log\left(L_{t,i}\right) + \beta\, log\left(K_{t,i}\right) + \mu\, log\left(Y_{t-1,i}\right) + v - u \qquad (1)$$

where Y stands for the output (value added), L for labour input, K for capital stock, v is the usual disturbance term (assumed to be $v \sim$i.i.d.$N(0, \sigma_v)$, while u is assumed to have i.i.d. truncated normal distribution (for $u > 0$), representing firm-specific inefficiencies, compared to the 'best-practice' firm in the sample.

As the returns to scale may also be interpreted as a measure of allocative efficiency of input use, or of market imperfection, we did not impose constant returns to scale (CRS).

The lagged dependent variable captures the fact that with substantial changes in factor input or in circumstances, adjustment to the new long-run production level may take a relatively long time. Fixed time effects are also included in all panel estimates, which in this case represents the change of the mean (in)efficiency for that year compared to the (first) base year.

The difference from the frontier, determined by the best-practice firm, is defined as inefficiency.[4] There are at least two possible problems with this interpretation. First, this term captures sub-optimal capacity utilization. In both market and emerging economies capacity utilization can depend on factors excluded from our specification (for example, on the business cycle[5]). Second, it is quite possible that labour and/or capital are not homogeneous, as labour skills and capital might differ across firms or sectors. Otto (1999) attempts to separate them at the aggregate level, but our approach, strongly influenced by the characteristics of the available sample information, does not allow us to

[4] Due to the features of the dataset – we only had 2-3 observations for many firms – it was impossible to estimate a panel model with fixed firm effects to separate short and long-term inefficiencies.

[5] Our sample is obviously too short to take account of such longer-term macroeconomic developments. It is also questionable whether one can speak of a business cycle in the transition period.

distinguish between these interpretations.

Two different models were estimated. First, frontier production functions were augmented by variables reflecting the competition firms have to face following the approach used by Nickell (1996), Nickell *et al.* (1997). Three variables are used to describe this pressure: import penetration, concentration and market share. We expect positive coefficients for import penetration and market share, and negative for concentration.[6] The rationale behind this approach is that stronger competition may force companies to become more efficient. Our empirical analysis also aims at assessing the temporal characteristics of these empirical relations. Market share is lagged in these equations in order to avoid possible simultaneity, as more efficient firms may increase their market share, thus leading to a possible reverse causality. On the other hand, increasing market share may be associated with weakening competition. The augmented production function is:

$$\begin{aligned} log(Y_{t,i}) = c + \alpha\, log(L_{t,i}) + \beta\, log(K_{t,i}) + \mu\, log(Y_{t-1,i}) \\ + \gamma_1 S_{t-1,i} + \gamma_2 C_{t,i} + \gamma_3 I_{t,i} + v - u \end{aligned} \tag{2}$$

where S stands for market share, C for concentration and I for import penetration.

Our second model assumes that market structure does not directly influence productive efficiency, but efficient firms will gain market share. It is a recursive system of two equations. It consists of the 'simple' production function (1), coupled with a dynamic market share equation following Hay and Liu (1997). The market share of the firm is explained by the same indicators of competitive pressure (concentration and import penetration) and also by the residual $\hat{u}$ of the production equation, representing the efficiency of the productive process.[7] The market share equation is:

$$S_{t,i} = \gamma_0 + \gamma_1 S_{t-1,i} + \gamma_2 \hat{u}_{t,i} + \gamma_3 C_{t,i} + \gamma_4 I_{t,i} + \varepsilon \tag{3}$$

where $\hat{u}$ is the inefficiency estimated in the production function. We expect that efficiency has a positive and growing effect on market share as long as market institutions evolve and competition increases. Our assumption is that concentration has a positive effect on market share, as higher concentration is

[6] The empirical literature on competition assumes that these variables are monotone in competition. As Boone (2000, p. 23) argues 'A rise in import penetration ... increases competition on the domestic market. But more aggressive interaction on the domestic market may cause a fall in import penetration if home producers are more efficient than foreign ones.' Another possibility of non-monotone relation can arise in the case of intra-firm trade. It is especially relevant to transition economies with high foreign investments. Concentration can also reveal non-monotone behaviour in relation to competition.

[7] Hay and Liu (1997) found for UK data that efficiency is exogenous to the market share. The reverse causation was also examined, long-run efficiency was regressed on investment, short-run efficiency was explained by lagged market share, lagged gross profit and by rival firms efficiency. Due to data constraints we were unable to explore all these issues. However, we assume that these results also apply to Hungary.

associated with a less competitive market, which makes it easier to increase market share. Finally, import penetration is expected to enter the equation with a negative sign, since we assume that higher import penetration increases domestic competition and reduces market share for domestic firms.

The two models differ in the direction of causality: the first one assumes that competition forces firms to allocate resources more efficiently, while the second supposes that efficiency can be assessed by the ability to allocate resources in production and this allocative efficiency is one of the explanatory factors of market share in addition to concentration and import penetration. Another important difference is that competitive pressure affects allocative efficiency directly in the first approach, while in the second case competitive pressure is separated from this allocative efficiency, and market share as a performance indicator is explained by competitive pressure and allocative efficiency. The theoretical models behind the two approaches do not provide any transition-specific arguments in favour of either. Thus, model selection will be rather based on empirical and econometric criteria. For the sake of brevity we will refer to these as the one-equation and two-equation models, respectively.

In this study, we only analyze the relationship between productive efficiency and market share. There are other obvious factors, like profit[8] and investment, which may be related to efficiency. We did not develop a model describing these possible relationships; we just checked the hypothesis that profitability may be related to efficiency and that investments may influence efficiency. Simple linear correlation is used for this purpose.

The models used in this paper are best applied to manufacturing. One important feature of the Hungarian corporate sector is that the sectoral classification may be biased, as the principal activity of the time of registration may be totally different from the actual one and firms may undertake quite distant and heterogeneous activities. That is why results for non-manufacturing sectors were also analyzed.

The dataset makes possible the estimation of panel models. The possibility was thoroughly tested by separating the entire estimation period into two sub-periods and bi-annual periods. These two sub-periods (1990–93 and 1994–97) somehow represent significantly different phases of economic transition. The first, very volatile phase was characterized by the effect of the output collapse, by the initial adjustment, recovery from this transitional recession, and by the creation of basic institutions of a market economy, while the second period can be characterized by the early phase of a functioning market economy. The bi-annual panel estimations are mainly used for testing parameter constancy.

[8] This issue was explored in Halpern and Kőrösi (1998a, b) for Hungarian exporting firms.

4. Estimation results

We estimated the models outlined above for the entire sample, and also for various sub-samples. The equations were estimated for sectors; for small, medium-sized, and large firms; and for five ownership categories. The sectoral classification of this study is: Agriculture, Manufacturing, Construction, Trade, and Services. Within manufacturing, Engineering, Chemical industry, Food industry, Light industry,[9] and Other industries were distinguished. Observations were grouped for state-owned, domestic private, foreign, important foreign minority and other ownership categories.[10] We do not report estimation results for all sub-samples. However, for most sub-samples for most years we found significantly different coefficient vectors. These structural differences necessitate the analysis of characteristic differences between the various groups of firms.

The frontier production function is relevant only if the second component of the disturbance term, representing (in)efficiency, is different from zero. This is indicated by the ratio of the two standard errors (σ_v/σ_u). There are a small number of cases, when the estimation of this ratio converges to extremely low (or high) values. This obviously indicates severe specification error in the cases involved, but we were unable to find a better specification.[11] In most cases the ratio of the two standard errors in the equation was above unity. These estimates are significantly larger than the usual estimates for developed countries. It may reflect higher inefficiency of firms in Hungary, compared to developed market economies, although direct comparison is strongly influenced by the actual model specification, the characteristics of the sample information, and also by the variance of the traditional disturbance term. Anyway, the overwhelmingly significant estimate for this coefficient clearly indicates that the use of frontier production functions was justified.

Although we use an unbalanced panel dataset, we estimate the model for each year separately. Even though coefficient vectors, estimated from the later years, are not far from each other, there are significant structural breaks between consecutive years. Tables A1–A4 in Appendix C present results of panel estimates of both models for different time spans. Parameter estimates in different time periods are significantly different from each other indicating structural breaks, with the exception of 1996–97. The relevant tests confirm our approach of treating the sample as repeated cross-sections instead of a panel.

