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Foreign Investment, Corporate Ownership, and Development: Are Firms in Emerging Markets Catching Up to the World Standard?*

Klara Sabirianova, Jan Svejnar and Katherine Terrell

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Abstract

Development implies that the efficiency of local firms converges to that of firms in advanced economies. We examine this using 1992-2000 panel data on virtually all industrial firms in the Czech Republic and Russia. We also test hypotheses that only firms near the efficiency frontier catch up. We find that privatization to domestic owners did not improve efficiency and firms are not converging to the frontier. Firms closer to the frontier are not more likely to converge. Foreign-owned firms displace local firms at the top of the efficiency distribution due to faster learning, acquisitions of more efficient firms and higher efficiency of foreign startups.

JEL classification: C33, D20, G32, L20

Key words: efficiency, productivity, economic development, foreign direct investment, ownership, convergence, frontier, Czech Republic, Russia, Washington Consensus.

1. Introduction

Economic development implies that the efficiency of firms in developing countries should be approaching the efficiency of firms in advanced economies. This aspect of development becomes especially relevant as globalization proceeds and greater openness to commodity and factor flows induces more intense worldwide competition. The development policies pursued over the last two decades by many governments under the influence of the international policy community, often referred to as the "Washington Consensus," have tried to increase efficiency in developing countries and reduce the gap between the poor and rich economies by pursuing a number of key reforms, including privatization of state-owned enterprises (SOEs), stimulating the entry of new firms, encouraging foreign direct investment (FDI) and trade, and assisting with institutional development. Given the depth and breadth of initial distortions and subsequent reforms in the transition economies, one may expect the positive effects of globalization and market-oriented policies to be larger and hence more detectable in these countries than in other developing economies. In this paper we examine whether the Washington Consensus policies have propelled domestic firms in transition economies to converge to the world standard.[1]

The Washington Consensus has been subject to debate. One group of critics argues that these policies have not contributed to the convergence process and that excessively rapid privatization and other measures account for the relatively poor performance of the former Soviet bloc countries in the early phase of the transition (e.g., Stiglitz, 1999). Other critics proclaim that the problems of the less successful transition economies have been brought about by insufficiently rapid and comprehensive policies (e.g., Sachs, 1996). A nuanced view is embedded in the recent theoretical arguments that an increase in competition encourages innovative behavior of firms that

[1] The Washington consensus policies reflected ideas that were widely held in Washington in the late 1980s and were guided primarily by the perception of what was desirable for Latin America (see e.g., Williamson, 2000). However, they were also widely implemented in other parts of the world, including the transition economies (see e.g., Svejnar 2002). In

are near the technological frontier but stifles those that lag significantly behind (Aghion *et al.*, 2002 and 2003; Acemoglu, Aghion, and Zilibotti, 2002 and 2003). We test this "proximity to the frontier" proposition, which implies that the Washington Consensus policies stimulate more efficient domestic firms to converge, but are too overwhelming and cause divergence (or outright failure) on the part of the less efficient domestic firms.[2] Finally, a relevant model developed by Monge-Naranjo (2002) proposes that in the short-run FDI reduces the productivity and increases the dispersion of efficiency of domestic firms but in the long run domestic firms catch up with firms in the developed world.

At the micro level, as better firm-level data come on stream, there is a growing literature questioning whether privatized firms have been more productive than SOEs and whether foreign ownership improves efficiency in the emerging market economies. There is evidence that firms with foreign ownership are more productive than domestic firms (e.g., Terrell and Svejnar, 1989; Aitken and Harrison, 1999; Djankov *et al*., 2002; and Smarzynska, 2004). However, surveys disagree about the effects of privatization on performance, ranging from those that find no or limited systematic effect (e.g., Bevan, Estrin, and Schaffer, 1999; Hanousek, Kocenda, and Svejnar, 2004), to cautiously concluding that privatization around the world improves firm performance (Megginson and Netter, 2001), to being fairly confident that privatization does indeed improve performance (Djankov and Murrell, 2002; Shirley and Walsh, 2000).[3] The literature raises the issue of whether the effect of privatization is conditioned by factors such as competition (e.g., Brown and Earle, 2001; Carlin, Schaffer and Seabright, 2004) and institutions such as the legal environment

addition to the firm-level oriented policies discussed above, the Consensus contained macro prescriptions such as fiscal and monetary discipline and maintaining a competitive exchange rate.

[2] Interestingly, over two decades ago the converse of this hypothesis was proposed by Findlay (1978, p. 2) who posits that "the rate of technological progress in relatively 'backward' region is an increasing function of the gap between its own level of technology and that of the 'advanced' region which improves at a constant rate, and the degree to which it is open to direct foreign investment." See Kosova (2004) for a review.

[3] See Roland (2000) for a theoretical analysis and overview of privatization in transition.

(e.g., Fox and Heller, 2000; Frydman *et al*., 1999). Indeed, some argue that the policies of the Washington Consensus failed because of a lack of institutional development (Williamson, 2000).

We examine the evolution of efficiency of industrial firms in two alternative prototypes of transition economies – the Czech Republic and Russia. These two countries provide excellent laboratories because they maintained central planning and virtually no private ownership and FDI inflows until the start of the transition,[4] both rapidly privatized most state assets, and yet they otherwise pursued very different paths in implementing the Washington Consensus policies. The Czech Republic represents the Central and East European (CEE) model, which emphasizes the opening up to trade and capital flows, developing a functioning market economy and gradually establishing institutions, rules and regulations that make a country eligible for accession to the European Union. Russia is a model of the countries in the Commonwealth of Independent States (CIS), which have remained more closed to world trade and FDI, and have changed their laws, regulations and institutions more slowly and without attempting to harmonize them with those of the European Union.[5]

The potential disadvantage of using the Czech Republic and Russia as prototype economies for the two models of transition and development is that they both selected rapid mass privatizations and may have therefore had inferior performance and hence not representative to otherwise similar countries. The only way to address this conjecture would be to carry out our tests on firm-level data from these other economies. However, we do not have access to comparable micro data in these other countries. But, we can significantly alleviate this concern by showing that the evolution of overall productivity in manufacturing in the 1990s and early 2000s was not very different in the

[4] See Ericson (1991) for a description of an intact Soviet model. Many other transition economies do not represent equally clear-cut shifts of regime. Hungary and Poland for instance introduced important reforms already under communism and hence operated with less tight central planning, significant private ownership and, especially in Hungary, FDI.

[5] For example, in 1997 the Business Environment and Enterprise Performance Survey carried out by the World Bank and the EBRD found that 40.1% of the sample in the Czech Republic, as compared to only 20.8% in Russia believed that the legal system would uphold contract and property rights.

Czech Republic and the other CEE economies. In particular, between 1993 and 2000, the average annual rate of productivity increase in manufacturing, calculated from EBRD (1999, 2003) data, was 8.01% for the Czech Republic, 8.76% for Hungary, 9.57% for Poland, 6.07% for Slovakia and 7.23% for Slovenia. We can also show that the change in Russian productivity was very different from the CEE countries at only 1.5%.[6] (The Russian average is greatly affected by a 17.7% decrease in 1993-94; the 1994-2000 average annual increase in productivity was 4.7%.) As these productivity data indicate, the Czech Republic is not an outlier relative to other CEE countries – in fact, it is right in the middle of the pack. Russia productivity growth is obviously in a different category, as are probably the other CIS countries on which we do not have data. Finally, as we show presently, we check for the possible influence of a particular type of privatization schemes by carrying out our analysis for periods immediately as well as several years after mass privatization, thus allowing for reallocation of ownership to take place and different patterns of performance to show over time.

Our approach for assessing whether domestic firms have been catching up to world standards is to estimate and compare changes in the levels of productive efficiency over the 1992-2000 period for foreign-owned firms and three types of domestic firms (SOEs, private domestic firms and firms with mixed ownership). We use the estimated efficiency of foreign-owned firms as the benchmark since by the mid-1990s these firms were well established in all the major sectors of the two economies and it is therefore likely that the best ones were operating at the world standard. This choice also reflects Helpman and Melitz's (2004) finding that it is the most efficient firms in advanced economies that establish subsidiaries in other countries. Moreover, using foreign-owned firms as proxies for the world standard is superior to using firms operating in advanced market economies since the latter approach is plagued by problems related to different institutions and

shocks in the advanced vs. transition economies, as well as major problems related to the wide exchange rate fluctuations and other conversion problems.

Our findings are derived from estimating translog production functions on panel data from medium and large industrial firms in the two economies. The data are drawn from the Registries of Industrial Enterprises of the Russian Statistical Office and the Czech Statistical Office. Whereas most studies of privatization in transition economies have been hampered by small data sets with observations concentrated immediately before and after privatization, our samples approach the populations of large and medium-sized industrial enterprises in each country and cover the period of 1985-2000. We analyze the period 1992-2000 after mass privatization took off in both countries, but we exploit the earlier data in constructing instrumental variables (IVs).

We first estimate the average level of productive efficiency in firms with the four different types of ownership, both for the entire 1992-2000 period and three sub-periods characterizing the early (1992-94), middle (1995-97) and mature (1998-2000) transition. We check the robustness of our results by using ordinary least squares (OLS), median quantile regression (QREG), random effects (RE), fixed effects (FE), two stage least squares random effects estimator (2SLS-RE), and a Blundell-Bond system GMM estimator (BB). The estimates are broadly similar across these methods and they lead us to conclude that in both countries the efficiency of the private and mixed firms is on average similar to that of the SOEs, and hence that privatization to domestic owners did not have its intended efficiency-enhancing effect during the first post-privatization decade. Moreover, the estimates show that the three types of domestic firms are not catching up to the world standard given by the efficiency of the foreign-owned firms. In the Czech Republic the gap between the efficiency of these three types of domestic firms and the world standard is smaller than in Russia

[6] The relative position of the Czech Republic is similar in the early part of the 1993-2000 period, when it received much less FDI per capita than Hungary, and the later part of the period, when it was one of the leading recipients of FDI.

and it ceases to increase after 1997, whereas in Russia the domestic firms continue to fall behind after 1997, albeit slightly.

We next examine the efficiency gap between foreign and domestic firms at different points in their distributions of efficiency in order to establish whether the average results hold throughout the distribution. We find that the relationship between state, private and mixed firms remains similar throughout the distribution and over time, but that the gap is much larger between the best foreign and best domestic firms than between the worst foreign and worst domestic firms. The average results hence understate the gap at the top and overstate it at the bottom of the distribution.

Finally, we address the question as to whether domestic firms are moving closer to an efficiency frontier, defined the efficiency of the best foreign firms in a two digit industrial classification. We show that neither the more nor the less efficient domestic firms have been reducing their distance to the frontier over the 1992-2000 period. Perhaps most striking is the finding that foreign firms are increasingly displacing domestic firms in the upper tail of the overall efficiency distribution.

In Section 3 we explore whether our findings are being driven by different starting conditions or by changes in the learning behavior of firms by ownership type. In other words, are foreign firms entering at a higher level of efficiency than domestic firms or do they increase their efficiency faster than domestic firms over time? We find that foreign startups are more efficient than domestic ones, which in turn are more efficient than existing domestic firms. We also find that when foreign firms use acquisition as a form of entry, they tend to acquire more efficient domestic firms, although the economic effect of this statistically significant result is limited. With respect to learning behavior, we show that on average domestic firms are improving their efficiency more slowly than foreign firms. Finally, except for the foreign owned firms, we do not find support for the hypothesis that firms closer to the efficiency frontier are increasing their efficiency at a faster rate than those farther behind the frontier.

The above results are buttressed by our estimates of conditional (β) convergence within ownership-specific distributions of productive efficiency (Barro and Sala-i-Martin, 2004). In particular, we find that while all four types of firms show signs of convergence (with foreign firms in Russia converging faster), the foreign owned firms converge to a higher steady state value of efficiency than the three types of domestic firms. Overall, our results bring into question the expected benefits of privatization and FDI for the development of domestically owned firms.

The paper is organized as follows. In Section 2 we present our estimation strategy, data, and findings on the evolution of efficiency by ownership. In Section 3 we explore the factors that may explain the patterns found in Section 2. We draw conclusions in Section 4.

2. Evolution of Efficiency by Ownership

In this section, we establish basic stylized facts. First, we estimate the average efficiency level of firms by ownership type over the entire 1992-2000 period and for the three sub-periods. Second, we investigate what patterns hold at various points in the ownership-specific efficiency distributions. Third, we examine the level and evolution of the distance of firms to the efficiency frontier. Fourth, we assess if foreign firms displace domestic firms in the upper deciles of the overall efficiency distribution.

2.1. The Central Tendency

Estimating the average efficiency levels is a useful starting point that makes our analysis comparable to most studies of productive efficiency.[7] We report estimates from a translog production function which in our data statistically dominates more restrictive functional forms:

$$\ln y_{it} = \beta_0 + \sum_k \beta_k \ln x_{ikt} + \frac{1}{2}\sum_k \sum_l \gamma_{kl} \ln x_{ikt} \ln x_{ilt} + \rho Z_{it} + \delta I_{it} + \varsigma T_t + v_i + \varepsilon_{it} \quad (1)$$

[7] See e.g., Djankov and Murrell (2002) for a survey of the production function literature in the transition economies.

where y_{it} represents the output (revenue) of firm i in period t, x's represent inputs, Z_{it} is a vector of categories of ownership, the I's and T's denote a set of dummy variables for industries and years, respectively, v_i are unobserved time-invariant firm-specific effects, and ε_{it} is an independently distributed error term. The specification allows productive efficiency to vary across types of ownership, industries, and time.[8]

We estimate equation (1) with 1992-2000 panel data on nearly the entire population of large- and medium-sized industrial firms in the Czech Republic and Russia. Our samples are comprised of industrial firms that have more than 100 employees in any year during the 1985-2000 period since the data on smaller firms is not representative over this period. Our estimates are based on data for 1,537 to 2,970 firms a year in the Czech Republic and 15,035 to 19,209 firms in a given year in Russia. In the Czech Republic, employment in these firms covers between 86% and 100% of total employment in enterprises with more than 100 employees. The Russian sample represents between 70% and 94% of total employment outside of the legally defined small enterprises (see Appendix 1 for definitions of small enterprises). The two data sets are comparable in terms of their sample construction and variable definition. In the Appendix we provide a detailed description of the data sources and data cleaning process (Appendix 1), sample construction (Table A1), definitions of the variables (Table A2), and summary statistics (Table A3).

For our dependent variable we use the real "value of production net of tax," with industry-specific producer price indices being used as deflators.[9] For capital, we use the average nominal

[8] In addition to the standard variables for the translog production function, we include several variables to control for special features of our data. Dummy variables were created for observations with a change in capital stock that was obviously too large (or too small) for the corresponding change in output or in employment. For Russia, two additional variables are included: i) an interaction term between a dummy for year 1992 and state ownership and ii) an interaction term between a dummy for year 1992 and the log of capital. The former variable is added because ownership is not available in 1992 and we assume state ownership for all firms in this year given that large-scale privatization in Russia started only at the end of 1992. The latter variable was necessary because 1992 was problematic in terms of accurate measures of capital in Russia since it was the first year of high inflation and the proper end-year capital re-valuation began only in 1993.

[9] In using output rather than value added (which we do not have), we implicitly assume that material inputs vary in proportion to labor or capital. We also capture fixed differences between output and value added across industries by

value of fixed assets for a given year, with annual time dummy variables serving as a capital goods deflator. The labor variable is the average number of full-time equivalent workers in a given year. Whereas in the Czech Republic the number of workers is explicitly adjusted for an eight-hour day, in Russia a partial adjustment is made for contracted part-time workers and all other workers are given a weight of one. The industry categories are made comparable between the two countries by recoding 5-digit OKONKh Russian Classification of Industries and 2-digit NACE Czech Industry Classification into 2-digit ISIC codes.