Due to the structural breaks we continued our analysis by departing from the panel framework. We use the sample as repeated cross-sections of a large and

[9] Light industry consists of textile, clothing, leather, footwear, wood, paper and printing industries.
[10] The definitions of size and ownership categories are given in Appendix B.
[11] Other distributions were also attempted (*cf.* Greene (1993) for further details), however, all attempted distributions led to very questionable estimates.

growing number of heterogeneous firms. See Tables A5 and A6 in Appendix C summarize estimation results for each year.[12]

We estimated both models for each sample: the production function extended with market variables, and the system of production and market share equations. Both models fit the data quite well.

The coefficients are in line with our expectations in general. However, the effect of import penetration is negative in the single equation panel estimations – especially for manufacturing – between 1990 and 1994, and positive afterwards. These results are consistent with an alternative interpretation. The expected positive effect of import penetration, outlined in the previous section, is the result of a long-run exposure of firms to foreign competition. An unanticipated import liberalization shock initially imposes high adjustment costs on firms, and it takes time until the positive efficiency effect of higher competition takes effect. Unfortunately, we could not meaningfully separate the short- and long-run in our models. Further, imports can also be an input for production. General import liberalization, just completed by 1990, had a significant negative short-run competition effect in the first half of the 1990s. This negative effect was gradually overshadowed by long-term improvements, and by the input effect, accompanying the massive foreign direct investment inflow in the subsequent period.[13] This challenges our initial hypothesis about the role of import penetration in the single equation model. Import penetration behaved much more consistently in the two-equation model, where market share was usually significantly reduced by import penetration; some exceptions, however, occurred.

Market concentration has rather poor explanatory power in our models. While it was significant in most cases with a positive sign in both models in the panel estimations, it is very rarely significant in the cross-sectional estimations, especially in the single-equation models.

Lagged market share had probably the most consistent effect among the market structure variables in the single-equation models: It had a consistently positive and usually significant effect after the transitional recession. Its influence on the productive efficiency, however, substantially declined: After the transitional recession its coefficient exceeded one, and it dropped to 0.1–0.2 in 1997. This is consistent with the results in the market share equation of the two equation models: The speed of adjustment increased substantially during the later years, indicating relatively fast shifts in sectoral dominance. Highly efficient firms became market leaders very rapidly.

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[12] The 'b' tables consist of mean inefficiencies of various groups of firms. While ranking firm-level inefficiency would be futile, these means have relatively small variances, thus their comparison is meaningful.

[13] This analysis is also compatible with the substitution versus complementarity effects of imports. It is, however, important to emphasize the role of institutions in creating these effects, as the incidence of substitution is more probable during the early phase of transition. Intra-firm, outward and inward processing trade are likely to appear as intra-industry trade, thus what is classified as import penetration may just be an input to the production process.

The major advantage of the two-equation model over the single equation model is the explicit role of allocative efficiency in explaining market share. Efficiency always had a positive and highly significant coefficient in the market share equation, indicating that, in fact, efficient firms could quickly gain prominence. Although market structure variables usually were jointly significant in the single-equation model, their role is very limited, and the production function hardly changes after their omission. On the other hand, efficiency seems to be the important driving force of the market share equation, strongly influencing the relative position of the firm. That was the most important factor behind our preference for the two-equation model in our analysis.

First, we analyze the efficiency of the production process. Second, the market share equations and the role of the variables representing competitive pressure are discussed. Third, the link between efficiency and profit and investment is shown. Fourth, estimates of returns to scale, by industry and size, are presented.

4.1 Efficiency

One can look at the mean (in)efficiency of the production process within a group of firms in two alternative ways. On the one hand, when the production function is estimated for the entire sample of all firms, groups of firms (say sectors) can be ranked according to differences in the mean efficiency. This is the traditional interpretation, and in this paper we mostly discuss this efficiency measure. On the other hand, when the production function is estimated for the individual groups of firms, mean inefficiency of the group reflects the heterogeneity of firms with respect to efficiency. Theoretically, the two measures may develop very differently: it may happen that a sector is rather homogeneous, all firms are close to the most efficient one within the sector, thus the mean inefficiency of the sectoral production function is small. But that does not tell us anything about the efficiency of the sector, compared to other sectors: It may happen, that the overall efficiency of the production process is (uniformly) much lower in this sector than in others. It is interesting to note that these two sorts of efficiency measures developed rather similarly over time and over the relevant groups of firms in the Hungarian corporate sector. It indicates that specific groups usually had lower or higher overall mean efficiency because firms were more or less heterogeneous within the group, and not because all firms were uniformly more or less efficient. For example, Engineering was the most heterogeneous manufacturing sector with respect to efficiency during the transitional recession. Even though there were some efficient engineering firms, the mean sectoral inefficiency was low because of this very large variation within the sector. In the later years the dispersion of efficiency became smaller in Engineering than in other sectors, and that is why the mean inefficiency is smaller there, even though we found firms very close to the efficiency frontier in all sectors.

The fixed time effect in the panel estimates represents the change of overall productive efficiency relative to the base (first) year of the sample period. These

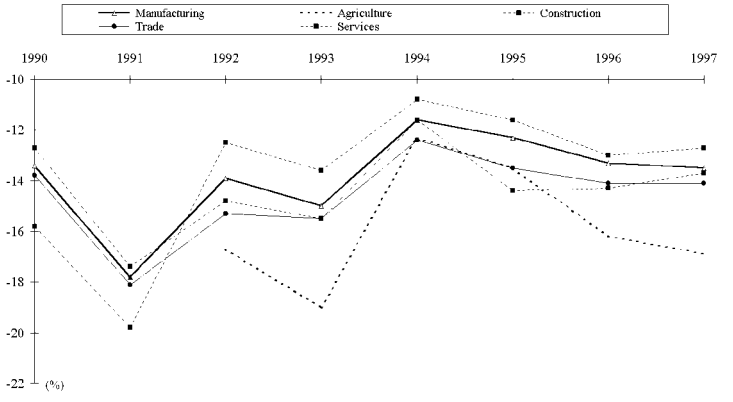
annual average inefficiencies show a very characteristic time path: the transitional recession of 1991 brought about a very substantial drop in the mean efficiency of firms, followed by a quick recovery. The overall level of efficiency remains quite stable afterwards; there is no obvious time trend in the coefficients. Although the highly significant structural breaks between consecutive years strongly question the validity of any inference based on the panel estimates, it still is a curious result that there does not seem to be any overall improvement in productive efficiency during this eight-year period. However, we mostly disregard the panel estimation results because of their statistical problems.

We look at the overall efficiency of firms from three different aspects in the following subsections: variations by sector, size of firm and ownership status of firms.

4.1.1 Sectors

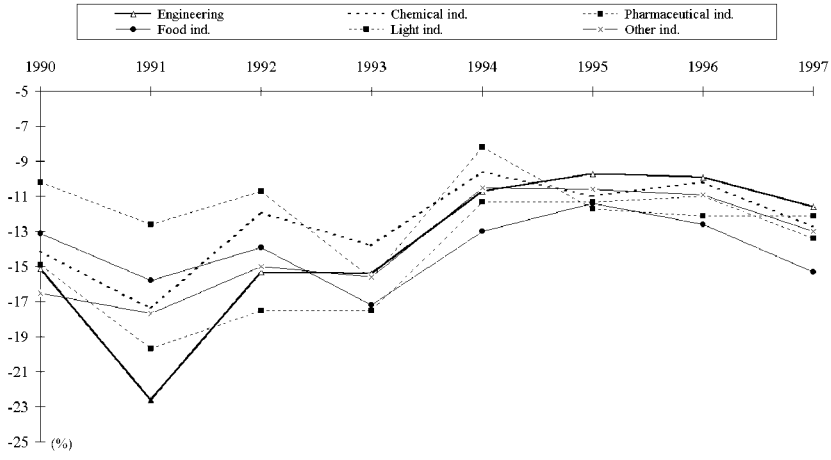
The time path of the efficiency of various sectors is quite similar to the overall picture obtained from the panel estimates: a substantial drop in 1991, rapid growth until 1994 and a mild decline afterwards. (See Figures 1 and 2.) There is a curious discrepancy between this assessment of the developments in corporate efficiency and the aggregate (macroeconomic) development: economic growth was rather sluggish after the 1991–92 recession, and it speeded up after 1996, by which time the productive efficiency of the corporate sector did not improve. It indicates that the substantial deterioration of firm level efficiency in 1991 basically reflected the enormous under-utilization of capacity of most firms, due to the sudden loss of important markets. First, firms had to adjust their capacities to the realities of the new market conditions, probably cutting excess capacities, and they could efficiently use the productive inputs only afterwards.