We use the following four categories of firm ownership: private (domestically owned); state (federal, regional and municipal); mixed; and foreign. In Russia, the ownership categories are based on 100% ownership, except for foreign ownership, where firms with any foreign ownership are classified as foreign. In the Czech Republic, ownership categories, including foreign, are based on more than 50% ownership. Hence, in the Czech Republic the category of mixed ownership includes firms in which no single type of owners has more than a 50% stake, while in Russia, the mixed category includes firms with no foreign ownership and no single type of domestic owner with 100% ownership. Mixed ownership in Russia therefore includes firms with much more concentrated ownership than in the Czech Republic. Moreover, in the Czech Republic firms classified as foreign are majority foreign-owned, while in Russia they may have only a small foreign ownership stake. Finally, unlike in Russia, in the Czech Republic firms with mixed ownership may have significant minority ownership by foreign investors.

As may be seen from Table 1, both countries display a pattern of declining state and rising private ownership during the 1990s in terms of shares of firms, employment or output. Where they differ is in the relative share with foreign ownership, which is much smaller in Russia, despite the more inclusive definition of this category in Russia than in the Czech Republic. For example, the

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including industry-specific dummy variables as regressors. For Russia, where we can check the sensitivity of our results to different industrial aggregation, we find than the basic results are similar for two- and four-digit industrial

Russian share of foreign firms in 2000 is about one-fifth of the share in the Czech Republic. In both countries the average foreign firm is larger and more productive than the average domestic firm.

As with any production function estimation, endogeneity is an important issue. The complication in our case is that the common problem of input endogeneity is entwined with the potential correlation between ownership types and the unobserved firm-specific productivity. Rewrite equation (1) in a vector form as

$$\ln y_{it} = X_{it}\beta + Z_{it}\rho + v_i + \varepsilon_{it}, \qquad (2)$$

where X is a vector of inputs and dummy variables for industry and years, Z is a vector of categories of ownership, and $E(v_i) = E(\varepsilon_{it}) = E(v_i\varepsilon_{it}) = E(\varepsilon_{it}\varepsilon_{is}) = 0$ for $\forall\ t > s$. The unobserved firm-specific productivity could determine the type of ownership by influencing the governments' decisions to privatize or investors' decisions to acquire the firm. Potential domestic and foreign owners may also respond to past productivity shocks. Thus, ownership enters equation (2) as a "predetermined variable" that may be correlated with past shocks (ε_{is}) and with firm-specific unobservables (v_i) but not correlated with present errors, that is $E(Z_{it}\varepsilon_{is}) \neq 0$ for $\forall\ t > s$, $E(Z_{it}v_i) \neq 0$, and $E(Z_{it}\varepsilon_{it}) = 0$.

Under these conditions, the OLS and RE estimators may be biased and inconsistent. The FE and first difference estimators allow for the correlation of Z_{it} with v_i but aggravate the measurement error by increasing the noise-to-true signal ratio (e.g., Griliches and Hausman, 1986), thus often leading to zero ownership effects.[10] In addition, first differencing equation makes ownership endogenous as $E(Z_{it}\varepsilon_{i-1}) \neq 0$ leads to $E(Z_{it}-Z_{it-1},\ \varepsilon_{it}-\varepsilon_{it-1}) \neq 0$.

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classification.

[10] The measurement error problem is especially severe for variables with little variation over time. Since we have a significant number of firms for which we do not observe ownership changes (65.6% of firms in the Czech Republic and 46.1% in Russia) and only few firms where we observe ownership changing more than once during 1992-2000 (8.5% in the Czech Republic and 13.4% in Russia), it is preferable not to rely too much on the FE or FD estimates. With limited observed changes in ownership, a small amount of measurement error in ownership classification may create a high noise to signal ratio. We therefore treat the FE and FD estimates with caution. RE estimates use within and cross sectional information and are hence less affected by this problem.

To address the endogeneity of inputs, several treatment methods have been proposed, including the Blundell-Bond (BB) system GMM estimator (2000), the Olley-Pakes investment proxy estimator (1996) and the Levinsohn-Petrin intermediate input proxy estimator (2003), among others.[11] None of these methods, however, deals directly with the problem of endogeneity in ownership. Mainly because of the lack of valid instruments, the common practice in the privatization literature has been to use OLS, RE or FE estimators.

Our data allow us to go further in treating the potential endogeneity of ownership since we can exploit the fact that we have information on the firms' supervisory ministries under central planning. The individual ministries were historically in charge of specific SOEs and were central in determining which ones were privatized as well as the extent and nature of privatization (foreign, mixed or domestic). The ministries were typically quite independent of one another and in Russia they also operated at different levels of government (federal, regional and municipal). As a result, their privatization decisions were fairly idiosyncratic (e.g., some were motivated more by revenue maximization and others by employment maximization at the local level). With the regime change in the early 1990s the ministries rapidly lost control over many activities of the firms in their jurisdiction and were no longer as informed about their activities. In particular, they were no longer able to give binding orders, transfer resources and obtain detailed information about the performance of the firms in the rapidly changing environment. As we show below, the ministry dummy variables are very good IVs for ownership since they are fine predictors of the ownership variables and they are not correlated with the relative levels of productivity of the enterprise.[12]

[11] We could not carry out the Olley-Pakes and Levinsohn-Petrin estimations in Russia since we do not have data on investment, materials, or energy inputs. In the Czech data, where we have information on investment and materials, the Levinsohn-Petrin estimates come close to those of Blundell and Bond.

[12] The correlations between industry dummies in the $\boldsymbol{X_{it}}$ vector of regressors and the ministry dummies identifying the effect of ownership variables are low. In Russia, for instance, firms in the same industry reported to different ministries at the federal, regional, and municipal levels.

We use information on the supervisory ministries in two approaches for treating endogeneity of ownership. In the 2SLS-RE estimator, we use ministry categories and one-year lagged *X*'s and *Z*'s to estimate a binary (probit) ownership model for each ownership type:

$$\mathrm{P}\left(Z_t^j = 1 \mid X_{t-1}, Z_{t-1,} M\right) = G_j\left(X_{t-1}, Z_{t-1,} M\right), \tag{3}$$

where *j* denotes the ownership type and *M* a vector of ministry categories. We use the fitted probabilities from the probit, $\hat{G}_{ij}$, as instruments for ownership categories. The F-test values of the ministry dummies in the first stage equation are high (well above 100) indicating that they are important in predicting the ownership category. The predicted probabilities have several useful properties as instruments for binary endogenous variables – the IV estimator is asymptotically efficient, the fitted probabilities stay within the [0,1] range, and the first stage equation need not be correctly specified (e.g., Wooldridge, 2002).

Our second approach is to treat ownership as a predetermined variable in a static BB estimation. This implies that not only inputs but also ownership variables in first differences are instrumented with lags of their own levels, and inputs and ownership in levels are instrumented with lags of their own first differences. In addition, ministries under central planning are included in the BB estimation as instruments for all endogenous variables. In both approaches, the Hausman test rejects OLS in favor of the IV estimates.

The estimates of average differences in productive efficiency by ownership (private, mixed and foreign firms relative to the SOEs, the base[13]) for the Czech Republic and Russia during 1992-2000 are reported in Table 2.[14] In order to assess the robustness of our results, we report coefficients from pooled OLS, QREG, RE, FE, 2SLS-RE, and BB estimations. All six methods

[13] Note that the number of SOEs decreases over time but remains sufficiently large to be usable as a base category. This permits us to avoid the inconvenience of switching the base over time and forcing the reader to reinterpret the results accordingly. Using the SOEs as a base is also appealing conceptually since state ownership constitutes the original category from which most firms evolved and to which one wants to compare the alternatives.

yield the same pattern of key results: First, firms with foreign ownership are found to be significantly more efficient than the SOEs, with their relative efficiency premium varying from 27.5 to 65.7 log points (31.7% to 92.9%) in the Czech Republic and 17.6 to 99.4 log points (19.2% to 170.2%) in Russia. The true efficiency differences are likely to be above the fixed effects estimates, which are the most affected by the measurement-error-driven attenuation bias. This suggests that the foreign-SOE efficiency differential is much greater in Russia than the Czech Republic.

Second, firms with foreign ownership are on average much more efficient than both domestic private firms and firms with mixed ownership.[15]

Third, within each country the private and mixed firms generate similar efficiency coefficients in most estimates. In the Czech Republic, these two types of firms are found to be approximately 10% more efficient than the SOEs, while in Russia the pooled OLS, QREG, and BB estimates suggest that these firms are somewhat more efficient than the SOEs, but the RE, FE, and 2SLS-RE coefficients point to the contrary.

In Table 3 we report coefficients of the production function estimated separately for 1992-94, 1995-97 and 1998-2000, which allows both the production technology and efficiency effects of different types of ownership to change over the three periods. In Russia, all methods suggest that the efficiency gap between foreign and domestic (state, private, and mixed) ownership increased over the three periods, but the increase appears to be more pronounced in the first than the second half of the transition period. For the Czech Republic, the results are more mixed: the foreign-state efficiency gap did not change much over the three sub-periods according to the RE and 2SLS-RE estimates, while the pooled OLS and QREG estimates indicate that there was an increase in this gap between 1992-94 and 1995-97, but no significant increase between 1995-97 and 1998-2000. Regarding the efficiency gap between foreign and mixed ownership, all four estimations indicate

[14] The complete sets of OLS and RE translog coefficients are presented in Appendix Table A4. The ownership effects do not change substantially when we constrain the translog production function to have constant returns to scale.

there is an increase between 1992-94 and 1995-97 in firms but less thereafter, while the foreign-private differential appears to be relatively constant across the three periods.

2.2. The Best and the Worst

In order to understand whether the more efficient local firms are catching up to and less efficient firms falling behind the world standard, one needs to look beyond the average performance and consider the distributions of efficiency of firms by ownership type. We start in this section by comparing firms at corresponding percentiles of their efficiency distributions in order to assess how the best (and worst) firms in each ownership category compare with each other. We define the best (worst) firms as those in the upper (lower) quartile or decile of the distribution of productive efficiency in their specific ownership type. The question is whether the patterns for the average results hold across the distribution.

We carry out two estimations comparing firms with different types of ownership at various points of the efficiency distribution. First, we estimate a series of quantile regressions of the form

$$Q_\theta[\ln y_{it} \mid X_{it}, Z_{it}] = X_{it}\beta_\theta + Z_{it}\rho_\theta, \quad (4)$$

where Q_θ is the θ^{th} quantile of ln y_{it} conditional on the covariates X and Z. The estimated coefficients ρ_θ give the relative efficiency of firms with different ownership at the θ^{th} quantile. The quantile approach provides a flexible estimation of all coefficients at different levels of efficiency.

A potential drawback of the quantile estimates is that they do not control for firm-specific unobserved heterogeneity. As a result, we also use the panel estimates of equation (2) and for each firm i we calculate firm-specific productive efficiency as $\varphi_i = \rho + v_i$ for each ownership type, with E(φ_i) = ρ and E(v_i) = 0. The idiosyncratic errors (ε_{it}) are excluded from the measure of firm-specific productive efficiency in order to reduce the effect of transitory productivity shocks and

[15] The differences in coefficients are statistically significant at 1% test level.

statistical noise. To allow for the variation in productive efficiency over time, the coefficients are estimated for each three-year panel.

The two approaches permit us to compare the efficiency of firms with different types of ownership at all points of the efficiency distribution, but they differ in their underlying constraints: the panel framework allows productive efficiency to vary across firms but constrains the production function coefficients to be identical for all firms, while the quantile approach constrains productive efficiency to be the same for all firms in a given percentile of the distribution but permits the production function coefficients to vary across percentiles.

The results of the quantile regressions, reported in Tables 4 and 5 (for the Czech Republic and Russia, respectively) as well as in Figure 1, allow us to compare the efficiency of foreign, domestic private, and mixed firms relative to the SOEs in the same percentiles of their respective efficiency distributions.[16] The tables and figure yield the following insights:

i) Foreign firms are considerably more efficient than all three types of domestic firms at virtually all levels of the distribution of relative efficiency – from the best to the worst.[17] At the same time, the differences in the distributions of efficiency of the three types of domestic firms are relatively small, with mixed and private firms being 0-25% more efficient than state-owned firms at nearly every point of the distribution and in each of the three periods.

ii) The gap between the efficiency of the foreign firms and all three types of domestic firms is greatest among the more efficient firms (75^{th} and 90^{th} percentiles) and smallest among the least efficient ones (10^{th} and 25^{th} percentiles). An important exception is the foreign-state efficiency gap in the Czech Republic during the late transition period, when the relative efficiency of the worst (remaining) Czech SOEs actually drops and the foreign-state difference in efficiency becomes the

[16] For instance, foreign firms in the 10^{th} percentile of their efficiency distribution are compared to SOEs in the 10^{th} percentile of the efficiency distribution of the SOEs, etc.

[17] The exception is the foreign-mixed efficiency differential which is insignificant in the bottom decile in Russia and the bottom half of the distribution in the Czech Republic at the start of the transition (1992-94) and also in the bottom decile

greatest in the bottom decile (61.5 log points).[18] The fact that these inefficient SOEs did not go out of business is consistent with the finding of Lizal and Svejnar (2002) that the pattern of bank lending for investment pointed to important signs of soft budget constraints (bailouts) among the large and medium size Czech firms in the 1990s. The large efficiency differentials that we find in Russia between firms with foreign ownership and all other firms are most likely also signs of the ongoing presence of soft budget constraints and limited competition. This is consistent with Brown and Earle's (2001) findings that in Russia competition did not lead to efficiency improvements unless the firm's competitors were private or foreign.

iii) As seen in Figure 1, the gap between the foreign and domestic firms in Russia is much larger than in the Czech Republic and the gap increases more rapidly from the worst to the best firms in Russia. For example, in the first period in Russia the foreign-state difference in efficiency ranges from 13.4 log points (14.6%) in 10^{th} decile to 104.0 (183%) in the 90^{th} decile whereas in the Czech Republic the corresponding log points are 18.7 (20.6%) and 38.9 (47.6 %).

iv) Using the estimates from Tables 4 and 5, we present in Table A5 the changes over time of the efficiency gap between foreign and domestic firms at selected percentiles of their efficiency distributions. For both countries, the foreign-domestic gap experiences significant growth at virtually all points of the distribution from early to mid transition.[19] In Russia, the growth in the gap from mid to late transition continues to be positive but smaller than earlier (in the range of 10-20%) for the majority of firms but it stabilizes or even becomes negative for the most efficient firms. In the Czech Republic, the change in the foreign-domestic gap is zero or negative (up to

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in the Czech Republic in mature transition (1998-2000). In this context, it must be remembered that in the Czech Republic firms with mixed ownership include foreign firms with less than 50% ownership stake.

[18] The fact that in mature transition the remaining least efficient Czech SOEs were considerably less efficient than the other types of firms supports the Gupta, Ham, and Svejnar (1999) models and findings suggesting that better firms were privatized first.

[19] The exception is the growth in the foreign-private gap in the Czech Republic, which is positive but not statistically significant. Otherwise, the percentage increase in the gap is about 15-20% for foreign-mixed and foreign-state in the Czech Republic and roughly 30-40% for all three foreign-domestic gaps in Russia.

16%) at all points of the distribution except for the less efficient SOEs. As noted earlier, the latter result is probably due to soft budget constraints in poorly performing SOEs.