Figure 1. Sectoral mean inefficiencies



While practically all major sectors move in the same direction, important sectoral differences can be observed. Agriculture is usually the least efficient sector, and it is clearly left behind by other sectors at the end of the sample period. Services and Manufacturing are the most efficient sectors in the second half of the sample.

Figure 2. Mean inefficiencies in the manufacturing sectors



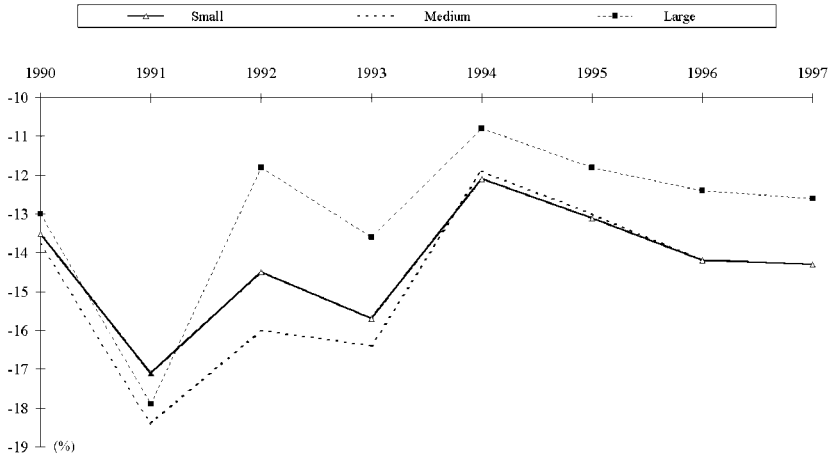
The picture is somewhat different within Manufacturing; there is no decline after 1994 for Engineering and Light industry. The 1991 crisis had hit Engineering the hardest, but it recovered within two years, and it became the most efficient industry. Pharmaceuticals, the traditional standard bearer in the Hungarian corporate sector, on the other hand, suffered a major efficiency loss in 1993, and it no longer stands out.

4.1.2 Size

Three size groups were defined: small, medium and large.[14] Results derived from the estimation on the entire sample reveal that large firms were consistently the most efficient group. (See Figure 3.) The difference between the other two groups was negligible. This ranking is also supported by the estimation results for these groups separately, as heterogeneity decreases with size. Does this result mean that small firms are the least efficient in general? Not necessarily. The missing element of the answer is the analysis of the returns to scale, which comes later.

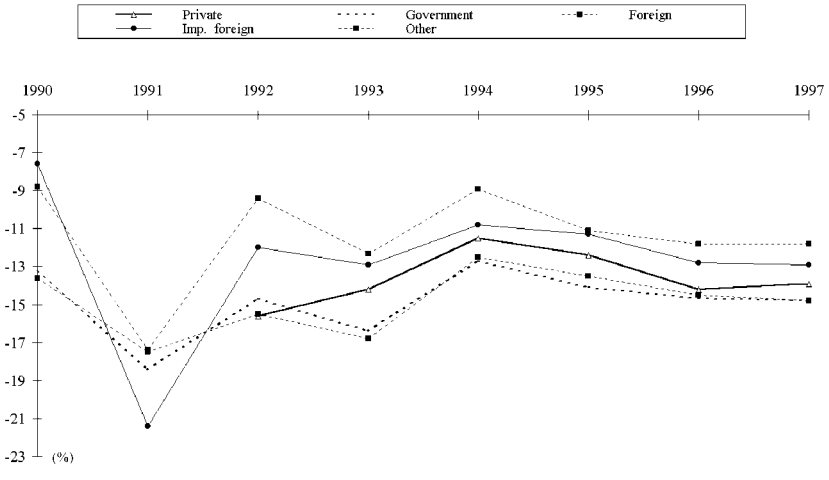
[14] Exact definitions are given in Appendix B.

Figure 3. Mean inefficiency by size



4.1.3 Ownership

Figure 4. Mean inefficiency by ownership categories



There is a clear ranking in efficiency according to ownership: 1) foreign; 2) important foreign minority ownership; 3) domestic private; 4,5) other and state.[15] It is true for the entire sample and is even more pronounced for Manufacturing. (See Figure 4.) This persistence in ranking can be the result of a selection bias in privatization; it goes beyond the scope of this paper to address the endogeneity issue between privatization and efficiency. However, we believe that sample selection bias may only be substantial in the initial years: Foreign and domestic private ownership became so widespread after 1993 that persistent substantial differences in the preconditions are unlikely. The more plausible explanation is that these differences are caused by differences in corporate governance, the quality of management, access to markets and resources, etc. The difference between the efficiency among firms in foreign and domestic private ownership is remarkable. It certainly reflects differences in market access. It may also indicate that domestic private owners are more constrained in the financial markets. Disentangling these explanations remains for future research. It is striking that state-owned enterprises are not much less efficient than domestic privately-owned firms, although most theoretical works would suggest that they would be. This is especially true for the 'other' ownership group, which largely consists of private firms after 1994.[16] This group of firms includes many medium-sized former SOEs, frequently bought up by the (former) management through limited liability companies. They are clearly less efficient than the majority of the corporate sector.

The efficiency gap between the firms privatized to foreign and domestic owners clearly indicates a curious failure of privatization in creating a group of domestic owners who can operate efficiently and compete internationally.[17] However, fluctuations and the gap between the most and least efficient groups diminished, especially after 1994, indicating a move towards homogeneity and competition.

4.2 Efficiency versus profitability and investment

The short sample and unstable parameters did not facilitate the separation of short and long-term efficiencies. This means that our efficiency measure incorporates both. As an attempt to explore the time effect of the efficiency measure, profit and investment are interpreted as performance indicators in the

[15] The group labelled as 'important foreign' consists of firms that also belong to one of the three domestic ownership categories.

[16] The 'other' group includes firms with no dominant owner, or firms which have a dominant corporate owner. This second type is much more numerous. Initially the corporate owners were usually state-owned holding companies, but as privatization progressed, the overwhelming majority of these indirectly owned firms were in fact (domestic) private. However, we have no exact information on the ownership structure of the parent company.

[17] Controlling for size and industry differences results in the same efficiency difference between ownership groups.

short and long run, respectively. Shortcomings of this interpretation are obvious; the conclusions will be drawn accordingly. Simple correlation coefficients show that there was a semi-strong positive link between efficiency and profit margin and only a very weak positive relationship between efficiency and investment. This indicates that efficient firms also have better financial results. However, the relationship between investment and efficiency could only be described in a more complex dynamic relationship, which is beyond the scope of the present paper.

4.3 Market share

As indicated earlier, we had little success with the attempt to augment the production functions with variables indicating market conditions and competitive pressure. In the preferred alternative (two-equation) model the market share in an autoregressive equation is explained by the productive efficiency (measured as $\hat{u}$), import penetration and concentration. (See the second equation in Tables A2, A4 and A6.) These regressions fit reasonably, but diagnostic tests indicate significant specification problems.[18] These variables most probably are insufficient to explain why firms gain or lose market share. Thus we have to interpret these results with due caution.

Efficiency was always significant with the expected positive sign, indicating that efficient firms gain market share. The positive link between efficiency and market share became even more pronounced in the second half of the period. This is the most important result of our market share estimations. It proved to be valid for most industries, ownership forms, and size groups. The exceptions to the rule occur mainly in the first half of the 1990s, there is only one important exception in the second half of the period: the large firms in 1996–97.