The corresponding panel results, which take into account firm heterogeneity, are depicted in Figure 2. The figure is constructed on the basis of the RE estimates of φ_i, but the FE and 2SLS-RE estimates are highly correlated and do not alter our conclusions.[20] We order firms in each ownership category by φ_i and compare efficiency across ownership categories relative to the SOEs. As may be seen from Figures 1 and 2, the patterns in relative efficiency obtained by the RE panel and quantile estimations are similar. In the panel data approach, the gap between the foreign and domestic firms is larger in Russia than in the Czech Republic and it is greater among the more than the less efficient firms in all three periods.

In sum, the average results overstate the gap at the bottom of the distribution and understate it at the top. The gap grows in the first half of the transition in both countries, but much faster in Russia. Between the second and third period the gap continues to grow (but more slowly) in Russia in all except the most efficient firms, while it stabilizes or shrinks for all firms except the least efficient SOEs in the Czech Republic.

2.3. Distance to the Frontier

Having examined the efficiency gaps on average and across the distributions, we next assess how far domestic firms are from the world technological frontier and how the distance changes over time. We proxy the frontier by the average level of efficiency of the top one-third of the foreign firms in a given two-digit industry in each period. The results are similar when we utilize four-digit industry and when we use other efficiency benchmarks (e.g., top 10%, top 50% or the average

[20] We show in appendix Table A6 that the various measures of φ_i are highly correlated.

efficiency of foreign firms).[21] We define the (inverse) distance to the frontier as the ratio of each firm's efficiency to the mean productive efficiency of the frontier foreign firms within a two-digit industry in each period. As the ratio approaches 1 the firm approaches the frontier. Since our measure of productive efficiency is in log form, we apply the following exponential transformation:

$$\alpha_i = \exp\left(\varphi_i - \bar{\varphi}_{k,FOR}\,|_{\theta>.66}\right), \tag{5}$$

where α_i is the firm-specific (inverse) measure of the distance to the frontier and $\bar{\varphi}_{k,FOR}\,|_{\theta>.66}$ is the mean productive efficiency of the top third of foreign firms in industry *k*.

In Figure 3 and Table 6 we show for each of the three time periods the distribution of the domestic firms' distance to the frontier (α_i).[22] Our findings are consistent with those in Section 2.2 in that a) the distance of domestic firms from the frontier grows from 1992-94 to 1995-97 and does not change much from 1995-97 to 1998-2000[23] and b) in every period domestic firms in Russia are much further away from the frontier than domestic firms in the Czech Republic at all points of the efficiency distribution. In particular, three-quarters of Russian domestic firms operate at less than 30% of the frontier in the first period and at 20-25% of the frontier in the last period, while three-quarters of the Czech Republic's firms operate at 60-70% of the frontier in the first period and 50-55% of the frontier in the last period. Put differently, the Russian domestic firm at the 90th percentile is at the same distance from the frontier as the median Czech domestic firm.

Table 6 also makes it clear that the range of the efficiency distribution of foreign firms is much greater in Russia than in the Czech Republic. For example, in the first period the foreign firm located at the 10th percentile of the distribution has a level of efficiency that is at 29.1% of the

[21] See appendix Table A7 for results obtained when the frontier is defined by the top 50% of the foreign firms in each industry vs. the top 10% or, the average of the foreign firms in the country. The four digit estimates were obtained for Russia, where we have the finer industrial categories of data.

[22] We use RE estimates of productive efficiency to obtain our measure of the distance. The results do not differ substantially from those obtained with FE or 2SLS-RE estimators.

frontier in the Czech Republic but only 7.8% of the frontier in Russia. At the 90th percentile, the foreign firm in the Czech Republic is at 112.0 % of the frontier whereas the Russian foreign firm is at 130.9%. What explains this greater dispersion in Russia? Whereas part of the reason lies in the fact that the definition of the foreign firm in Russia is broader than in the Czech Republic, the greater dispersion probably also reflects the less competitive nature of the Russian economy.[24] Another explanation, from the Monge-Naranjo (2002) model mentioned above, is that the greater dispersion in Russia is due to the more recent entry of FDI in Russia than in the Czech Republic. If our findings were to be interpreted within that model, however, the short run in terms of theory is equivalent to eight years or more in terms of the empirical reality.

Finally, Figure 3 and Table 6 reveal considerable stability of the distribution of foreign firms relative to the frontier over time, while the distribution of domestic firms shifts away from the frontier in the early-to-mid transition.[25] These patterns are consistent with firms changing positions within the distribution, an issue that we examine in Section 3 below.

2.4. Do Foreign Firms Crowd Out Domestic Firms?

The next question that naturally arises is whether foreign firms are gradually replacing local firms at the top of the *overall* distribution of efficiency. Given our findings in Tables 1-6, one may expect that foreign firms will make up a larger share of firms at the top of the distribution as they increasingly enter each country. In Figure 4 we depict the distribution of firms by ownership within

[23] For example, in the Czech Republic SOEs at the 25th percentile are at 32.5% of the frontier in 1992-94 but fall to 24.1% in 1995-97 and 22.5% in 1998-2000. In Russia, SOEs at the 25th percentile fall from 11.4% to 6.1% and move up to 7.0% of the frontier over the same three periods.

[24] It is also possible that the larger gap in Russia is brought about by the fact that foreign firms are scarcer and presumably go after the most productive opportunities. We think that this is unlikely to be an important factor since we observe the differential even in the first period when foreign firms are scarce in both economies, and a similar pattern obtains in industries with a high and low share of foreign firms.

[25] In the Czech Republic there is a slight increase in the distance of foreign firms from the first to the second period but this increase is not as great as that of the domestic firms.

the overall distribution of efficiency in each sub-period.[26] (The values of all shares are given in appendix Table A9.)

In the early 1990s the Russian economy is composed mainly of SOEs (56.7% of all firms) and firms with mixed ownership (26.7%); whereas SOEs are disproportionately represented in the lowest two deciles of the distribution of efficiency, the mixed firms are disproportionately found in the upper half of the distribution. As transition proceeds, the SOEs continue to be a larger share of the bottom two deciles and the mixed tend to be distributed evenly throughout the distribution. Interestingly, the private firms also seem to be distributed fairly evenly across the ten deciles in all three periods. In 1992-1994, the few foreign firms (1.4% of all firms) are disproportionately represented in the highest decile of the efficiency distribution (4.6%). Over time as the share of foreign firms in the economy rises to 3.3% and 4.9% in 1995-1997 and 1998-2000, respectively, their share in the top decile of the efficiency distribution rises even faster, to 14.3% and 21.8% in these respective time periods.

In the Czech Republic there is already a substantial presence of foreign firms in the early 1990s and they are disproportionately located in the top three deciles. Over time, one observes a more marked penetration of foreign owned firms in the Czech Republic than in Russia, and their growing representation in the top three deciles of the efficiency distribution. For example, in 1998-2000 foreign firms represent 25.3% of all firms but 51.5% of firms in the top decile. As state ownership withers away, private firms make up larger shares of the lower deciles and firms with mixed ownership move into the middle part of the distribution.

In sum, in this section of the paper we carry out several tests of whether domestic firms approach the efficiency of foreign firms during the first decade of the transition. Our findings suggest that the answer is a no in both countries, irrespective of whether we compare the central tendency, counterpart firms at various parts of their respective efficiency distributions, or firm-

[26] We use random effects estimates of the average efficiency level of each firm within each three-year period.

specific distance to a frontier. In fact, foreign firms are increasingly displacing local firms in the top deciles of the efficiency distribution.

3. Factors Affecting the Evolution in Relative Efficiency of Different Types of Firms

In this section we examine factors that may drive the patterns in relative efficiency that we have identified in Section 2. In particular, we focus on the efficiency of new firms (startups), efficiency of domestic firms that are acquired by foreign investors and the differential rates of learning by existing firms with different types of ownership.

3.1. Startups

We begin by asking whether foreign firms enter the market at a higher level of efficiency than the domestic firms. If foreign startup operations have higher initial efficiency than domestic startups, then emerging market economies could achieve higher levels of efficiency by allowing these more efficient new foreign firms to enter.

We first carry out a nonparametric test of the startup hypothesis by comparing the efficiency levels of entering firms by ownership type. We use firm-specific estimates of productive efficiency calculated from the standardized residuals of the translog production function estimated for each year separately (1992-2000).[27] Based on its individual efficiency measure, each firm is categorized each year by whether it falls in the bottom, middle or top third of the overall distribution of efficiency. The values in Table 7 indicate the annual probability that a firm will enter the market in the bottom, middle or top of the distribution.[28] As may be seen from the table, in both countries, foreign firms are most likely to enter at the top of the distribution, with about a 50% probability. The pattern for mixed firms varies across the two countries: in the Czech Republic they are most likely to start at the top and the middle, whereas in Russia they are most likely to enter at the top or

[27] We standardize the residuals because we recognize that there may be year-to-year variation in the distribution of the residuals that reflects changes in inflation, or shocks to the economy, which we want to control for.

bottom of the distribution.[29] Private firms are equally likely to enter the market in any of these three parts of the distribution in both countries. Whereas the same is true for state enterprises in the Czech Republic, in Russia, state enterprises are most likely to enter at the bottom of the distribution.

Our parametric test consists of augmenting the production function in equation (1) by interaction terms between ownership dummy variables and a variable "startup" which is coded one in the first year of a firm's existence and zero otherwise. The coefficient on interaction terms gives the relative efficiency of startups to existing firms in the same ownership category. We present OLS and random effects estimates of the key coefficients in Table 8. In both countries, the newly created foreign firms are less efficient than existing foreign firms. However, by adding the ownership specific startup coefficients to the corresponding base ownership coefficients, one finds that with the exception of Czech startups with mixed ownership (which often have foreign investors), foreign owned startups are more efficient than domestic startups. Moreover, according to both OLS and RE estimates in the Czech Republic and the OLS estimates in Russia, domestic startups are more efficient than existing domestic firms . Hence, our results suggest that startups, especially foreign owned ones, have a positive effect on productive efficiency of the emerging market economies.

3.2. Selective Acquisitions by Foreign Firms

An alternative but complementary hypothesis about the superior performance of foreign-owned firms is that foreign investors enter emerging market economies by acquiring the more productive domestic firms ("creaming"). This hypothesis implies that foreign firms move instantly ahead of the average domestic firms and that the latter experience declining average efficiency as a result of their deteriorating composition (negative duration dependence). In this scenario, the

[28] A random distribution would be represented by equal probabilities (of 33.3%) in each category since the sum of the three probabilities must necessarily equals one.

[29] The Czech firms with mixed ownership have the same probability of starting in the top third of the efficiency distribution as do the foreign owned firms.

foreign investors gain efficiency advantage by selective acquisition of firms rather than by special capabilities that they bring in or by superior learning and other gradual improvements in performance. A competing hypothesis, also consistent with the evidence provided earlier, is that foreign investors select less efficient firms and turn them around.

In order to test these hypotheses, we estimate a probit model to see whether the more or less efficient domestic firms have a greater probability of being acquired by foreign investors. Specifically, we test whether the productive efficiency of a domestic firm in year *t*-1 affects the probability of being acquired by a foreign firm at *t*.[30] We control for the firm's ownership at *t*-1 and the type of ownership interacted with the calendar time, the logarithm of the firm's capital (to control for size), and industry, year and regional dummy variables.[31]

The marginal effects from the probit, reported in Table 9, indicate that in both countries foreign investors tend to acquire the more efficient domestic firms. The effect is larger in the Czech Republic than in Russia but, while highly statistically significant, its economic significance is limited in both countries. One standard deviation increase in domestic firm's productive efficiency leads to an increase in the mean annual probability of the firm being acquired by a foreign firm from 2.12% to 2.87% in the Czech Republic and from 0.41% to 0.45% in Russia.[32] The results of our estimation hence suggest that foreign investors indeed "cream" but that the part of their superior performance that can be explained by selective acquisitions of local firms is limited. Our estimates

[30] The measure of productive efficiency continues to be the annual RE firm-specific residual estimated from the translog production functions for each year, which we normalize to have zero mean and unitary standard deviation.

[31] Coefficients on more distant lags of the efficiency variable were statistically insignificant. Foreign investors hence seem to be guided by current performance.

[32] Given that SOEs are the base and the linear time trend hence captures the interaction of state ownership and time, we see that in the Czech Republic foreign investors are more likely to acquire domestic private firms than SOEs or firms with mixed ownership, and that the probability of acquisitions rises for all types of firms over time. In Russia, firms with mixed ownership have a lower base probability of being acquired by a foreign firm, but the mean probability of being acquired by a foreign investor rises for them and for the private firms over time by 19.7% and 14.3%, respectively. Finally, in both economies, the probability of a firm being acquired rises with the size of its capital stock, indicating that foreign investors tend to acquire larger rather than smaller firms.

reject the competing hypothesis that foreign investors select less efficient firms and turn them around.

3.3. Differential Rates of Learning and Innovation by Existing Firms

The next set of hypotheses that we examine is that domestic and foreign firms learn how to operate in the local emerging market economy at different speeds. In particular, foreign firms start their operations in the emerging markets with limited local knowledge and their efficiency may be expected to rise over time as they acquire this knowledge. Domestic firms in turn enter the transition with a lack of knowledge of the operation of a market economy, as well as a lack of western managerial and technical know-how. Their efficiency increases as they acquire this knowledge. The evolution of the relative position of foreign and domestic firms in the overall distribution of efficiency, depicted in Figure 4, reflects the uneven speed of these two processes.

We start by estimating the growth of efficiency of firms over the period τ during which they are owned by a particular type of owner (i.e., foreign, domestic private, state or mixed). We obtain these estimates by adding to equation (1) a term capturing the interaction of τ (the length of time since the start of a given ownership) and Z_{it} (the vector of ownership dummies). The estimates of these time varying coefficients, presented in Table 10, indicate that the foreign-state efficiency gap has been steadily increasing over time in both countries. In the Czech Republic, for instance, the efficiency of SOEs has declined by 0-2.5% per year, while the efficiency of foreign firms increased at a rate of 0-3.4% every year since the foreigners became owners, resulting in significant differentials in most estimates. In Russia, although the efficiency of SOEs has grown at 0-3.8% per year of ownership, the efficiency of foreign firms increased considerably faster at 6.2-16.4% per year. The growth in efficiency of domestic private and mixed firms relative to the efficiency of SOEs falls over time in all estimations in Russia.

We next test the Aghion *et al.* (2002 and 2003) and Acemoglu, Aghion, and Zilibotti's (2002 and 2003) hypothesis that competition brought about by the transition and entry of new firms encourages learning and innovative behavior of firms that are near the technological frontier but stifles learning among those firms that lag significantly behind. According to this view, we should observe convergence toward the frontier by the more efficient firms, but divergence or outright failure on the part of the less efficient firms. In order to provide evidence on this hypothesis, we test whether more efficient firms have a higher (lower) probability than less efficient firms of moving up (down) in the overall distribution of productive efficiency in any given year. We also check if the less efficient firms are more likely to exit than the more efficient ones. To carry out these tests, in every year we allocate firms into the bottom third, middle third and top third of the overall efficiency distribution on the basis of their individual estimated productive efficiency.[33] For firms within each ownership category we calculate the average annual probability that a firm in a given efficiency group moves to one of the other two efficiency groups, stays in the same group, or exits during the 1992-2000 period. These probabilities are reported in 3x4 annual transition matrices for each ownership category in Table 11, with the groups of origin being given by the row names and the groups of destination by the names of the columns. The bootstrap standard errors corresponding to the transition probabilities are very small, indicating each probability is statistically significant at the 1% confidence level.

The proximity to the frontier hypothesis is supported by the behavior of foreign firms in Russia and (somewhat less so) in the Czech Republic. It is contradicted, however, by the behavior of domestic private, mixed and state-owned firms. As may be seen from Table 11, the probability that foreign firms in the middle efficiency group move into the top group is higher than the probability that foreign firms in the bottom efficiency group move to the middle group (32.7% vs.

[33] The measure of efficiency is again each firm's residual from an annual translog production function that is estimated without ownership variables.

18.0% in Russia and 19.9% vs. 14.6% in the Czech Republic). Similarly, the probability that foreign firms in the top efficiency group move down into the middle group is smaller than the probability that they move from the middle to the bottom group (8.8% vs. 14.6% in Russia and 13.7% vs. 14.7% in the Czech Republic). In contrast, the counterpart probabilities are virtually indistinguishable within each of the three categories of domestically owned firms in Russia, and they are actually reversed in the Czech Republic. Hence, in the Czech Republic the probability of moving from the bottom to the middle group is higher than the probability of moving from the middle to the top group within each of the three domestic ownership categories (19.2% vs. 14.7% for the SOEs, 15.1% vs. 13.0% for the private firms and 17.9% vs. 11.5% for firms with mixed ownership). Similarly, the probability of moving down from the middle to the bottom group is smaller than moving from the top to the middle group within two of the three domestic ownership categories, with private firms being the exception.

The proximity to the frontier hypothesis also does not receive much support in the probabilities of exit if one ignores the exit rates of the group of the least efficient firms that are likely to have high exit rates in general and on account of various theories. Focusing on firms in the middle and top efficiency groups, it may be seen from Table 11 that in all ownership categories in both countries the probability of exit is very similar for firms from the top and middle efficiency groups. In other words, the idea that firms that are further from the frontier would be more likely to fail than the ones near the frontier is not supported by data for the top and middle-level efficiency firms. However, one could argue that the distance to the frontier hypothesis receives some support from the fact that the exit rates are higher in Russia than in the Czech Republic, where the level of development is higher and institutions are stronger.[34]

[34] However, the relative magnitude of exit rates across ownership varies in the two countries. In Russia, the probability that a foreign, mixed or private firm exits is generally higher than the probability that a state enterprise exits. In the Czech Republic, the reverse is true: the SOEs have higher exit rates than the others.

The transition probabilities in Table 11 also complement our findings in Table 10 that foreign firms are learning more rapidly than domestic firms. We find that in both countries foreign firms are more likely to move up in the overall efficiency distribution (especially into the top group) and stay in the top group than firms in any of the three domestic ownership categories, which in turn display similar patterns of mobility. Firms with foreign ownership are also less likely to move down in the overall distribution than the other types of firms. The differential pattern of mobility between the foreign and domestic firms is more pronounced in Russia than in the Czech Republic. For example, in Russia foreign firms in the middle efficiency group have a 33% probability of moving into the top group and a 15% probability of moving into the bottom group within a year. The corresponding probabilities in the state, mixed and private firms are 17-19% for moving to the top and 18-20% for moving to the bottom. In the Czech Republic foreign firms in the middle group have a 20% probability of moving into the top group and a 15% probability of moving into the bottom group. Czech state, mixed and private firms face a 12-15% probability of moving from the middle to the top group and a 19-23% probability of moving into the bottom group. Our estimates hence indicate that domestic firms are improving their efficiency slower than the foreign owned firms, a finding that is consistent with the hypothesis that domestic firms are learning slower than foreign firms.

Using the 3x3 sub-matrices reflecting the bottom, middle and top efficiency states in Table 11, we have also calculated the stationary probability matrices of efficiency by ownership. With bootstrap standard errors being small, we find that in both economies the stationary probability that foreign owned firms are in the top third of the overall efficiency distribution is twice as high as the corresponding probability for any of the three types of domestic firms. In particular, in the Czech Republic the stationary probability of the foreign firms being in the top group is 0.45, while the

corresponding probabilities of the domestic private, mixed and state firms are 0.21, 0.22 and 0.26. In Russia, the corresponding probability values are 0.69, 0.30, 0.29, and 0.30.[35]

3.4. Conditional (β) Convergence

Our previous analysis does not reveal any signs of convergence of domestic firms to the world efficiency frontier defined by the best foreign-owned firms. The question arises as to whether this is because domestic firms converge more slowly or because they converge to a lower (steady state) level of efficiency than the foreign firms. We examine this question by estimating a dynamic conditional convergence equation of the form

$$\varphi_{ip} = Z_{ip}\kappa + \varphi_{ip-1}Z_{ip}\eta + I_{ip}\delta + P\nu + u_{ip}, \quad (6)$$

where φ_{ip} is the logarithm of the average efficiency of each firm i in each consecutive two-year period p, Z_{ip} is a vector of categories of ownership (averaged across the two years within each period p), κ proxies the steady state efficiency levels of firms with different types of ownership, η is (the negative of the log of) the speed of convergence of firms to their ownership-specific steady state efficiency level, I_{ip} is a set of industry dummy variables controlling for industry-specific (e.g., technology) factors that may affect the steady state efficiency levels of firms, and P are period dummies (e.g., Barro and Sala-i-Martin, 2004).[36] Equation (6) hence allows both the steady state efficiency levels and the speed of convergence to vary with ownership type. In order to reduce the effects of short-term variations in the data, we use for each firm its estimated two-year average efficiency levels during the 1993-2000 period. We estimate equation (6) by pooled OLS as well as by using the difference between the third and second lags as an instrumental variable for the first lag of efficiency in our level equation (see Arellano and Bover, 1995).

[35] The stationary probability matrices also indicate that foreign owned firms are much less likely to be in the bottom tier of the efficiency distribution. The respective stationary probabilities for the foreign, mixed, private and state firms are 0.26, 0.40, 0.45, and 0.38 for the Czech Republic and 0.13, 0.36, 0.36, and 0.37 in Russia.

The OLS and IV estimates of the conditional convergence model are reported in Table 12, with the SOEs again serving as the base. As may be seen from the estimates of κ in the second and third rows, all three types of domestic firms are converging to the same steady state level (except possibly for the mixed firms in the Czech Republic). On the other hand, foreign firms are converging to a 0.11 to 0.23 log point higher steady state level in the Czech Republic and a 0.34-0.40 log point higher level of efficiency in Russia. The estimated η coefficient on lagged efficiency in row four measures the speed of convergence of the SOEs (the base category), while the coefficients in rows five to seven give the difference in the speed of convergence of the other ownerships categories relative to SOEs (where the speed of convergence is given by 1 - η). These estimates suggest that in the Czech Republic all four types of firms are converging to their respective steady states at the same speed. In Russia, foreign firms converge at a faster speed than the three types of domestic firms, which are converging at the same speed. The results suggest that the nature of the convergence is such that foreign firms will remain more efficient in both the short and long run.

3.5. Development, Institutions and Market Culture

Overall, our results suggest that for a number of reasons foreign owned firms start with higher productive efficiency, are better able to increase this efficiency over time and converge toward a higher steady state efficiency level than domestic firms. The results imply that domestic firms are not "catching up" with the world standard as they are privatized and face more competition, and that they may not catch up even in the long term.

These results are complemented by Sabirianova, Svejnar and Terrell's (2005) study, which shows that foreign firms have negative efficiency spillovers on local firms in the same industry and that while the negative spillovers diminish over time in the Czech Republic, they become

[36] Although the two literatures do not cross-reference each other, equation (6) can be shown to be in the same class of

increasingly more negative in Russia. These findings are in stark contrast to those of Griffith, Redding and Simpson (2002) for the UK, who find that establishments further behind the technological frontier experience faster rates of productivity growth and that increased foreign presence within an industry raises the speed of convergence to the technological frontier. These and related findings suggest that the effect of multinational corporations on local firms varies with the level of economic, legal and institutional development: FDI tends to crowd out local firms in relatively undeveloped countries with weak legal and institutional systems, but it yields positive technological spillovers for local firms in more developed economies and institutional systems.

The Russian data permit us to pursue the above hypothesis more sharply. In particular, we can go some way toward distinguishing whether the different findings for Russia and the Czech Republic are brought about by differences in (a) the level of economic development, (b) the institutional/ legal structure and (c) the market/business culture stemming from the physical proximity to a western market economy. In order to do so, we focus on the Moscow and St. Petersburg regions of Russia, both of which happen to have a similar population size as the Czech Republic. The Moscow region resembles the Czech Republic in that it is economically much more advanced than the other Russian regions. The St. Petersburg region resembles the Czech Republic in that it borders on a western market economy and, like the Czech Republic, is often said to have more of a western market/business culture. The Moscow and St. Petersburg regions could hence be expected to generate similar results to those for the Czech Republic on account of the level of development and market/business culture, respectively. Yet, the two regions share with the rest of Russia the legal and institutional environment. In order to assess which effect dominates, we carry out the estimations reported in Tables 1 and 10 on data from firms located in the Moscow and St. Petersburg regions and check whether the estimated coefficients resemble more those from the Czech Republic or Russia as a whole. We find that the parameter estimates for both Moscow and

functions as that estimated by Griffith, Redding and Simpson (2002) on British firms.

St. Petersburg are similar to those for Russia as a whole rather than the Czech Republic. This result suggests that policies and institutional environment rather than the level of economic development or market/business culture determine the relative performance of foreign and domestic firms.

4. Conclusions

The Czech Republic and Russia represent important alternative models of transition and implementation of the development policies known widely as the Washington Consensus policies – the Central-East European (CEE) model and the Commonwealth of Independent States (CIS) model, respectively. The two models differ markedly in the degree to which they have opened their markets to competition from trade and foreign direct investment and the extent to which they developed market-oriented institutions and legal system. Hence, they provide suitable alternative laboratories for testing the effects of the Washington Consensus policies on the efficiency of firms. We use large firm-level data sets from these two countries to examine whether the systemic changes and market liberalization during 1992-2000 enabled local firms to converge in productive efficiency to the world standard which we define as the efficiency of foreign owned firms in these economies. In doing so, we provide micro-econometric foundations for the debate about the effects of globalization, privatization and foreign direct investment (FDI) on economic development.

Guided by the ideas of the Washington consensus, both the CEE and CIS countries carried out large scale privatizations on the presumption that this would increase the efficiency of firms. Although the Russian privatization is characterized more by selling to insiders than the Czech privatization, our results indicate that the method did not matter in that firms with domestic private and mixed ownership are similarly efficient and their efficiency is only slightly higher than that of the state-owned enterprises (SOEs) in the Czech Republic and either slightly higher or lower, depending on the estimation method, in Russia. These results suggest that a principal justification for carrying out large scale privatizations of state assets to domestic private owners has not been

borne out by performance during the post-privatization decade. Referring to policies related primarily to household income distribution, Francois Bourguignon asked in a keynote address whether development policies do not often bring about "wrong transfers of wealth."[37] Since both the CEE and CIS economies have transferred 50-90% of their total capital stock from state to private hands, the lack of a substantial positive effect on productive efficiency raises a major question about the effectiveness of this particular form of a *very* large policy-driven wealth transfer.

The Washington Consensus also advocated foreign direct investment (FDI) as a vehicle for development -- both through the higher efficiency of the multinationals and the positive effects foreign firms would have on domestic firms' efficiency. We find that foreign owned firms are far more efficient than domestic firms in both countries. However, the efficiency gap between domestic and foreign firms is not closing and foreign-owned firms increasingly displace local firms in the top three deciles of the efficiency distribution. We demonstrate that one factor contributing to this displacement is that foreign-owned startups tend to be more efficient than domestic startups, which in turn are more efficient than existing domestic firms. We also show that foreign investors tend to acquire more efficient domestic firms, although the magnitude of this effect is limited. Finally, we provide evidence that existing foreign owned firms are improving their efficiency (learning) faster than domestic firms. It could of course be argued that we are observing the short term effects of FDI, as described in the Monge-Naranjo (2002) model. While this may be the case, our results provide sobering evidence on how quickly one may expect policies to have the positive expected effect on development.

A recent literature is hypothesizing that the development policies pursued under the Washington Consensus are more effective in increasing growth/efficiency in countries/firms that are closer to the frontier, but that the policies are too overwhelming and may even cause failure in the less efficient countries/firms. Our study provides evidence related to this hypothesis both at the

[37] **August 2004 European Meetings of the Econometric Society.**

country and the firm levels. At the country level, we find that the foreign-domestic efficiency gap is much larger in Russia than the Czech Republic and that domestic firms continue to fall behind in Russia over the entire 1992-2000 period, whereas in the Czech Republic the gap stabilizes in the second half of the period. This evidence may be interpreted as supporting the hypothesis since the Czech Republic is closer than Russia to the "frontier" in terms of its initial efficiency. However, we cannot rule out the alternative hypothesis that the differential in the gap is due to greater liberalization and competition or more market-oriented institutional development in the Czech Republic.

At the firm level we test the "proximity to the frontier" hypothesis by examining whether firms at the middle or highest levels of productive efficiency are more likely to improve their efficiency and less likely to exit than firms that at the lower efficiency levels. We find the hypothesis is supported by the behavior of foreign owned firms but contradicted by the behavior of all three types of domestic firms. We also find divergence in the efficiency of the domestically owned firms relative to the efficiency frontier set by foreign firms. Moreover, we show that in both countries foreign firms are converging to a higher steady state level of efficiency than domestic firms. Finally, by comparing the Moscow and St. Petersburg regions to the Czech Republic, we provide evidence suggesting that institutional and legal environment, rather than level of economic development or market/business culture, accounts for the different patterns observed for the Czech Republic and Russia.

Overall, rather than finding evidence supporting either the basic or the nuanced version of the Washington consensus policies, we show that both the CEE and CIS countries continue to face the development challenge of how to bring their firms to the world efficiency standard. The CEE economies are meeting this challenge by rapidly increasing the shares of their GDP and exports accounted for by foreign firms -- an option that is not readily open to all developing countries and that raises the question of whether foreign capital is too foot-lose to constitute a reliable basis for

long term economic development.[38] In contrast, the CIS economies have not yet started to meet the challenge, despite the fact that it will become increasingly acute as globalization proceeds and the countries become more open economies, with or without entering WTO. Finally, our results indicate that future research needs to examine carefully the differential effect that development policies, FDI and globalization in general have on (a) the performance of local vs. foreign owned firms and (b) the macro performance of the emerging market economies.

[38] Studies by Fabbri, Haskel and Slaughter (2002), Bernard and Jensen (2002) and Bernard and Sjoholm (2003) suggest that controlling for firm size and productivity multinational firms are more likely to close their plants than domestic firms. An evaluation of the welfare effects of foreign ownership hence needs to examine other factors in addition to whether domestic firms that are being displaced by foreign firms are the poorly or well performing ones.

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Table 1: Percentage Share of Industrial Firms, Employment and Output by Ownership Type, for Selected Years

	Czech Republic			Russia		
	1992	1996	2000	1993	1996	2000
Firm Shares						
Foreign	3.5	12.6	30.7	1.8	3.5	5.6
Mixed	0.7	21.0	12.9	32.6	42.7	28.2
Private (domestic)	18.4	57.4	54.1	16.7	38.3	51.3
State	77.4	9.0	2.4	48.9	15.6	15.0
Employment Shares						
Foreign	2.6	12.1	33.7	0.7	1.9	11.5
Mixed	0.1	42.6	25.9	38.0	56.2	35.2
Private (domestic)	10.2	36.7	37.6	9.0	28.0	44.5
State	87.0	8.6	2.9	52.3	13.8	8.8
Output Shares						
Foreign	7.7	21.4	51.1	2.3	3.0	19.6
Mixed	0.1	40.8	22.3	45.5	68.6	33.3
Private (domestic)	7.6	30.6	24.9	6.8	19.5	41.7
State	84.6	7.2	1.7	45.4	8.9	5.4
No. of obs.	1537	2283	2084	17923	17138	15035

Notes: In the Czech Republic the ownership category is based on majority ownership while in Russia, it is based on 100% ownership, except for foreign ownership, which can be partial. The sample consists of firms with non-missing values for industry, ownership, output, fixed assets, and employment.