4.4 Returns to scale

The null hypothesis of constant returns to scale was rejected in almost all cases. In the early years of transition all groups of firms faced decreasing returns to scale, indicating substantial mismatch of input use under the new market conditions. Returns to scale estimates for the later years are larger; they usually exceed unity. We interpret this general tendency as the consequence of institutional and behavioural changes: the hardening of the budget constraint brought about substantial improvements in resource allocation, hence in efficiency. One may be tempted to refer to one of the following, almost trivial explanations for this

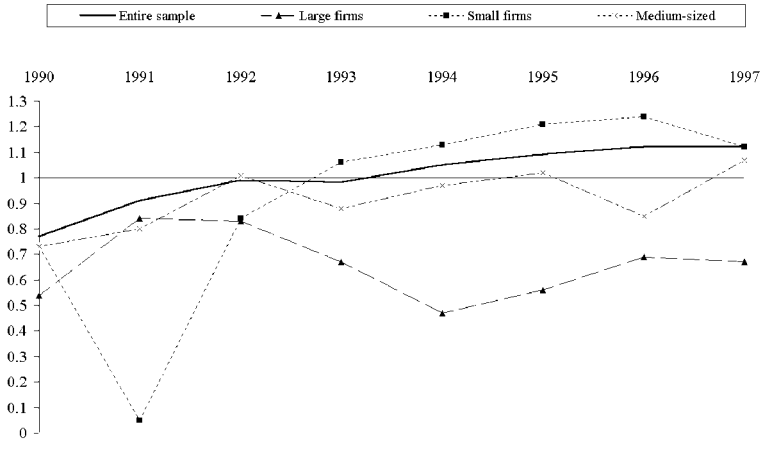
[18] The Reset test indicates that at least one important explanatory variable is missing from the regression. (Significant reset test can also indicate the non-linearity of the relationship, but in this case we did not find a clearly more appropriate non-linear equation.) However, we had no further information on the market structure variables. Especially, our concentration indicator is a very poor measure to assess characteristics of a sector. We did not have information on all the firms of a sector to compute better indicators. Heteroscedasticity consistent standard errors were used, as disturbances also proved to be heteroscedastic. Obviously, heteroscedasticity can just be the consequence of the specification problems, indicated by the reset test.

phenomenon: (i) the sample includes a large number of SMEs, where the underreporting of output can be larger than for the inputs; (ii) some industries are rather concentrated, and very small firms are disadvantaged by oligopolistic competition.[19] These propositions, however, cannot be easily sustained after a detailed analysis of the results.

Return to scale grew over time and exceeded unity after 1994. This tendency could suggest another interpretation of efficiency: the larger the firm, the better the output to input ratio. Another important possibility is related to the market structure and entry conditions: the larger the firm, the wider the possibility to have access to monopoly rents.[20]

Market structure can be very different across sectors, resulting in a varying potential for increasing returns to scale. However, the sectoral differences were rather small. All sectors started with decreasing returns to scale in 1990–91, and most, except Agriculture and Services, entered the increasing returns to scale region by 1997. It is also important to note that the sectoral variation declined substantially. The same is largely true for the ownership classification.[21]

Figure 5. Returns to scale by size categories



[19] Evidence, supporting this hypothesis, was documented in Halpern and Kőrösi (1995), (1998b).

[20] In our previous works (Halpern and Kőrösi, 1998a, 1998b) we studied monopoly rent; it had disappeared around 1989 and 1990, during the period of large scale price and import liberalization, and reappeared after 1993.

[21] The number of privately-owned firms was too small in our sample prior to 1992. Thus we were unable to estimate production functions for each ownership category for 1990–91.

Classification by size, however, reveals substantial and persistent differences. (See Figure 5.) Results for the entire sample were strongly influenced by the change in composition: by the growing share of small firms (from one-quarter to two-thirds), and by the increase of their returns. Medium-sized firms were practically in CRS after 1991. It is curious that the returns to scale remained rather low for the large firms: always in decreasing returns to scale, although with substantial fluctuations. Splitting the sample of the large firms into two parts – foreign and domestic ownership – gives higher returns in favour of domestic firms.

This result is rather surprising.[22] Based on these results the market structure explanation of the increasing returns for the entire sample should be rejected. The large number of small firms with increasing returns to scale may be interpreted as a positive sign of efficiency and a prospect for further competition. However, it may refer to further differentiation, namely, that very small firms are strongly disadvantaged by their meagre resources and insufficient access to important markets. This possibility requires further investigation.

5. Conclusions

Our results show that there were considerable differences in efficiency according to size and ownership. Intertemporal fluctuations were largely dominated by macroeconomic developments, like the fall in external and/or internal demand that happened in Hungary in 1991 or by a wave of bankruptcies and liquidation in 1992–93. Microeconomic restructuring had a positive effect and it can be seen that after 1993, efficiency in different sub-samples became more homogeneous and higher as compared to previous years.

Transition started before 1990 in Hungary, but the speed of adjustment was relatively slow (*cf.* Halpern and Kőrösi, 1998a, 1998b, and Halpern and Wyplosz, 1998). Thus, the 1990 conditions were not far from the initial stage. Contrary to the findings in Brada *et al.* (1997), we have no evidence supporting the hypothesis that larger firms had higher allocative efficiency in this initial period.

The overall picture of corporate performance is that the 1990–91 transitional crisis was characterized by huge inefficiencies and decreasing returns. Capacity underutilization was very large in this period, mainly because of the fall of overall demand and the high cost of supply reaction to the changing pattern of demand. Corporate efficiency improved rapidly from 1992, also accompanied by higher (close to constant) returns to scale, or, from 1994 even slightly above that. This confirms the positive development of performance after a painful and deep

[22] One explanation may be that large multinationals may start their activity with low value-added. Most of them entered the Hungarian market rather early, which makes this explanation quite unappealing. We do not have, however, data to test the usual transfer pricing or pricing-to-market hypotheses.

microeconomic restructuring and macroeconomic adjustment. However, firm-level efficiency improvement was substantially slower from 1995. It was no longer uniform: the heterogeneity of the firms increased with respect to efficiency, but this increase cannot be attributed to any specific group of firms.

State-owned firms were among the least efficient, while foreign-owned firms were clearly the most efficient ones throughout the transition period. However, enterprises owned by domestic private investors do not seem to be much more efficient than state-owned ones.[23] This is an important difference from our earlier findings (Halpern and Kőrösi, 1998a, 1998b) on the performance of firms: the link between profitability and foreign ownership was less obvious, and less persistent, than between productive efficiency and ownership.

Market characteristics play a changing role during transition. Import competition, sectoral concentration and efficiency are important explanatory factors for the development of market share of a firm. Heterogeneity can be observed across sectors, according to ownership and to size. The differences, however, are not that large and were diminishing. This makes the hypothesis of the importance of market environment in the determination of corporate performance plausible.

When looking at corporate performance, the 1990–97 period can be divided into three distinct sub-periods. Transition started by a sudden collapse of corporate efficiency, as one important element of the transitional recession. It was followed by a fast consolidation period, with rapidly increasing efficiency and improving returns to scale. During this period, performance was frequently improved by downsizing, thus fast improving corporate performance could not be translated into aggregate economic growth. This consolidation period ended in 1994–95; after which mean firm-level efficiency only changed slowly. However, the 1995 stabilization created a favourable environment for substantial investments in the Hungarian corporate sector.[24] These investments largely increased the market share of the better performing firms and sectors, and the massive investments, together with substantial structural improvements brought about rapid economic growth. However, this economic growth may become vulnerable if productive efficiency fails to improve further.

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[23] State-owned firms are a relatively small and a rather peculiar group by 1997.
[24] Arguments and details can be found in Halpern and Wyplosz (1998).

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Appendix A

Data

The database for this empirical study consists of the profit and loss account and balance sheet data of the main Hungarian firms between 1989 and 1997.[25]

The dataset is based on a survey, covering firms with at least 20 employees until 1995, and 10 afterwards. Only those firms are covered which have to comply with double-entry accounting rules, thus family firms and individual entrepreneurs are excluded, unless their equity or turnover exceeds a rather high limit. Given these constraints, the survey was designed to be representative[26] in each year, but the actual compliance was far from complete, especially among smaller firms. On the other hand, some smaller firms, employing fewer people, are also in the sample. However, we tried to extend the dataset: Data for the 'neighbouring' years was also included, if the firm could be identified for those years. That is, if a firm only participated in the survey in 1993, our dataset should include the balance sheet of the firm in years 1992–94, provided that the firm existed and following up the firm was possible.