Table 2: Average Effects of Ownership on Productive Efficiency, 1992-2000

Czech Republic

	OLS	QREG	RE	FE	2SLS-RE	BB
Foreign	0.435**	0.413**	0.319**	0.275**	0.349**	0.657**
	(0.019)	(0.021)	(0.017)	(0.019)	(0.024)	(0.037)
Mixed	0.122**	0.086**	0.110**	0.094**	0.097**	0.074*
	(0.019)	(0.022)	(0.014)	(0.015)	(0.020)	(0.031)
Private	0.145**	0.122**	0.115**	0.117**	0.075**	0.053*
	(0.015)	(0.016)	(0.013)	(0.014)	(0.017)	(0.027)
No. of obs.	19,971	19,971	19,971	19,971	15,142	19,971
No. of firms	4,657	4,657	4,657	4,657	3,781	4,657
R^2	0.754	0.526	0.741	0.656	0.754	…

Russia

	OLS	QREG	RE	FE	2SLS-RE	BB
Foreign	0.994**	0.885**	0.398**	0.176**	0.629**	0.771**
	(0.021)	(0.015)	(0.019)	(0.022)	(0.029)	(0.049)
Mixed	0.124**	0.159**	-0.020**	-0.050**	-0.110**	0.081**
	(0.008)	(0.007)	(0.007)	(0.007)	(0.018)	(0.016)
Private	0.163**	0.174**	-0.019*	-0.060**	-0.114**	0.140**
	(0.008)	(0.008)	(0.008)	(0.009)	(0.018)	(0.017)
No. of obs.	153,402	153,402	153,402	153,402	140,658	153,402
No. of firms	26,286	26,286	26,286	26,286	24,595	26,286
R^2	0.680	0.482	0.670	0.594	0.688	…

Notes: Coefficients = estimated log effects of different types of ownership relative to state ownership. Standard errors are in parentheses (robust in OLS); * significant at 5%; ** significant at 1%. The estimates are obtained from the translog production function specified in equation (1) and which includes industry dummies, year dummies, and controls for data anomalies. τ is the time since the change in the corresponding ownership status. QREG – median regression, RE – random effects estimator, FE – fixed effects estimator, 2SLS-RE – two stage least squares random effect estimator, and BB – Blundell-Bond system GMM estimator (first four lags of levels and differences in inputs and ownership are used as instruments for differences and levels, respectively). Both 2SLS-RE and BB estimators use exogenous information on ministries under central planning as instruments for endogenous variables.

Table 3: Average Effects of Ownership on Productive Efficiency by Period

	Czech Republic					Russia				
	OLS	**QREG**	**RE**	**FE**	**2SLS-RE**	**OLS**	**QREG**	**RE**	**FE**	**2SLS-RE**
					1992-1994					
Foreign	0.263**	0.285**	0.246**	0.218*	0.331**	0.580**	0.455**	0.373**	-0.235**	0.772**
	(0.041)	(0.042)	(0.044)	(0.092)	(0.054)	(0.054)	(0.036)	(0.043)	(0.077)	(0.077)
Mixed	0.178**	0.156*	0.137*	0.078	0.283*	0.126**	0.136**	-0.016*	-0.039**	0.046
	(0.058)	(0.066)	(0.057)	(0.077)	(0.113)	(0.012)	(0.011)	(0.008)	(0.008)	(0.093)
Private	0.042	0.042	0.057*	0.099	0.054	0.120**	0.109**	0.005	-0.015	0.011
	(0.022)	(0.025)	(0.026)	(0.058)	(0.031)	(0.012)	(0.013)	(0.009)	(0.010)	(0.058)
No. of obs.	6,657	6,657	6,657	6,657	3,331	53,371	53,371	53,371	53,371	47,010
R^2	0.762	0.551	0.760	0.595	0.800	0.670	0.503	0.666	0.523	0.689
					1995-1997					
Foreign	0.462**	0.432**	0.195**	0.078**	0.266**	0.957**	0.850**	0.626**	0.020	0.985**
	(0.032)	(0.033)	(0.025)	(0.029)	(0.042)	(0.036)	(0.025)	(0.033)	(0.054)	(0.049)
Mixed	0.061*	0.063	0.015	-0.001	0.065*	0.150**	0.161**	0.116**	0.025	0.153**
	(0.029)	(0.033)	(0.016)	(0.017)	(0.031)	(0.014)	(0.012)	(0.014)	(0.020)	(0.031)
Private	0.147**	0.146**	0.027	0.001	-0.008	0.186**	0.186**	0.116**	0.004	0.165**
	(0.024)	(0.026)	(0.016)	(0.017)	(0.025)	(0.014)	(0.013)	(0.015)	(0.022)	(0.031)
No. of obs.	6,786	6,786	6,786	6,786	6,054	53,035	53,035	53,035	53,035	49872
R^2	0.7517	0.522	0.741	0.647	0.755	0.692	0.479	0.685	0.518	0.696
					1998-2000					
Foreign	0.555**	0.449**	0.218**	-0.035	0.301**	1.086**	0.980**	0.666**	0.101	1.223**
	(0.059)	(0.046)	(0.045)	(0.059)	(0.070)	(0.031)	(0.026)	(0.033)	(0.058)	(0.054)
Mixed	0.250**	0.115*	0.019	-0.105*	-0.008	0.123**	0.162**	0.135**	0.025	0.076*
	(0.060)	(0.048)	(0.043)	(0.050)	(0.072)	(0.018)	(0.016)	(0.022)	(0.046)	(0.032)
Private	0.275**	0.163**	0.040	-0.108	0.031	0.204**	0.208**	0.203**	0.052	0.173**
	(0.058)	(0.045)	(0.045)	(0.061)	(0.068)	(0.016)	(0.016)	(0.022)	(0.047)	(0.029)
No. of obs.	6,528	6,528	6,528	6,528	5,757	46,996	46,996	46,996	46,996	43,776
R^2	0.750	0.510	0.737	0.609	0.752	0.696	0.487	0.686	0.615	0.705

Notes: Coefficients = estimated log effects of different types of ownership relative to state ownership. Standard errors are in parentheses (robust in OLS);
* significant at 5%; ** significant at 1%. The estimates are obtained from the translog production function specified in equation (1) and which includes industry dummies, year dummies, and controls for data anomalies. The estimation methods are the same as in Table 2. Blundell-Bond system GMM estimation is not performed because of the short length of the sub-periods.

Table 4: Quantile Estimates of Ownership Effects by Percentile and Period, the Czech Republic

Percentile	Foreign-State (1)	Mixed-State (2)	Private-State (3)	Foreign-Mixed (4)=(1)-(2)	Foreign-Private (5)=(1)-(3)
			1992-1994		
10	0.187**	0.162	0.019	0.025	0.168**
	(0.057)	(0.090)	(0.035)	(0.101)	(0.056)
25	0.198**	0.128	0.005	0.070	0.193**
	(0.044)	(0.070)	(0.027)	(0.078)	(0.043)
50	0.285**	0.156*	0.042	0.129	0.243**
	(0.042)	(0.066)	(0.025)	(0.074)	(0.040)
75	0.368**	0.082	0.063*	0.286**	0.305**
	(0.046)	(0.072)	(0.026)	(0.081)	(0.044)
90	0.389**	0.155	0.072	0.235*	0.318**
	(0.067)	(0.104)	(0.038)	(0.116)	(0.064)
			1995-1997		
10	0.347**	0.121**	0.141**	0.225**	0.206**
	(0.038)	(0.037)	(0.031)	(0.038)	(0.033)
25	0.387**	0.049	0.109**	0.338**	0.278**
	(0.036)	(0.036)	(0.029)	(0.037)	(0.031)
50	0.432**	0.063	0.146**	0.369**	0.286**
	(0.033)	(0.032)	(0.026)	(0.034)	(0.027)
75	0.527**	0.015	0.141**	0.513**	0.386**
	(0.041)	(0.041)	(0.032)	(0.043)	(0.034)
90	0.470**	0.041	0.101**	0.429**	0.370**
	(0.051)	(0.050)	(0.039)	(0.053)	(0.042)
			1998-2000		
10	0.615**	0.551**	0.439**	0.065	0.177**
	(0.065)	(0.069)	(0.062)	(0.040)	(0.031)
25	0.476**	0.300**	0.239**	0.176**	0.237**
	(0.054)	(0.056)	(0.052)	(0.032)	(0.024)
50	0.449**	0.115*	0.163**	0.334**	0.287**
	(0.046)	(0.048)	(0.045)	(0.028)	(0.020)
75	0.457**	0.070	0.152**	0.387**	0.305**
	(0.055)	(0.058)	(0.053)	(0.033)	(0.024)
90	0.448**	0.000	0.127	0.447**	0.320**
	(0.075)	(0.079)	(0.072)	(0.044)	(0.034)

Notes: Standard errors are in parentheses; * significant at 5%; ** significant at 1%. The percentile estimates are obtained from the quantile regression of output on capital and labor inputs (translog specification), industry dummies, year dummies, and controls for data anomalies. The omitted (base) ownership category is state ownership.

Table 5: Quantile Estimates of Ownership Effects by Percentile and Period, Russia

Percentile	Foreign-State (1)	Mixed-State (2)	Private-State (3)	Foreign-Mixed (4)=(1)-(2)	Foreign-Private (5)=(1)-(3)
			1992-1994		
10	0.134*	0.213**	0.193**	-0.078	-0.059
	(0.054)	(0.016)	(0.019)	(0.054)	(0.055)
25	0.309**	0.152**	0.113**	0.158**	0.196**
	(0.040)	(0.012)	(0.014)	(0.040)	(0.040)
50	0.455**	0.136**	0.109**	0.319**	0.346**
	(0.036)	(0.011)	(0.013)	(0.036)	(0.037)
75	0.635**	0.105**	0.099**	0.530**	0.535**
	(0.036)	(0.012)	(0.014)	(0.036)	(0.037)
90	1.040**	0.059**	0.064**	0.981**	0.976**
	(0.052)	(0.017)	(0.019)	(0.052)	(0.053)
			1995-1997		
10	0.517**	0.169**	0.230**	0.348**	0.287**
	(0.047)	(0.024)	(0.024)	(0.044)	(0.045)
25	0.690**	0.197**	0.221**	0.492**	0.469**
	(0.032)	(0.016)	(0.016)	(0.031)	(0.031)
50	0.850**	0.161**	0.186**	0.689**	0.664**
	(0.025)	(0.012)	(0.013)	(0.024)	(0.024)
75	1.116**	0.129**	0.132**	0.986**	0.983**
	(0.026)	(0.013)	(0.013)	(0.025)	(0.025)
90	1.388**	0.138**	0.130**	1.250**	1.258**
	(0.032)	(0.017)	(0.017)	(0.030)	(0.031)
			1998-2000		
10	0.617**	0.075*	0.163**	0.543**	0.454**
	(0.050)	(0.032)	(0.031)	(0.045)	(0.045)
25	0.779**	0.140**	0.179**	0.639**	0.599**
	(0.030)	(0.018)	(0.018)	(0.027)	(0.027)
50	0.980**	0.162**	0.208**	0.817**	0.772**
	(0.026)	(0.016)	(0.016)	(0.024)	(0.024)
75	1.172**	0.151**	0.191**	1.021**	0.981**
	(0.023)	(0.015)	(0.014)	(0.021)	(0.021)
90	1.356**	0.188**	0.248**	1.168**	1.108**
	(0.034)	(0.021)	(0.020)	(0.030)	(0.030)

Notes: Standard errors are in parentheses; * significant at 5%; ** significant at 1%. The percentile estimates are obtained from the quantile regression of output on capital and labor inputs (translog specification), industry dummies, year dummies, and controls for data anomalies. The omitted (base) ownership category is state ownership.

Table 6: Distance to the Efficiency Frontier by Percentile, Ownership, and Period

Czech Republic

Percentile	Foreign			State			Private			Mixed		
	1992-1994	1995-1997	1998-2000	1992-1994	1995-1997	1998-2000	1992-1994	1995-1997	1998-2000	1992-1994	1995-1997	1998-2000
10	0.291	0.219	0.207	0.246	0.180	0.140	0.254	0.186	0.190	0.267	0.193	0.199
25	0.415	0.350	0.346	0.325	0.241	0.225	0.330	0.250	0.260	0.387	0.266	0.279
50	0.608	0.572	0.554	0.448	0.338	0.330	0.439	0.347	0.380	0.531	0.353	0.357
75	0.886	0.853	0.835	0.590	0.476	0.499	0.619	0.504	0.544	0.707	0.481	0.496
90	1.120	1.120	1.106	0.778	0.690	0.671	0.856	0.743	0.778	1.001	0.641	0.730

Russia

Percentile	Foreign			State			Private			Mixed		
	1992-1994	1995-1997	1998-2000	1992-1994	1995-1997	1998-2000	1992-1994	1995-1997	1998-2000	1992-1994	1995-1997	1998-2000
10	0.078	0.075	0.094	0.066	0.035	0.036	0.078	0.053	0.047	0.086	0.051	0.041
25	0.159	0.157	0.166	0.114	0.061	0.070	0.125	0.089	0.088	0.135	0.090	0.083
50	0.280	0.321	0.338	0.186	0.118	0.129	0.200	0.148	0.152	0.208	0.149	0.146
75	0.723	0.679	0.706	0.305	0.206	0.215	0.331	0.232	0.247	0.333	0.235	0.240
90	1.309	1.319	1.280	0.471	0.328	0.325	0.497	0.355	0.387	0.505	0.359	0.370

Notes: The frontier is defined as the mean productive efficiency of the top third foreign firms in a 2-digit ISIC industry. The efficiency estimates are obtained from the translog production function estimated with the random effect estimator for each period separately. The specification includes inputs, ownership dummies, industry dummies, year dummies, and controls for data anomalies. Percentiles are constructed from the distribution of the firm-specific distance to the frontier for each ownership type. For example, looking at Russia during the 1992-1994 period private firms at the 50^{th} percentile are reaching only 20% of the efficiency level of the frontier foreign firms in a corresponding industry.

Table 7: The Efficiency Distribution of Startups, by Type of Ownership 1992-2000

	Czech Republic			Russia		
	Bottom 33%	Middle 33%	Top 33%	Bottom 33%	Middle 33%	Top 33%
Foreign	0.255	0.260	0.485	0.317	0.171	0.513
Mixed	0.140	0.360	0.500	0.324	0.286	0.391
Private	0.318	0.326	0.356	0.336	0.278	0.386
State	0.336	0.334	0.330	0.435	0.276	0.289

Notes: The productive efficiency estimates (PE) are obtained from the standardized residuals of the translog production function estimated for each year separately (1992-2000), with industry dummies and controls for data anomalies included. The table shows the average annual probability that a firm will enter the market in the bottom, middle or top of the efficiency distribution. All probabilities are statistically significant at 5% level (using bootstrapped standard errors)

Table 8: Relative Efficiency of Startups by Ownership Type, 1992-2000

	Czech Republic		Russia	
	RE	OLS	RE	OLS
Foreign	0.316**	0.439**	0.411**	1.012**
	(0.018)	(0.020)	(0.020)	(0.022)
Mixed	0.097**	0.096**	-0.027**	0.104**
	(0.015)	(0.020)	(0.007)	(0.008)
Private	0.100**	0.133**	-0.024**	0.144**
	(0.014)	(0.016)	(0.008)	(0.008)
S_{For}(=Startup*Foreign)	-0.057**	-0.010	-0.182**	-0.192**
	(0.022)	(0.041)	(0.025)	(0.060)
S_{Mix}(=Startup*Mixed)	0.100**	0.426**	-0.039*	0.096**
	(0.038)	(0.069)	(0.015)	(0.027)
S_{Pri} (=Startup*Private)	0.039**	0.099**	0.016	0.093**
	(0.012)	(0.020)	(0.014)	(0.022)
S_{Sta}(=Startup*State)	-0.024	0.095**	-0.177**	-0.218**
	(0.016)	(0.029)	(0.011)	(0.021)
No. of obs.	19,971	19,971	153,402	153,402
No. of firms	4,657	4,657	26,286	26,286
R^2	0.742	0.755	0.670	0.680
P-values:				
Foreign+ S_{For} = Private+S_{Pri}	0.000	0.000	0.000	0.000
Foreign+ S_{For} = Mixed+S_{Mix}	0.170	0.219	0.000	0.000
Foreign+ S_{For} = 0	0.000	0.000	0.000	0.000
Private + S_{Pri} = Mixed+S_{Mix}	0.145	0.000	0.005	0.282
Private + S_{Pri} = 0	0.000	0.000	0.611	0.000
Mixed + S_{Mix} = 0	0.000	0.000	0.000	0.000

Notes: Standard errors are in parentheses (robust in OLS); * significant at 5%; ** significant at 1%. The omitted category is state ownership. The estimates are obtained from the translog production function, given by equation (1), which included industry dummies, year dummies, and controls for data anomalies. Startup=1 if firm is a startup at time *t*. RE – random effects estimator.

Table 9: The Effect of Local Firm Characteristics on the Probability of Acquisition by Foreign Investors, 1993-2000

	Czech Republic		Russia	
	d*F*/d*X*	Mean(*X*)	d*F*/d*X*	Mean(*X*)
PE_{t-1} (Productive Efficiency)	0.750**	0.006	0.047**	0.036
	(0.087)		(0.010)	
$Mixed_{t-1}$	1.634	0.114	-0.193**	0.359
	(1.872)		(0.047)	
$Private_{t-1}$	2.030**	0.582	-0.114*	0.314
	(0.509)		(0.052)	
$Mixed_{t-1}$* Time	-0.297	0.678	0.080**	1.705
	(0.177)		(0.013)	
$Private_{t-1}$* Time	-0.351**	2.960	0.058**	1.703
	(0.113)		(0.013)	
Time	0.606**	4.475	-0.004	4.359
	(0.097)		(0.010)	
lnK_{t-1}	0.548**	11.464	0.085**	0.596
	(0.060)		(0.006)	
No. of obs.	14,424		122,182	
Pseudo R^2	0.111		0.146	
Unconditional probability (%)	2.121		0.407	

Notes: The reported marginal effects (multiplied by 100) are obtained from probit estimates. The dependent variable is a dummy indicating whether a formerly domestic firm is acquired by foreign investors. Standard errors (multiplied by 100) are in parentheses; * significant at 5%; ** significant at 1%. The omitted category is state ownership lagged one year. The firm-specific measure of productive efficiency (PE) is obtained from the standardized residuals of the translog production function estimated for each year separately, with industry dummies and controls for data anomalies included. Time is calendar time, starting with 1 in 1993. Regional dummies (for Russia) and industry dummies are included in the probit estimates but not shown here.

Table 10: Time-Varying Effects of Ownership on Productive Efficiency, 1992-2000

Czech Republic

	OLS	QREG	RE	FE	2SLS-RE	BB
Foreign	0.303**	0.280**	0.149**	0.140**	0.208**	0.337**
	(0.031)	(0.031)	(0.025)	(0.029)	(0.046)	(0.043)
Mixed	0.023	0.002	0.009	0.022	0.003	-0.002
	(0.035)	(0.037)	(0.023)	(0.025)	(0.063)	(0.046)
Private	0.144**	0.142**	0.089**	0.103**	0.103**	0.105**
	(0.022)	(0.023)	(0.018)	(0.019)	(0.029)	(0.033)
τ * Foreign	-0.002	0.006	0.018**	0.033**	0.033**	0.002
	(0.007)	(0.007)	(0.005)	(0.006)	(0.005)	(0.008)
τ * Mixed	-0.013	-0.013	-0.003	0.006	0.020*	-0.004
	(0.009)	(0.010)	(0.006)	(0.007)	(0.010)	(0.011)
τ * Private	-0.038**	-0.038**	-0.031**	-0.018**	-0.012*	-0.038**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
τ * State	-0.025**	-0.017**	-0.016**	-0.010*	-0.001	-0.017*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.007)
No. of obs.	19,971	19,971	19,971	19,971	15,142	19,971
No. of firms	4,657	4,657	4,657	4,657	3,781	4,657
R^2	0.756	0.528	0.744	0.659	0.754	…

Russia

	OLS	QREG	RE	FE	2SLS-RE	BB
Foreign	0.693**	0.616**	0.296**	0.107**	0.465**	1.155**
	(0.040)	(0.029)	(0.025)	(0.028)	(0.132)	(0.051)
Mixed	0.299**	0.373**	0.134**	0.093**	-0.012	0.496**
	(0.017)	(0.014)	(0.012)	(0.013)	(0.144)	(0.026)
Private	0.332**	0.383**	0.124**	0.071**	0.006	0.548**
	(0.016)	(0.014)	(0.014)	(0.015)	(0.122)	(0.027)
τ * Foreign	0.131**	0.152**	0.080**	0.068**	0.060**	0.077**
	(0.010)	(0.007)	(0.005)	(0.006)	(0.007)	(0.012)
τ * Mixed	-0.024**	-0.016**	-0.023**	-0.021**	-0.014**	-0.027**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.005)	(0.004)
τ * Private	-0.023**	-0.013**	-0.022**	-0.020**	-0.019**	-0.034**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
τ * State	0.014**	0.021**	0.014**	0.013**	0.002	0.037**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.011)	(0.003)
No. of obs.	153,402	153,402	153,402	153,402	140,658	153,402
No. of firms	26,286	26,286	26,286	26,286	24,595	26,286
R^2	0.681	0.484	0.672	0.595	0.689	…

Notes: Coefficients = estimated log joint effects of different types of ownership relative to state ownership. Standard errors are in parentheses (robust in OLS); * significant at 5%; ** significant at 1%. The estimates are obtained from the translog production function specified in equation (1) and which includes industry dummies, year dummies, and controls for data anomalies. τ is the time since the change in the corresponding ownership status. QREG – median regression, RE – random effects estimator, FE – fixed effects estimator, 2SLS-RE – two stage least squares random effect estimator, and BB – Blundell-Bond system GMM estimator (first four lags of levels and differences in inputs and ownership are used as instruments for differences and levels, respectively). Both 2SLS-RE and BB estimators use exogenous information on ministries under central planning as instruments for endogenous variables.

Table 11: Average Annual Transition Probabilities of Existing Firm Moving Across Efficiency Groups by Ownership Type, 1992-2000

	Czech Republic					Russia			
Foreign									
	Bottom	Middle	Top	Exit		Bottom	Middle	Top	Exit
Bottom	0.782	0.146	0.049	0.023	Bottom	0.504	0.180	0.132	0.185
Middle	0.147	0.648	0.199	0.006	Middle	0.146	0.449	0.327	0.079
Top	0.018	0.137	0.833	0.012	Top	0.028	0.088	0.823	0.062
Mixed									
	Bottom	Middle	Top	Exit		Bottom	Middle	Top	Exit
Bottom	0.782	0.179	0.021	0.018	Bottom	0.694	0.163	0.022	0.121
Middle	0.191	0.685	0.115	0.010	Middle	0.180	0.596	0.168	0.056
Top	0.025	0.233	0.735	0.007	Top	0.036	0.187	0.718	0.059
Private									
	Bottom	Middle	Top	Exit		Bottom	Middle	Top	Exit
Bottom	0.801	0.151	0.018	0.031	Bottom	0.659	0.167	0.023	0.152
Middle	0.223	0.625	0.130	0.022	Middle	0.182	0.578	0.166	0.074
Top	0.019	0.199	0.755	0.027	Top	0.037	0.192	0.695	0.076
State									
	Bottom	Middle	Top	Exit		Bottom	Middle	Top	Exit
Bottom	0.679	0.192	0.056	0.073	Bottom	0.708	0.177	0.020	0.095
Middle	0.233	0.572	0.147	0.048	Middle	0.198	0.562	0.188	0.052
Top	0.042	0.247	0.662	0.050	Top	0.035	0.199	0.711	0.055

Notes: The average annual probabilities are based on a firm-specific measure of productive efficiency (PE) obtained from the standardized residuals of the translog production function estimated for each year separately (1992-2000), with industry dummies and controls for data anomalies included. Based on its individual PE measure, a firm is then categorized each year by where it falls in the distribution of PE's: bottom, middle or top third. All transition probabilities are statistically significant at 5% level (using bootstrapped standard errors), except for a middle-to-exit flow of foreign firms and a top-to-exit flow of firms with mixed ownership in the Czech Republic.

Table 12: Parameters of Conditional (β) Convergence by Firm Ownership

	Czech Republic		Russia	
	OLS	IV	OLS	IV
Ownership=Foreign	0.106***	0.226***	0.340***	0.397***
	(0.020)	(0.083)	(0.030)	(0.118)
Ownership=Mixed	0.013	0.143*	-0.006	-0.023
	(0.021)	(0.076)	(0.008)	(0.014)
Ownership=Private	0.004	0.098	0.003	-0.006
	(0.016)	(0.074)	(0.007)	(0.014)
$Efficiency_{P-1}$	0.869***	0.604*	0.862***	0.983***
	(0.033)	(0.365)	(0.015)	(0.060)
$Efficiency_{P-1}$*Foreign	0.017	0.222	-0.084***	-0.287*
	(0.037)	(0.361)	(0.028)	(0.163)
$Efficiency_{P-1}$*Mixed	-0.091	0.159	0.018	-0.074
	(0.062)	(0.364)	(0.019)	(0.059)
$Efficiency_{P-1}$*Private	0.028	0.298	0.024	-0.042
	(0.035)	(0.371)	(0.018)	(0.062)
No. of obs.	7344	1952	65208	24226
R^2	0.696	0.748	0.598	0.631

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is firm specific (random effect) efficiency estimated on the 2-year panels. Industry and period dummies are included. The omitted category is state ownership. The difference between the third and second lags of the efficiency level is used as an instrument.

Figure 1: Quantile Estimates of Relative Ownership Effects on Efficiency by Period

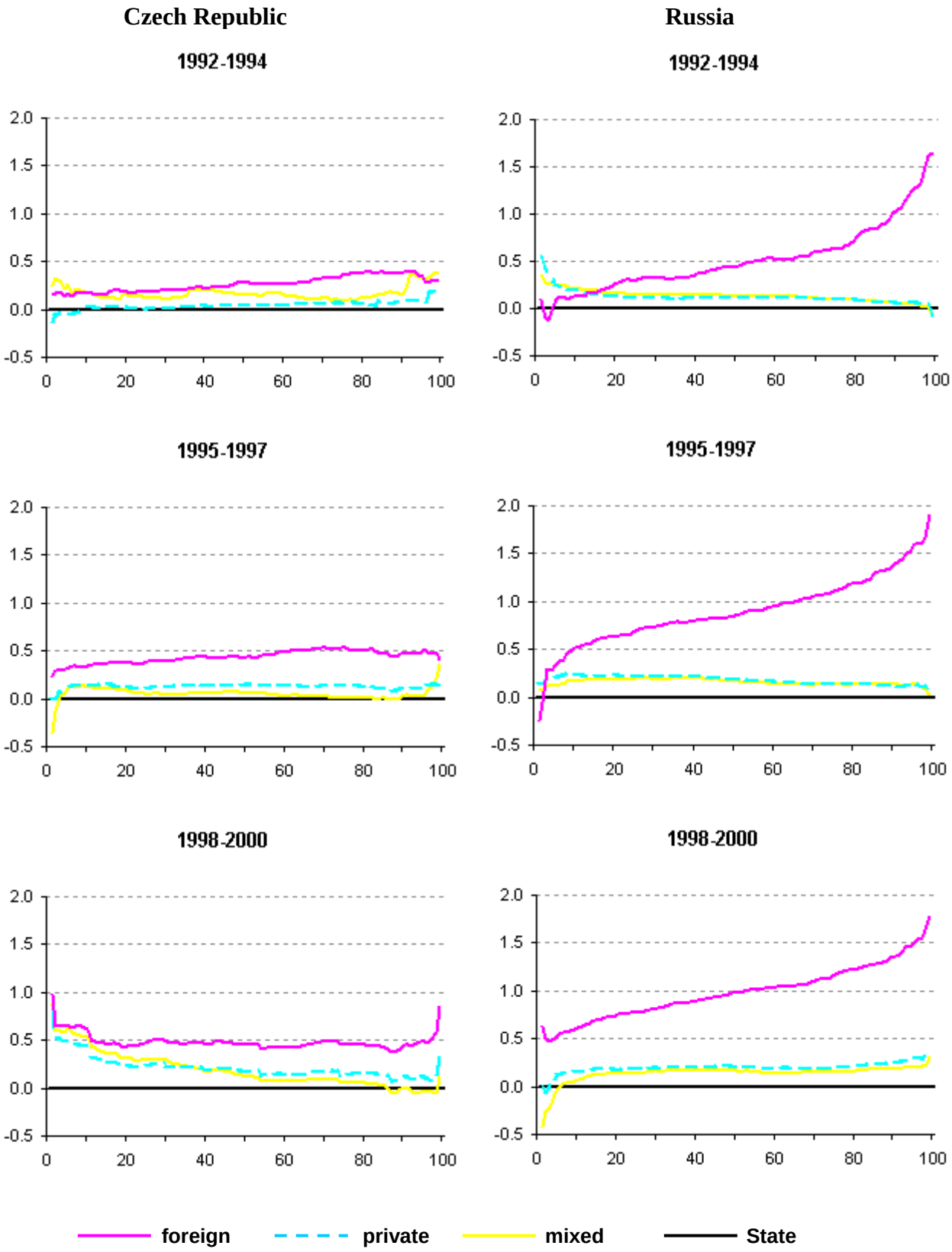


Figure 2: Random Effect Estimates of Relative Ownership Effects on Efficiency by Period