[25] We would like to express our gratitude to Mr. Jozsef Becsei and his collaborators for their help in compiling the database.
[26] Agriculture and some service sectors were excluded from the survey before 1992.

Firms are identified by their tax-file number in the dataset. If a firm was reorganized: broken up, merged with another firm, or, sometimes, it simply changed name, relocated headquarters, etc., it got a new tax-file number. As our sample covers the period, when former SOEs were corporatized, frequently reorganized, and later privatized, there were many such changes, when a new tax-file number had to be assigned to the firm. Thus, in some cases, existing firms disappear from our sample, because their tax-file number was changed for some reason, and 'new' firms enter the dataset where the tax-file number is the only novelty. Unfortunately, we cannot distinguish *de novo* firms from the reorganized or merely relabeled ones, or from the spin-offs of break-ups. Firm creation and destruction is over-reported in our database, and thus in our analysis. And these groups are rather large: Since the mid-1980s many small private firms were founded. Many grew to considerable size, and they represent a large fraction of new firms in our sample, although they frequently enter this sample only after several years of operation. On the other hand, there are many new firms created from existing former SOEs: Voszka (1997) reports that from remnants of 49 well-known former socialist SOEs which in 1989 produced approximately 30 per cent of Hungarian GDP and 50 per cent of the exports at least 690 firms were created by 1996, most of them privately owned by then.

As the compliance was much larger with large firms, sample selection is biased towards them. The dataset covers approximately 10–13 per cent of these firms obliged to use double-entry accounting in each year. The sample included 2,682 firms out of 23,314 in 1990 and 11,172 firms out of 120,423 in 1997. The coverage varied a lot over sectors: while only 5–7 per cent of trading firms are included, coverage is over 50 per cent in mining in all years. The sample almost always covers at least 20 per cent of the firms in all broad industrial sectors.

The coverage is much higher with respect to sales volume. It is more than 50 per cent even in the trade sector. In other sectors, including services and agriculture, at least 70 per cent of the sales were at firms included in our sample. There are sectors, like mining, or electricity generation, where the coverage is well over 90 per cent.

Many observations, however, had to be excluded due to data problems, e.g., missing observations, so the actual sample size of the estimations is smaller, but the coverage, measured by sales, is still high in all years. There was one important characteristic feature of the sample, which has a strong systematic influence on our results: There are many firms with negative (or zero) value added. As the dependent variable of the reported production functions is the logarithm of the value added, these firms had to be excluded from estimation. These firms represented more than 5 per cent of our sample in all years, peaking with 20 per cent of the covered firms in 1991. These firms are the heavy loss-makers, frequently bankrupt or at least approaching insolvency. Some resurface in later years, but most of them were closed down. This characteristically different group

of firms was excluded from the current analysis, although we plan to study them later.[27]

Capital is a key variable of production functions. It is always difficult to measure capital stock appropriately. It is a probably even more problematic task in a transition economy. The assets of practically all pre-existing firms were revalued at least once (frequently for several times) during the process of commercialization and privatization. The asset value could change substantially without any change in the physical composition of the capital, and the timing of the revaluation(s) is unknown. For example, in the 1992 sample some firms will have capital stock recently revalued, and it is supposed to reflect the actual market value of the assets. Other firms, where no reorganization occurred, reported assets calculated from past investments flows. That certainly influences our results, however, we cannot assess its importance.

Definitional changes also caused some problems. Some definitions changed with the introduction of new accounting standards in 1992, but those changes could be followed through. Sectoral classification also changed in 1992. We aggregated the sectoral classification to a level where it is reasonably homogeneous for the sectoral sub-samples, but some inconsistencies are inevitable. The four digit sectors, used for the determination of the market size, substantially changed from 1991 to 1992.

Appendix B

Definitions

All variables (except employment) were deflated, usually with four digit sectoral producer price indices. There were some – usually small – sectors, where the price index was only available at a higher level of aggregation (2 or 3 digit sectors). Variables are measured in million Forints at 1991 prices. The variables are:

Valued-added: Sales less broadly defined material costs. Its logarithm is the dependent variable of all production functions.

Labour (L): Annual average employment at the firm.

Capital (K): Fixed assets. See data section for qualifications.

Market share: Sales of the firm divided by the market size, where market size is the sectoral production plus competing imports less exports, all measured at the four digit sectoral level. The sectoral classification of imports is based on the four-digit product classification.

Import penetration: The ratio of the sectoral imports to the above defined market size.

[27] We experimented with production functions where the dependent variable was sales. These estimates were severely influenced by the observations corresponding to firms with negative value-added.

Concentration: The reciprocal of the number of firms in the four-digit sector.
Efficiency: The error term u of the frontier production function.
Profit margin: Pre-tax profits relative to sales.
Investment ratio: Change of capital value plus depreciation over the current capital value.
Large firm: A firm where the number of employees is greater than 500, or the value of fixed assets is greater than 1bn./1991 forints or sales volume is greater than 1.5bn./1991 forints.
Small firm: A firm where the number of employees is less than 50, or the value of fixed assets is less than 20m./1991 forints or sales volume is less than 25m./1991 forints.
New firm: A firm with an identifier (tax-file number), which was not in the sample in an earlier year.
Disappearing firm: A firm with an identifier (tax-file number), which was not in the sample in a later year.
Private firm: A firm where named persons (investors, employees and managers) owned more than 50 per cent of the equity capital. Firms owned indirectly (by domestic firms) are excluded, as the parent company can be a SOE.
State-owned firm: A firm where the central and local governments together owned more than 50 per cent of the equity capital.
Foreign-owned firm: Foreign investors owned more than 50 per cent of the equity capital.
Important foreign ownership: Foreign investors owned 25–50 per cent of the equity capital. This category may include firms, which are present at other ownership categories.

Appendix C

Selected estimation results

Notes to the tables: Production functions were estimated by maximum likelihood. Asterisks after the coefficients and test statistics indicate that the test is significant at 0.05 level (*) or at 0.01 level (**). The null for returns to scale (v) is that $v = 1$. σ denotes the standard error of the compound disturbance term $\sigma^2 = \sigma_u^2 + \sigma_v^2$, while σ_u/σ_v stands for the ratio of the two standard errors (often denoted by λ). Mean inefficiency is normalized by the mean of the dependent variable. ***Abbreviations***: Nob: number of observations; SEE: standard error of the estimation; Reset y^2, y^3: Ramsey's Reset test using both the squares and the cubes of the fitted values. Chow test is for structural break between the two consecutive years; for production functions it is the LR-test, while for share equations the Wald-test. All share equations were estimated by OLS using White heteroscedasticity consistent standard errors. Figures in italics are standard errors.

Table A1. Single equation models: panel estimates

Variable	All firms			Manufacturing		
	1990–97	1990–93	1994–97	1990–97	1990–93	1994–97
Constant	–0.10**	0.09**	0.17**	0.00	0.29**	0.20**
	0.018	*0.034*	*0.013*	*0.024*	*0.047*	*0.021*
y_{t-1}	0.63**	0.45**	0.72**	0.60**	0.46**	0.68**
	0.002	*0.004*	*0.002*	*0.004*	*0.007*	*0.004*
Log (L)	0.28**	0.40**	0.22**	0.26**	0.31**	0.22**
	0.003	*0.007*	*0.003*	*0.005*	*0.009*	*0.005*
Log (K)	0.10**	0.10**	0.09**	0.13**	0.16**	0.11**
	0.002	*0.004*	*0.002*	*0.003*	*0.006*	*0.003*
Import penetration	0.02**	0.00	0.02**	0.00	–0.03**	0.01*
	0.003	*0.005*	*0.004*	*0.003*	*0.007*	*0.004*
Market share $_{t-1}$	0.23**	0.49**	0.16**	0.23**	0.44**	0.17**
	0.019	*0.052*	*0.020*	*0.023*	*0.079*	*0.021*
Concentration	0.51**	0.83**	0.23**	0.78**	1.36**	0.48**
	0.108	*0.227*	*0.142*	*0.147*	*0.348*	*0.183*
Dummy for 1991	–0.25**	–0.27**		–0.23**	–0.24**	
	0.019	*0.024*		*0.023*	*0.030*	
Dummy for 1992	0.46**	0.33**		0.59**	0.51**	
	0.015	*0.020*		*0.020*	*0.027*	
Dummy for 1993	0.31**	0.26**		0.35**	0.32**	
	0.014	*0.018*		*0.019*	*0.024.*	
Dummy for 1994	0.31**			0.31**		
	0.015			*0.020*		
Dummy for 1995	0.26**		–0.05**	0.31**		0.000
	0.014		*0.009*	*0.018*		*0.014*
Dummy for 1996	0.27**		–0.05**	0.31**		–0.01
	0.014		*0.009*	*0.018*		*0.014*
Dummy for 1997	0.28**		–0.03**	0.31**		0.00
	0.014		*0.009*	*0.019*		*0.014*
σ	0.78**	0.90**	0.70**	0.75**	0.91**	0.66**
	0.002	*0.006*	*0.002*	*0.003*	*0.009*	*0.003*
σ_u/σ_v	1.40**	1.49**	1.35**	1.58**	1.93**	1.38**
	0.013	*0 .030*	*0.013*	*0.022*	*0.060*	*0.021*
Ret. to scale	1.02**	0.092**	1.08**	0.99**	0.88**	1.05**
	0.007	*0.010*	*0.009*	*0.009*	*0.015*	*0.012*
Nobs	45777	13345	32432	17292	5320	11972
Mean of dep var	3.38	3.64	3.27	3.63	3.75	3.58
S. Dev of dep. var	1.47	1.36	1.49	1.54	1.43	1.59
R^2	0.83	0.75	0.87	0.86	0.79	0.90
Mean inefficiency (%)	–14.63	–16.07	–13.46	–13.65	–16.75	–11.66

Note: For an explanation of these tests, see the beginning of this appendix.

Table A2. Two-equation models: panel estimates

Variable	All firms			Manufacturing		
	1990–97	1990–93	1994–97	1990–97	1990–93	1994–97
Production function						
Constant	–0.13**	0.02	0.16**	–0.04	0.21**	0.19**
	0.018	*0.033*	*0.013*	*0.024*	*0.043*	*0.020*
y_{t-1}	0.63**	0.46**	0.72**	0.60**	0.47**	0.69**
	0.002	*0.004*	*0.002*	*0.004*	*0.006*	*0.004*
Log (L)	0.29**	0.41**	0.22**	0.27**	0.32**	0.22**
	0.003	*0.007*	*0.003*	*0.005*	*0.009*	*0.005*
Log (K)	0.10**	0.10**	0.09**	0.14**	0.16**	0.12**
	0.002	*0.004*	*0.002*	*0.003*	*0.006*	*0.003*
Dummy for 1991	–0.25**	–0.27**	.	–0.24**	–0.25**	.
	0.019	*0.024*	.	*0.024*	*0.031*	.
Dummy for 1992	0.46**	0.34**	.	0.60**	0.51**	.
	0.015	*0.020*	.	*0.020*	*0.027*	.
Dummy for 1993	0.31**	0.27**	.	0.35**	0.32**	.
	0.014	*0.018*	.	*0.019*	*0.024*	.
Dummy for 1994	0.32**	.	.	0.32**	.	.
	0.015	.	.	*0.020*	.	.
Dummy for 1995	0.27**	.	–0.05**	0.32**	.	0.00
	0.014	.	*0.009*	*0.018*	.	*0.014*
Dummy for 1996	0.28**	.	–0.05**	0.31**	.	–0.01
	0.014	.	*0.009*	*0.018*	.	*0.014*
Dummy for 1997	0.30**	.	–0.02*	0.32**	.	0.00
	0.014	.	*0.009*	*0.019*	.	*0.014*
σ	0.77**	0.90**	0.70**	0.75**	0.91**	0.66**
	0.002	*0.006*	*0.002*	*0.003*	*0.008*	*0.003*
σ_u/σ_v	1.39**	1.45**	1.35**	1.54**	1.86**	1.35**
	0.013	*0.030*	*0.013*	*0.021*	*0.057*	*0.021*
Ret. to scale	1.05**	0.95**	1.10**	1.02**	0.92**	1.07**
	0.006	0.009	0.009	0.008	0.013	0.012
Nob	45777	13345	32432	17292	5320	11972
Mean of dep. var	3.38	3.64	3.27	3.63	3.75	3.58
S. dev of dep. var	1.47	1.36	1.49	1.54	1.43	1.59
R^2	0.83	0.75	0.87	0.86	0.79	0.90
Mean inefficiency (%)	–14.57	–15.88	–13.43	–13.52	–16.53	–11.57

Table A2 (cont). Two-equation models: panel estimates

Variable	All firms			Manufacturing		
	1990–97	**1990–93**	**1994–97**	**1990–97**	**1990–93**	**1994–97**
Market share equation						
Constant	0.01**	0.01**	0.01**	0.02**	0.01**	0.02**
	0.002	*0.001*	*0.002*	*0.003*	*0.002*	*0.004*
Market share $_{t-1}$	0.63**	0.81**	0.59**	0.50**	0.82**	0.44**
	0.114	*0.035*	*0.130*	*0.146*	*0.060*	*0.147*
Efficiency	1.18**	0.82**	1.42**	1.52**	0.88**	2.17**
	0.113	*0.128*	*0.170*	*0.182*	*0.199*	*0.299*
Import penetration	–0.01**	–0.01**	–0.01**	–0.01**	–0.01**	–0.01**
	0.002	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Concentration	0.73**	0.61**	0.70**	0.77**	0.45**	0.77**
	0.214	*0.160*	*0.250*	*0.221*	*0.130*	*0.232*
Mean of dep. var	0.02	0.03	0.02	0.03	0.03	0.03
S. dev of dep. var	0.10	0.10	0.10	0.10	0.10	0.10
SEE	0.06	0.05	0.06	0.07	0.04	0.07
R^2	0.69	0.77	0.66	0.57	0.80	0.52
White–hetero	28072**	397**	20513**	16488**	2895**	10882**
Reset y^2, y^3	13924**	12**	16764**	14316**	7**	14017**
Corr of rel efficiency						
Profit margin	0.17	0.17	0.17	0.40	0.37	0.42
Investment rate						

Note: For explanation of tests, see the beginning of this appendix.

Table A3. Single equation models: bi-annual panels, all firms

Variable	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
Constant	0.45**	–0.28**	0.22**	0.23**	0.18**	0.12**	0.13**
	0.053	*0.061*	*0.035*	*0.026*	*0.020*	*0.016*	*0.014*
y_{t-1}	0.67**	0.30**	0.39**	0.60**	0.69**	0.72**	0.74**
	0.008	*0.007*	*0.005*	*0.004*	*0.004*	*0.004*	*0.003*
Log (L)	0.17**	0.54**	0.48**	0.31**	0.24**	0.22**	0.20**
	0.012	*0.012*	*0.008*	*0.006*	*0.005*	*0.005*	*0.004*
Log (K)	0.10**	0.11**	0.10**	0.08**	0.09**	0.09**	0.08**
	0.008	*0.007*	*0.004*	*0.004*	*0.003*	*0.003*	*0.003*
Import penetration	–0.07	0.02	0.00	0.00	0.03**	0.04**	0.01*
	0.268	*0.021*	*0.006*	*0.005*	*0.006*	*0.005*	*0.006*
Market share $_{t-1}$	–0.13	0.76**	0.79**	0.29**	0.23**	0.21**	0.13**
	0.093	*0.091*	*0.056*	*0.046*	*0.047*	*0.052*	*0.022*
Concentration	1.78**	0.93**	0.33	0.37	–0.01	0.26	0.41*
	0.278	*0.394*	*0.270*	*0.218*	*0.240*	*0.211*	*0.182*
Year$_2$	–0.23**	0.53**	–0.03*	0.01	–0.05**	0.01	0.02**
	0.021	*0.024*	*0.015*	*0.012*	*0.009*	*0.008*	*0.008*
σ	0.89**	0.92**	0.88**	0.78**	0.69**	0.71**v	0.70**
	0.009	*0.011*	*0.008*	*0.005*	*0.004*	*0.004*	*0.003*
σ_u / σ_v	1.96**	1.64**	1.37**	1.37**	1.35**	1.33**	1.36**
	0.052	*0.061*	*0.037*	*0.027*	*0.024*	*0.019*	*0.016*
Ret. to scale	0.81**	0.93**	0.95**	0.99	1.05**	1.07**	1.10**
	0.027	*0.014*	*0.011*	*0.014*	*0.014*	*0.013*	*0.012*
Nob	3552	4870	9793	12040	13814	16881	18618
Mean of dep. var	4.08	3.68	3.49	3.52	3.46	3.27	3.12
S. dev of dep. var	1.33	1.31	1.34	1.37	1.43	1.48	1.52
R^2	0.76	0.73	0.74	0.81	0.86	0.86	0.87
Mean inefficiency (%)	–15.05	–16.84	–16.09	–13.99	–12.59	–13.59	–14.18
Chow test (χ^2)	22.19**	353.28**	518.09**	149.54**	28.13**	36.17**	5.89

Note: For explanation of tests, see the beginning of this appendix.