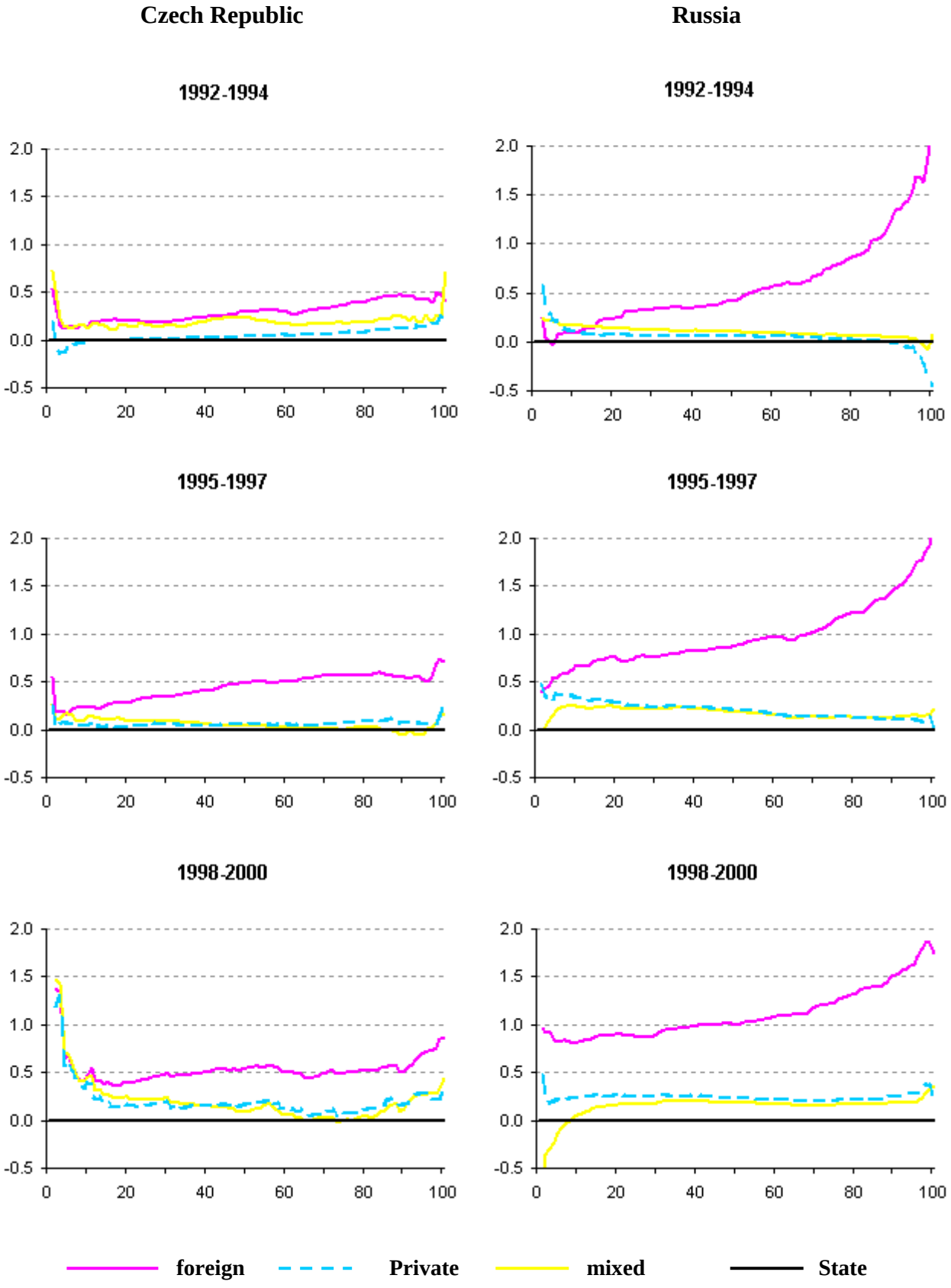


Figure 3: Distance to the Frontier by Ownership and Period

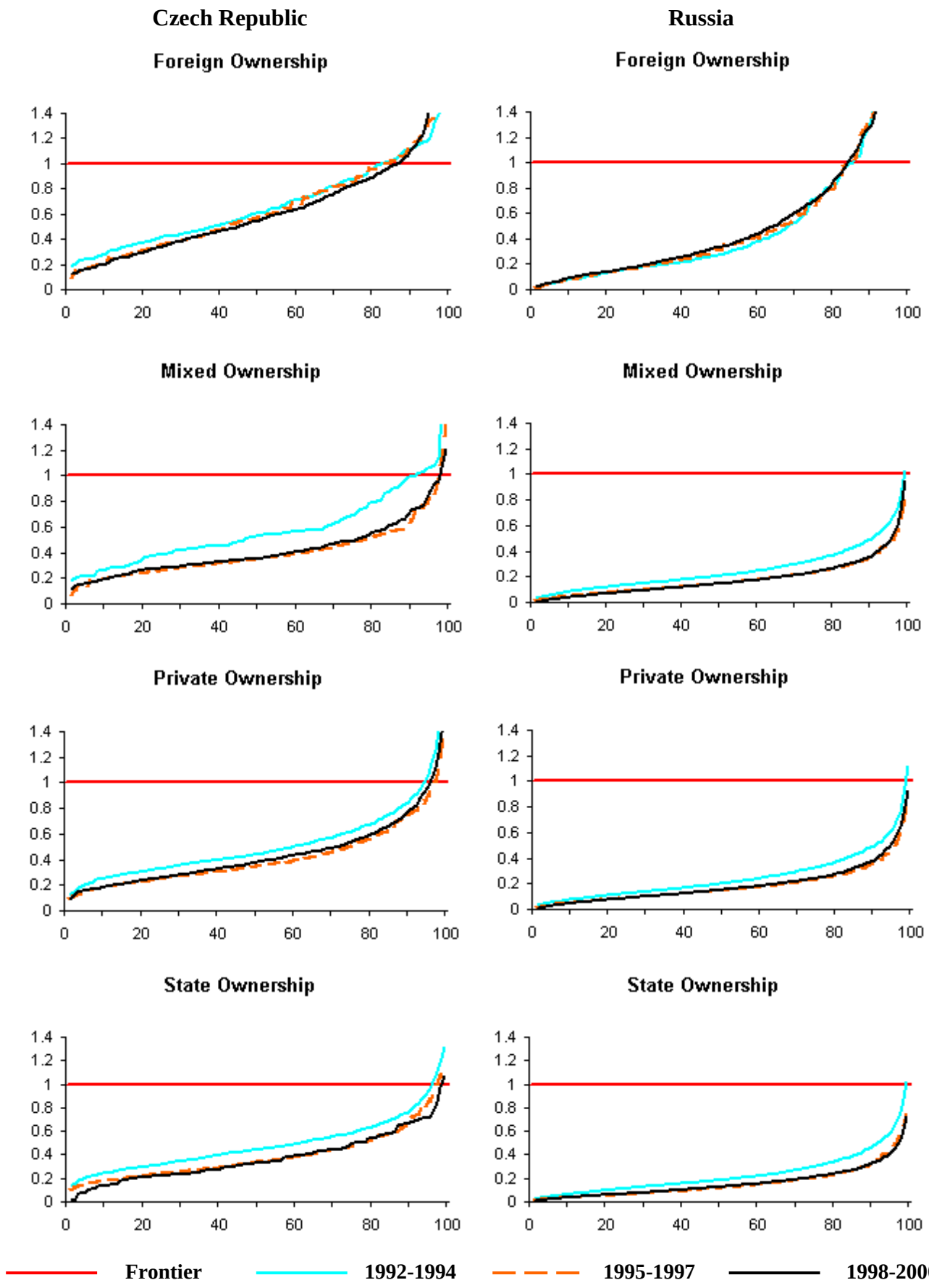
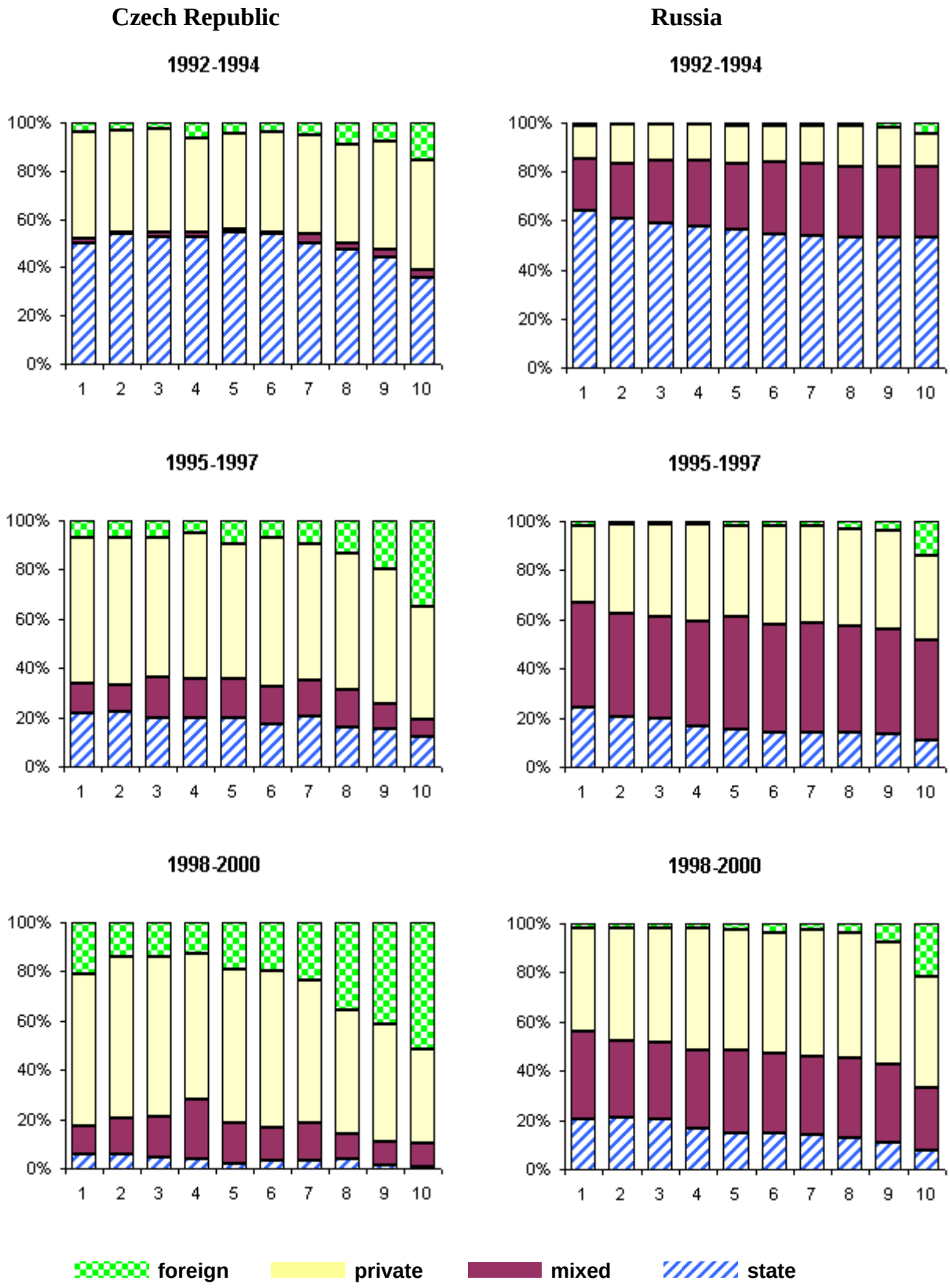


Figure 4: Distribution of Productive Efficiency by Ownership and Period



Appendix 1: Data and Variable Description

The data are drawn from the Annual Registries of Industrial Enterprises, based on the reports of medium and large industrial (mining, manufacturing and utilities) firms submitted to the Russian Statistical Office and the Czech Statistical Office. The data come in different formats over the years and require cleaning. This includes checking for consistency in variables and measurement units, eliminating duplicate observations, finding firms that changed their identification number, and standardizing classifications of industry and ownership. We made every effort to make two data sets comparable in terms of their construction and variable definition. As seen in Appendix Table A1, we start with the statistical offices' data and eliminate firms that are non-industrial, do not have 100 or more employees in at least one year or have missing or unreasonable data (e.g., negative output). In any given year, this leaves us with 1,537-2,970 firms in the Czech Republic and 15,035-19,209 firms in Russia. In the Czech Republic, employment in these firms covers between 86% and 100% of total employment in enterprises with more than 100 employees. In Russia, our sample represents a significant share of total employment outside of the legally defined small enterprises: 89-94% in 1993-95, 81-86% in 1996-97, and 70-73% in 1998-2000.[39] The definitions of the variables are provided in Table A2, while the means and standard deviations of the principal variables are provided in Table A3.

[39] In 1993-95, small industrial enterprises in Russia were defined as having 200 or fewer employees. In 1996-2000, they were defined as for-profit enterprises with average annual employment of 100 or fewer workers and with the share of state or other legal entity in the charter capital not exceeding 25%. The drop in sample coverage in 1998-2000 is mostly due to the exclusion of defense industries and manufacturing of precious metals from the Registry.

Table A1: Construction of the Sample of Firms, 1992-2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Czech Sample									
Initial number of firms[1]	2416	3559	4379	2385	2357	9136	22949	22201	19282
Small firms[2]	454	939	1364	19	16	4791	16688	13294	12064
Non-industrial firms[3]	0	0	0	2	0	0	2634	4721	3260
Firms with missing observations[4]	425	470	45	47	58	2159	1447	1922	1874
Final sample (no. of firms)	1537	2159	2970	2317	2283	2186	2180	2264	2084
Russian Sample									
Initial number of firms[1]	25824	25633	27983	29053	28607	28601	29139	29153	29252
Small firms[2]	7739	6769	7785	8213	8989	9250	10689	10938	11343
Non-industrial firms[3]	872	514	754	970	891	895	963	945	940
Firms with missing observations[4]	580	427	629	661	1589	1768	1404	1392	1934
Final sample (no. of firms)	16633	17923	18815	19209	17138	16688	16083	15878	15035

Notes:

[1] The Czech sample for 1992 and the Russian sample for 1985-2000 constructed from total number of firms at the end of the year, whereas the annual number of firms in the Czech 1993-2000 sample is constructed from quarterly observations.

[2] Firms with less than 100 employees in all years or which have missing values for number employed in all years.

[3] Firms with a non-industrial or unidentified ISIC classification in all years; 5-digit industry codes (OKONKh) for Russian firms were reclassified into new 2-digit ISIC categories.

[4] Missing values and inconsistencies in other key variables: ownership, output and fixed assets.

[5] Czech Statistical Office (2003) and Goskomstat (2001). Total industrial employment includes employment in small enterprises.

Table A2: Description of Variables

Variable	Czech Data	Russian Data
Output	1992: Value of production in current prices of enterprises; 1993-2000 Revenue from own production and services plus change in inventory (without taxes);	Volume of production in current prices of enterprises (without taxes)
Capital	1992: equity 1993-2000: tangible and intangible assets	Average value of fixed productive assets used in industrial production in a given year.
Labor	Average number of fulltime-equivalent employees, adjusted on the basis of an eight hour day.	Average number of industrial employees in a given year -- partial adjustment is made for contracted part-time workers. All others are considered as one.
Ownership	Available for 1991-2000. Defined as more than 50% ownership: 1. Private - includes private local firms, individuals, cooperatives, and NGOs; 2. State - includes federal and municipal ownership; 3. Mixed - combination of any types of ownership with no one category having 50%; 4. Foreign	Available for 1993-2000. Defined as 100% ownership: 1. Private - includes private local firms, cooperatives, and NGOs; 2. State - includes federal, regional and municipal ownership; 3. Mixed - combination of any domestic types of ownership 4. Foreign -- including partial ownership
Startup	=1 when a firm appears in the registry for the first time	=1 when a firm appears in the registry for the first time
Industry - Old Classification	3-digit old industry codes are recoded into 2-digit ISIC	5-digit OKONH (Russian Classification of Industries of the National Economy)
Industry - New Classification	2-digit NACE (some years up to 6-digit) is recoded into 2-digit ISIC	5-digit OKONH is recoded into 2-digit ISIC
Ministry	Available for 1990-1993. 4-digit ministry codes are recoded into 8 ministry categories	Available for 1985-1995. 4-digit ministry codes are recoded into 37 ministry categories

Table A3: Mean Log Values of Output, Capital and Labor, 1992-2000

	Czech Republic			Russian Federation		
	lnY	lnL	lnK	lnY	lnL	lnK
Foreign	10.067	5.516	11.499	0.449	5.412	0.556
	(1.444)	(0.886)	(2.014)	(2.156)	(1.357)	(2.446)
Mixed	10.423	6.111	12.295	0.062	5.779	0.834
	(1.356)	(1.049)	(1.728)	(1.847)	(1.195)	(1.943)
Private	9.348	5.277	10.650	-0.296	5.480	0.195
	(1.132)	(0.761)	(1.615)	(1.652)	(0.989)	(1.795)
State	9.990	6.003	12.441	-0.088	5.642	0.448
	(1.290)	(1.018)	(1.324)	(1.860)	(1.197)	(1.890)
All	9.711	5.567	11.362	-0.089	5.628	0.499
	(1.303)	(0.942)	(1.811)	(1.809)	(1.145)	(1.916)
N of obs.	19,971			153,402		

Notes: Standard deviations are in parentheses. The sample consists of firms with non-missing values on industry, ownership, output, fixed assets, and employment.