Table A4. Two-equation models: bi-annual panels, all firms

Variable	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
Production function							
Constant	0.44**	–0.41**	0.13**	0.19**	0.15**	0.10**	0.11 **
	0.051	*0.057*	*0.034*	*0.025*	*0.020*	*0.016*	*0.014*
y_{t-1}	0.67**	0.30**	0.40**	0.61**	0.69**	0.72**	0.74 **
	0.007	*0.007*	*0.005*	*0.004*	*0.004*	*0.004*	*0.003*
Log (L)	0.17**	0.56**	0.49**	0.32**	0.24**	0.22**	0.21 **
	0.012	*0.012*	*0.008*	*0.006*	*0.005*	*0.005*	*0.004*
Log (K)	0.11**	0.11**	0.10**	0.08**	0.09**	0.09**	0.08 **
	0.008	*0.007*	*0.005*	*0.004*	*0.003*	*0.003*	*0.003*
$Year_2$	–0.24**	0.54**	–0.02	0.01	–0.05**	0.01	0.02**
	0.021	*0.024*	*0.015*	*0.012*	*0.009*	*0.008*	*0.008*
σ	0.90**	0.92**	0.88**	0.78**	0.69**	0.71**	0.70**
	0.009	*0.011*	*0.008*	*0.005*	*0.004*	*0.004*	*0.003*
σ_u / σ_v	1.94**	1.55**	1.33**	1.36**	1.34**	1.32**	1.35**
	0.052	*0.059*	*0.037*	*0.027*	*0.024*	*0.019*	*0.016*
Ret. to scale	0.83**	0.97*	0.99	1.01	1.08**	1.11**	1.12 **
	0.025	*0.013*	*0.011*	*0.013*	*0.013*	*0.013*	*0.012*
Nob	3552	4870	9793	12040	13814	16881	18618
Mean of dep. var	4.08	3.68	3.49	3.52	3.46	3.27	3.12
S. dev of dep. var	1.33	1.31	1.34	1.37	1.43	1.48	1.52
R^2	0.76	0.73	0.74	0.81	0.86	0.86	0.87
Mean inefficiency (%)	–15.05	–16.44	–15.86	–13.92	–12.54	–13.57	–14.15
Chow test (χ^2)	15.39**	289.37**	500.50**	140.34**	15.59**	31.97**	3.15

Table A4 (cont). Two-equation models: bi-annual panels, all firms

Variable	1990–91	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
Market share equation							
Constant	0.00	0.01**	0.01**	0.01**	0.01**	0.01**	0.01 **
	0.002	*0.002*	*0.002*	*0.002*	*0.001*	*0.001*	*0.003*
Market share $_{t-1}$	0.92**	0.72**	0.75**	0.81**	0.87**	0.87**	0.48**
	0.041	*0.083*	*0.047*	*0.059*	*0.059*	*0.061*	*0.142*
Efficiency	0.87**	1.03**	1.05**	1.25**	1.46**	1.17**	1.35 **
	0.308	*0.223*	*0.138*	*0.182*	*0.201*	*0.135*	*0.203*
Import penetration	0.00	–0.02**	–0.01**	0.00*	0.00*	0.00**	–0.01 **
	0.003	*0.005*	*0.003*	*0.002*	*0.001*	*0.001*	*0.002*
Concentration	0.15*	0.94**	0.94**	0.46*	0.07	0.21	0.93 **
	0.071	*0.177*	*0.265*	*0.224*	*0.076*	*0.108*	*0.274*
Year$_2$	0.00**	0.01**	0.00**	0.00	0.00**	0.00	0.00
	0.001	*0.002*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
Mean of dep. var	0.03	0.03	0.02	0.02	0.02	0.02	0.02
S. dev of dep. var	0.11	0.09	0.10	0.11	0.11	0.10	0.09
SEE	0.03	0.05	0.05	0.05	0.05	0.05	0.06
R^2	0.92	0.66	0.72	0.81	0.80	0.80	0.62
White–hetero	1503**	1949**	690**	942**	379**	543**	17333**
Reset y^2, y^3	187.73**	38.96**	12.39**	142.93**	266.72**	298.46**	18400**
Chow test (F)	6.48	21.76**	17.90**	9.55*	7.38	9.80*	8.88

Note: For explanation of tests, see the beginning of this appendix.

Table A5a. Single equation models: all firms

Variable	1990	1991	1992	1993	1994	1995	1996	1997
Constant	0.55**	0.04	0.10	0.28**	0.21**	0.11**	0.14**	0.14**
	0.064	*0.095*	*0.062*	*0.039*	*0.030*	*0.025*	*0.020*	*0.017*
y_{t-1}	0.68**	0.63**	0.23**	0.54**	0.69**	0.69**	0.74**	0.73**
	0.009	*0.014*	*0.008*	*0.006*	*0.005*	*0.005*	*0.005*	*0.004*
Log (L)	0.13**	0.24**	0.62**	0.35**	0.24**	0.24**	0.20**	0.21**
	0.014	*0.022*	*0.015*	*0.010*	*0.008*	*0.007*	*0.007*	*0.005*
Log (K)	0.10**	0.10**	0.10**	0.08**	0.08**	0.09**	0.08**	0.09**
	0.010	*0.015*	*0.008*	*0.005*	*0.004*	*0.004*	*0.004*	*0.004*
Import penetration	0.54	–0.08	0.00	–0.01	0.01	0.05**	0.02*	0.01
	0.337	*0.288*	*0.016*	*0.007*	*0.012*	*0.008*	*0.009*	*0.007*
Market share $_{t-1}$	0.03	–0.34**	1.65**	0.38**	0.23**	0.25**	0.18*	0.12**
	0.134	*0.128*	*0.093*	*0.084*	*0.055*	*0.085*	*0.069*	*0.022*
Concentration	1.66**	1.62	0.64	0.71	–0.21	0.08	0.44	0.33
	0.295	*0.871*	*0.430*	*0.366*	*0.344*	*0.375*	*0.242*	*0.337*
σ	0.85**	0.97**	0.87**	0.86**	0.67**	0.71**	0.71**	0.70**
	0.010	*0.018*	*0.015*	*0.008*	*0.006*	*0.006*	*0.005*	*0.004*
σ_u/σ_v	1.85**	2.22**	1.50**	1.34**	1.49**	1.28**	1.39**	1.33**
	0.057	*0.127*	*0.079*	*0.040*	*0.037*	*0.033*	*0.024*	*0.021*
Ret. to scale	0.73**	0.92	0.93**	0.95**	1.02	1.06**	1.09**	1.10**
	0.034	*0.045*	*0.015*	*0.018*	*0.021*	*0.018*	*0.020*	*0.016*
Nob	2156	1396	3474	6319	5721	8093	8788	9830
Mean of dep. var	4.22	3.85	3.62	3.42	3.64	3.34	3.20	3.06
S. dev of dep. var	1.31	1.34	1.29	1.35	1.38	1.45	1.50	1.54
R^2	0.77	0.74	0.75	0.76	0.86	0.85	0.86	0.87
Mean inefficiency (%)	–13.55	–17.71	–15.72	–15.86	–11.97	–13.06	–14.10	–14.24

Note: For explanation of tests, see the beginning of this appendix.