Table A4: Estimates of the Translog Production Function, 1992-2000

	Czech Republic		Russia	
	RE	OLS	RE	OLS
lnL	1.322**	1.019**	1.124**	1.452**
	(0.050)	(0.056)	(0.019)	(0.061)
lnK	-0.099**	-0.274**	0.332**	0.327**
	(0.023)	(0.046)	(0.010)	(0.030)
lnL*lnK	-0.021**	-0.013	-0.042**	-0.034**
	(0.005)	(0.008)	(0.002)	(0.005)
lnL^2	-0.013*	-0.008	0.006**	-0.029**
	(0.007)	(0.010)	(0.002)	(0.005)
lnK^2	0.016**	0.026**	0.017**	0.023**
	(0.001)	(0.002)	(0.001)	(0.001)
Ownership				
Foreign	0.319**	0.435**	0.398**	0.994**
	(0.017)	(0.019)	(0.019)	(0.021)
Mixed	0.110**	0.122**	-0.020**	0.124**
	(0.014)	(0.019)	(0.007)	(0.008)
Private	0.115**	0.145**	-0.019*	0.163**
	(0.013)	(0.015)	(0.008)	(0.008)
Industries				
Fuels	-0.729**	-0.915**	-0.829**	-0.826**
	(0.099)	(0.074)	(0.035)	(0.022)
Mining	-0.912**	-1.091**	-0.545**	-0.720**
	(0.072)	(0.052)	(0.039)	(0.021)
Light	-1.111**	-1.147**	-0.554**	-0.581**
	(0.034)	(0.019)	(0.022)	(0.010)
Wood	-1.103**	-1.040**	-0.769**	-0.853**
	(0.045)	(0.027)	(0.022)	(0.008)
Paper	-0.654**	-0.639**	-0.414**	-0.502**
	(0.044)	(0.024)	(0.041)	(0.016)
Chemicals	-0.861**	-0.808**	-0.461**	-0.470**
	(0.037)	(0.023)	(0.031)	(0.015)
Building Materials	-1.054**	-1.088**	-0.616**	-0.671**
	(0.041)	(0.020)	(0.022)	(0.008)
Metals	-0.867**	-0.809**	-0.688**	-0.679**
	(0.030)	(0.018)	(0.025)	(0.012)
Machinery n.e.c.	-1.091**	-1.088**	-0.834**	-0.941**
	(0.030)	(0.017)	(0.022)	(0.009)
Electrical Equipment	-1.031**	-1.107**	-1.113**	-1.211**
	(0.033)	(0.023)	(0.025)	(0.013)
Transport Equipment	-0.951**	-0.987**	-0.795**	-0.842**
	(0.040)	(0.024)	(0.031)	(0.015)
Other Manufacturing	-0.924**	-0.983**	-0.717**	-0.723**
	(0.036)	(0.023)	(0.027)	(0.013)
Electricity	-1.209**	-1.511**	-0.966**	-0.839**
	(0.053)	(0.037)	(0.032)	(0.033)
Non-industrial	-1.025**	-1.004**	-0.824**	-0.889**
	(0.048)	(0.087)	(0.042)	(0.037)
Undefined			-0.949**	-1.165**
			(0.046)	(0.074)
Year 1993	0.196**	0.168**	-0.107	0.810**
	(0.013)	(0.024)	(0.198)	(0.144)

Year 1994	0.232**	0.211**	-0.290	0.563**
	(0.012)	(0.023)	(0.198)	(0.143)
Year 1995	0.286**	0.268**	-0.371	0.458**
	(0.013)	(0.023)	(0.198)	(0.143)
Year 1996	0.289**	0.277**	-0.395*	0.432**
	(0.014)	(0.025)	(0.198)	(0.143)
Year 1997	0.399**	0.466**	-0.350	0.519**
	(0.014)	(0.025)	(0.198)	(0.143)
Year 1998	0.384**	0.450**	-0.619**	0.288*
	(0.025)	(0.042)	(0.198)	(0.143)
Year 1999	0.451**	0.557**	-0.486*	0.468**
	(0.015)	(0.025)	(0.198)	(0.143)
Year 2000	0.527**	0.645**	-0.356	0.635**
	(0.015)	(0.026)	(0.198)	(0.143)
Constant	3.858**	5.235**	-5.797**	-7.466**
	(0.367)	(0.241)	(0.206)	(0.219)
No. of obs.	19,971	19,971	153,402	153,402
No. of firms	4,657	4,657	26286	26286
R^2	0.741	0.754	0.670	0.680

Notes: Standard errors are in parentheses; * significant at 5%; ** significant at 1%. Food industry, state ownership, and 1992 year are omitted categories. In Czech data dummies for the last available quarter and for the number of non-missing quarters are added. In the Russian Federation the regressions also include a dummy for 1992 capital/output mismeasurement and a dummy for 1992 state ownership. In both countries two additional dummy variables were included for data anomalies. RE – random effects estimator. The estimated coefficients on inputs of the underlying translog production function display concavity and monotonicity at the geometric mean values of the variables.

Table A5: Changes over Time in the Efficiency Gains of Foreign Firms Relative to Other Types of Ownership from the Quantile Estimates

Czech Republic

Percentile	Foreign-Mixed		Foreign-Private		Foreign-State	
	95/97-94/92	98/00-95/97	95/97-94/92	98/00-95/97	95/97-94/92	98/00-95/97
10	0.200*	-0.161**	0.038	-0.029	0.160**	0.269**
	(0.090)	(0.048)	(0.056)	(0.040)	(0.004)	(0.004)
25	0.268**	-0.162**	0.085	-0.041	0.189**	0.089**
	(0.089)	(0.053)	(0.055)	(0.043)	(0.004)	(0.005)
50	0.240**	-0.035	0.043	0.001	0.147**	0.018**
	(0.075)	(0.042)	(0.045)	(0.032)	(0.002)	(0.003)
75	0.226*	-0.126*	0.081	-0.081*	0.160**	-0.071**
	(0.089)	(0.053)	(0.053)	(0.041)	(0.003)	(0.005)
90	0.195)	0.018	0.052	-0.049	0.081**	-0.023**
	(0.113	(0.064)	(0.069)	(0.050)	(0.006)	(0.007)

Russia

Percentile	Foreign-Mixed		Foreign-Private		Foreign-State	
	95/97-94/92	98/00-95/97	95/97-94/92	98/00-95/97	95/97-94/92	98/00-95/97
10	0.426**	0.195**	0.346**	0.167**	0.383**	0.100**
	(0.072)	(0.063)	(0.073)	(0.063)	(0.005)	(0.005)
25	0.335**	0.147**	0.273**	0.130**	0.380**	0.089**
	(0.051)	(0.041)	(0.052)	(0.041)	(0.003)	(0.002)
50	0.370**	0.129**	0.318**	0.108**	0.395**	0.130**
	(0.044)	(0.034)	(0.044)	(0.034)	(0.002)	(0.001)
75	0.457**	0.034	0.448**	-0.003	0.481**	0.056**
	(0.045)	(0.032)	(0.045)	(0.032)	(0.002)	(0.001)
90	0.269**	-0.082	0.282**	-0.150**	0.348**	-0.031**
	(0.059)	(0.043)	(0.060)	(0.043)	(0.004)	(0.002)

Notes: Standard errors in parentheses are computed by the Delta method (Greene, 2003); * significant at 5%; ** significant at 1%. All coefficients are significant at 5%, except two: last column first and last rows for Russia. The estimates of the coefficients and covariance matrices are obtained from the Chow quantile regressions of output on capital and labor inputs (translog specification), ownership dummies, industry dummies, and controls for data anomalies.

Table A6: Correlation among the Alternative Measures of Productive Efficiency

	Czech Republic		Russia	
	RE vs. FE	RE vs. 2SLS-RE	RE vs. FE	RE vs. 2SLS-RE
1992-1994				
Overall	0.768	0.920	0.808	0.988
Foreign	0.844	0.917	0.923	0.936
Mixed	0.687	0.913	0.811	0.988
Private	0.799	0.929	0.688	0.986
State	0.731	0.910	0.820	0.990
1995-1997				
Overall	0.753	0.994	0.815	0.995
Foreign	0.858	0.997	0.901	0.987
Mixed	0.674	0.995	0.828	0.997
Private	0.748	0.995	0.763	0.995
State	0.732	0.985	0.840	0.994
1998-2000				
Overall	0.882	0.992	0.910	0.991
Foreign	0.904	0.992	0.930	0.988
Mixed	0.843	0.990	0.922	0.993
Private	0.871	0.992	0.895	0.990
State	0.906	0.989	0.898	0.991

Notes: The efficiency estimates are obtained from the translog production function estimated for each period separately. RE – random effects estimator, FE – fixed effects estimator, and 2SLS-RE – two stage least squares random effect estimator. The specification includes inputs, ownership dummies, industry dummies, year dummies, and controls for data anomalies.

Table A7: Sensitivity of the Distance Measure to the Alternative Definitions of the Frontier

Czech Republic

Frontier =	Top 50% Foreign Firms in Industry				Top 10% Foreign Firms in the Country				Average Foreign Firm in the Country			
Percentile	Foreign	Mixed	Private	State	Foreign	Mixed	Private	State	Foreign	Mixed	Private	State
					1992-1994							
10	0.326	0.327	0.290	0.282	0.212	0.210	0.182	0.185	0.514	0.509	0.441	0.448
50	0.691	0.604	0.508	0.521	0.413	0.385	0.321	0.307	0.999	0.933	0.778	0.744
90	1.314	1.138	0.982	0.894	0.819	0.660	0.593	0.530	1.983	1.598	1.435	1.282
					1995-1997							
10	0.277	0.238	0.223	0.208	0.151	0.139	0.126	0.119	0.424	0.391	0.355	0.336
50	0.697	0.429	0.425	0.408	0.372	0.236	0.240	0.226	1.049	0.663	0.676	0.637
90	1.318	0.789	0.891	0.804	0.800	0.449	0.491	0.462	2.253	1.266	1.382	1.302
					1998-2000							
10	0.240	0.241	0.221	0.175	0.149	0.143	0.132	0.091	0.409	0.395	0.362	0.251
50	0.661	0.436	0.455	0.400	0.380	0.241	0.260	0.219	1.047	0.664	0.715	0.604
90	1.298	0.851	0.909	0.774	0.748	0.508	0.539	0.446	2.059	1.397	1.482	1.226

Russia

Frontier =	Top 50% Foreign Firms in Industry				Top 10% Foreign Firms in the Country				Average Foreign Firm in the Country			
Percentile	Foreign	Mixed	Private	State	Foreign	Mixed	Private	State	Foreign	Mixed	Private	State
					1992-1994							
10	0.119	0.126	0.122	0.104	0.029	0.032	0.030	0.027	0.252	0.275	0.259	0.233
50	0.413	0.313	0.300	0.280	0.099	0.072	0.069	0.065	0.855	0.622	0.594	0.562
90	1.829	0.695	0.690	0.659	0.588	0.163	0.155	0.155	5.092	1.414	1.339	1.341
					1995-1997							
10	0.111	0.069	0.075	0.053	0.037	0.024	0.026	0.019	0.254	0.164	0.181	0.128
50	0.459	0.220	0.217	0.186	0.140	0.070	0.071	0.058	0.968	0.480	0.491	0.400
90	1.844	0.555	0.518	0.548	0.646	0.167	0.164	0.147	4.449	1.152	1.129	1.012
					1998-2000							
10	0.128	0.057	0.068	0.053	0.046	0.021	0.025	0.020	0.268	0.126	0.150	0.119
50	0.473	0.205	0.213	0.192	0.164	0.072	0.077	0.060	0.966	0.426	0.451	0.356
90	1.738	0.501	0.532	0.468	0.674	0.177	0.191	0.148	3.968	1.045	1.125	0.871

Notes: The efficiency estimates are obtained from the translog production function estimated with the random effect estimator for each period separately. The specification includes inputs, ownership dummies, industry dummies, year dummies, and controls for data anomalies. Percentiles are constructed from the distribution of the firm-specific distance to the frontier for each ownership type. For example, in Russia during the 1992-1994 period, private firms at the 50^{th} percentile reach only 30% of the efficiency level of the top 50% foreign firms in a corresponding industry or 7%of the efficiency of the top 10% of all foreign firms in the country.

Table A8: Distribution of Efficiency by Decile, Ownership, and Period, %

Czech Republic

Deciles	1992-1994				1995-1997				1998-2000			
	State	Mixed	Private	Foreign	State	Mixed	Private	Foreign	State	Mixed	Private	Foreign
1	50.3	1.4	44.8	3.6	21.9	12.1	58.8	7.2	5.8	11.5	61.8	21.0
2	53.9	0.9	42.2	3.0	22.5	10.6	60.1	6.8	5.5	14.6	66.0	14.0
3	52.3	2.0	43.0	2.7	19.7	16.5	56.7	7.1	4.6	16.5	65.0	13.9
4	52.6	1.8	39.3	6.3	19.6	15.9	59.1	5.3	4.0	24.0	59.1	12.9
5	54.6	1.5	39.3	4.7	19.6	15.9	54.9	9.6	1.7	17.0	62.3	19.0
6	53.8	1.1	41.4	3.8	17.2	15.4	60.6	6.8	3.5	13.1	63.4	20.0
7	50.2	3.6	40.9	5.3	20.5	14.8	55.2	9.6	3.4	15.1	58.2	23.4
8	47.3	2.6	41.0	9.2	16.1	14.9	56.0	13.1	4.0	10.0	50.5	35.5
9	44.4	2.7	45.2	7.7	15.2	10.2	54.7	19.9	1.4	9.7	47.5	41.5
10 (Best)	35.8	3.2	45.4	15.6	11.8	7.4	45.6	35.3	0.8	9.2	38.5	51.5
Total	49.5	2.1	42.2	6.2	18.4	13.4	56.2	12.1	3.5	14.1	57.2	25.3

Russia

Deciles	1992-1994				1995-1997				1998-2000			
	State	Mixed	Private	Foreign	State	Mixed	Private	Foreign	State	Mixed	Private	Foreign
1	64.1	21.1	13.4	1.4	24.0	42.7	31.5	1.8	20.3	35.5	42.5	1.7
2	61.2	22.5	15.6	0.8	20.2	42.1	36.4	1.3	20.9	31.4	45.9	1.8
3	58.7	25.6	14.9	0.8	19.6	41.4	37.7	1.4	20.2	31.6	46.3	1.9
4	57.6	26.8	15.0	0.7	16.3	42.7	39.5	1.5	16.3	32.1	49.7	2.0
5	56.6	27.0	15.4	1.0	15.2	45.7	37.2	1.9	14.9	33.7	49.0	2.4
6	54.8	28.9	15.1	1.2	14.1	43.8	40.1	2.0	14.5	32.4	49.4	3.8
7	53.9	29.4	15.6	1.1	14.2	44.5	39.1	2.2	14.3	31.8	51.4	2.5
8	53.4	28.6	17.0	1.0	13.8	43.6	39.8	2.9	12.7	32.3	50.8	4.1
9	53.0	29.2	15.9	1.9	13.4	42.7	40.2	3.7	10.8	31.8	50.0	7.4
10 (Best)	53.5	28.3	13.6	4.6	10.7	40.9	34.1	14.3	7.6	25.3	45.3	21.8
Total	56.7	26.7	15.2	1.4	16.1	43.0	37.6	3.3	15.3	31.8	48.0	4.9

Notes: The efficiency estimates are obtained from the translog production function estimated with the random effect estimator for each period separately. Deciles are constructed from the overall distribution of estimated random effects.