Table A5b. Mean relative inefficiency for subsets of observations

Variable	1990	1991	1992	1993	1994	1995	1996	1997
Manufacturing	–13.6	–17.6	–14.7	–15.1	–11.7	–12.5	–13.4	–13.6
Engineering	–13.7	–20.1	–14.3	–14.4	–11.4	–11.5	–12.4	–12.6
Chemical ind.	–12.6	–15.5	–11.9	–12.7	–9.9	–13.0	–12.7	–13.4
Pharmaceutical ind.	–9.0	–10.9	–10.6	–14.1	–8.7	–13.6	–15.0	–12.7
Food ind.	–11.9	–14.5	–12.6	–15.5	–13.4	–12.9	–15.4	–15.5
Light ind.	–13.7	–17.5	–16.3	–16.2	–11.9	–13.3	–13.7	–14.0
Other ind.	–14.9	–15.9	–14.3	–13.8	–10.6	–12.0	–13.3	–13.3
Agriculture	.	.	–17.2	–18.9	–12.3	–13.4	–16.2	–16.9
Construction	–12.7	–17.2	–15.6	–15.5	–11.7	–14.3	–14.2	–13.7
Trade	–13.7	–17.9	–16.0	–15.6	–12.5	–13.4	–14.0	–14.2
Services	–17.6	–20.2	–13.9	–14.1	–11.0	–11.6	–13.1	–12.8
Owner:								
Private	.	.	–16.4	–14.3	–11.6	–12.5	–14.2	–13.9
Government	–13.3	–18.2	–15.7	–16.5	–12.7	–14.1	–14.7	–14.8
Foreign	–9.2	–17.9	–9.7	–12.3	–9.0	–11.2	–11.9	–11.9
Imp./foreign	–7.5	–20.7	–12.6	–13.1	–11.0	–11.4	–12.9	–13.0
Other	–13.7	–17.3	–16.3	–16.8	–12.5	–13.5	–14.5	–14.9
Size:								
Small	–13.8	–17.0	–15.5	–15.8	–12.2	–13.2	–14.2	–14.3
Medium	–13.8	–18.2	–16.6	–16.4	–11.9	–13.0	–14.1	–14.3
Large	–13.0	–17.6	–12.7	–13.8	–10.9	–11.9	–12.6	–12.8

Table A6a. Two-equation models: all firms

Variable	1990	1991	1992	1993	1994	1995	1996	1997
Production function								
Constant	0.51**	0.08	–0.10	0.24**	0.18**	0.09**	0.13**	0.13**
	0.060	*0.091*	*0.057*	*0.039*	*0.029*	*0.024*	*0.020*	*0.017*
y_{t-1}	0.69**	0.62**	0.24**	0.55**	0.69**	0.69**	0.75**	0.73**
	0.009	*0.013*	*0.008*	*0.006*	*0.005*	*0.005*	*0.005*	*0.004*
Log (L)	0.13**	0.24**	0.65**	0.36**	0.25**	0.24**	0.20**	0.21**
	0.014	*0.021*	*0.014*	*0.010*	*0.008*	*0.007*	*0.006*	*0.005*
Log (K)	0.11**	0.10**	0.10**	0.08**	0.08**	0.10**	0.08**	0.09**
	0.009	*0.015*	*0.008*	*0.005*	*0.004*	*0.004*	*0.004*	*0.004*
σ	0.84**	0.98**	0.85**	0.86**	0.67**	0.71**	0.71**	0.70**
	0.010	*0.018*	*0.015*	*0.008*	*0.006*	*0.005*	*0.005*	*0.004*
σ_u/σ_v	1.80**	2.27**	1.35**	1.33**	1.48**	1.26**	1.38**	1.32**
	0.057	*0.126*	*0.077*	*0.040*	*0.037*	*0.033*	*0.024*	*0.021*
Ret. to scale	0.77**	0.91*	0.99	0.98	1.05*	1.09**	1.12**	1.12**
	0.031	*0.041*	*0.014*	*0.018*	*0.020*	*0.017*	*0.020*	*0.016*
Nob	2156	1396	3474	6319	5721	8093	8788	9830
Mean of dep. var	4.22	3.85	3.62	3.42	3.64	3.34	3.20	3.06
S. dev of dep. var	1.31	1.34	1.29	1.35	1.38	1.45	1.50	1.54
R^2	0.77	0.73	0.74	0.76	0.86	0.85	0.86	0.87
Mean inefficiency (%)	–13.46	–17.91	–14.97	–15.81	–11.91	–13.00	–14.10	–14.18

Table A6a (cont). Two-equation models: all firms

Variable	1990	1991	1992	1993	1994	1995	1996	1997
Market share equation								
Constant	0.00	0.01	0.02**	0.00**	0.01**	0.01**	0.01**	0.01**
	0.001	*0.004*	*0.002*	*0.001*	*0.002*	*0.001*	*0.002*	*0.002*
Market share $_{t-1}$	0.89**	0.97**	0.54**	0.83**	0.79**	0.97**	0.81**	0.36**
	0.032	*0.088*	*0.077*	*0.060*	*0.090*	*0.055*	*0.086*	*0.133*
Efficiency	0.50**	1.30**	1.75**	0.86**	1.65**	1.26**	1.09**	1.32**
	0.122	*0.582*	*0.259*	*0.171*	*0.298*	*0.219*	*0.166*	*0.240*
Import penetration	–0.02	0.00	–0.02**	–0.01	0.00**	0.00	0.00**	–0.01**
	0.012	*0.005*	*0.004*	*0.004*	*0.001*	*0.001*	*0.001*	*0.002*
Concentration	0.17*	0.15	1.27**	0.68	0.21	–0.07	0.43*	1.10**
	0.069	*0.149*	*0.224*	*0.424*	*0.113*	*0.076*	*0.173*	*0.319*
Mean of dep. var	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
S.dev of dep. var	0.10	0.11	0.08	0.11	0.11	0.11	0.09	0.09
SEE	0.03	0.04	0.05	0.05	0.04	0.05	0.04	0.06
R^2	0.94	0.89	0.55	0.78	0.87	0.76	0.85	0.54
White–hetero	343**	879**	950**	465**	3689**	281**	3344**	8575**
Reset y^2, y^3	57.62**	173.2**	54.84**	0.57	322.3**	55.98**	381.0**	14929**
Corr of rel efficiency								
Profit margin	0.32	0.48	0.33	0.18	0.24	0.16	0.17	
Investment rate								

Note: For explanation of tests, see the beginning of this appendix.

Table A6b. Mean relative inefficiency for subsets of observations

Variable	1990	1991	1992	1993	1994	1995	1996	1997
Manufacturing	–13.4	–17.8	–13.9	–15.0	–11.6	–12.3	–13.3	–13.5
Engineering	–13.6	–20.4	–13.6	–14.4	–11.2	–11.2	–12.2	–12.4
Chemical ind.	–12.5	–16.0	–10.7	–12.7	–9.9	–12.6	–12.5	–13.3
Pharmaceutical ind.	–9.0	–11.7	–9.6	–14.1	–8.7	–13.5	–15.0	–12.7
Food ind.	–11.8	–14.5	–12.4	–15.5	–13.4	–12.9	–15.5	–15.5
Light ind.	–13.6	–17.7	–15.4	–16.2	–11.8	–13.0	–13.6	–13.9
Other ind.	–14.1	–16.0	–13.0	–13.6	–10.6	–11.9	–13.2	–13.2
Agriculture	.	.	–16.7	–19.0	–12.3	–13.5	–16.2	–16.9
Construction	–12.7	–17.4	–14.8	–15.5	–11.6	–14.4	–14.3	–13.7
Trade	–13.8	–18.1	–15.3	–15.5	–12.4	–13.5	–14.1	–14.1
Services	–15.8	–19.8	–12.5	–13.6	–10.8	–11.6	–13.0	–12.7
Owner:								
Private	.	.	–15.6	–14.2	–11.5	–12.4	–14.2	–13.9
Government	–13.2	–18.4	–14.7	–16.4	–12.7	–14.1	–14.7	–14.8
Foreign	–8.8	–17.4	–9.4	–12.3	–8.9	–11.1	–11.8	–11.8
Imp./foreign	–7.6	–21.4	–12.0	–12.9	–10.8	–11.3	–12.8	–12.9
Size:								
Small	–13.5	–17.1	–14.5	–15.7	–12.1	–13.1	–14.2	–14.3
Medium	–13.8	–18.4	–16.0	–16.4	–11.9	–13.0	–14.2	–14.3
Large	–13.0	–17.9	–11.8	–13.6	–10.8	–11.8	–12.4	–12.6