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

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**Abstract**

Economic development implies that the efficiency of firms in developing countries starts approaching that of firms from advanced economies. Various development policies have been pursued to achieve this convergence. We test for this convergence in two economies that represent alternative models of implementing market-oriented development policies: the Czech Republic and Russia. Using 1992-2000 panel data on virtually all medium and large industrial firms in each country, and accounting for endogeneity of ownership, we find that foreign ownership markedly improved the efficiency of firms, whereas domestic private ownership did not; domestic firms are not catching up to the (world) efficiency standard given by foreign-owned firms. This is due in part to a slower growth of efficiency in domestic firms over time. However, foreigners' acquisitions of more efficient domestic firms are also contributing to the gap. Domestic firms closer to the frontier are not more likely to catch up than firms further from the frontier, although foreign firms do exhibit this behavior. The distance of the Russian firms to the efficiency frontier is much larger than that of the Czech firms. Nevertheless, after nearly a decade of reforms, neither model of development has resulted in convergence of domestic firms to the world standard.

*JEL classification*: 01, C33, D20, G32, L20

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## 1. Introduction

Economic development is often viewed as a process through which living standards in poor countries converge to those of the rich countries.[1] A necessary condition for this convergence is that the efficiency of firms in developing countries starts approaching the efficiency of firms in advanced economies. The need for efficiency improvement becomes especially relevant as globalization induces more intense worldwide competition. The development policies pursued over the last three decades by many governments included privatization of state-owned enterprises (SOEs), stimulating the entry of new firms, and encouraging foreign direct investment (FDI) and trade. Given the depth and breadth of initial distortions and the fundamental nature of subsequent reforms in the formerly centrally planned and state-owned transition economies, one may expect the positive effects of globalization and market-oriented policies to be even larger and more detectable in these countries than in other developing economies. In this paper we examine whether these policies have propelled domestic firms in two prototypical transition economies to converge to the world standard.

The implementation of market-oriented development policies in the transition economies has been subject to debate. One group 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 transition (e.g., Stiglitz, 1999). Others claim 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 maintains that an increase in competition encourages innovative behavior of firms and countries that are near the efficiency frontier but stifles those that lag significantly behind (e.g., Aghion *et al.*, 2005 and 2008; Acemoglu, Aghion, and Zilibotti, 2002 and 2006).[2] Finally, a model by Monge-Naranjo (2008) proposes that in the short-run FDI reduces the efficiency of

[1] This "convergence" view in development economics dates at least as far back as W. Arthur Lewis (1955).

[2] Interestingly, over three 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 (2010) for a review.

domestic firms and increases the dispersion of their efficiency, but in the long run domestic firms catch up with firms in the developed world.

At the micro level, there is a literature questioning whether firms privatized to domestic owners have become more productive than SOEs and whether foreign ownership improves efficiency in the emerging market economies. The evidence from numerous studies has shown that firms with foreign ownership are more productive than domestic firms in all parts of the world.[3] However, the evidence on the performance effects of privatization is mixed, ranging from those that find no or limited systematic effect (e.g., Bevan, Estrin, and Schaffer, 1999; Hanousek, Kocenda, and Svejnar, 2007), to those that cautiously conclude that privatization improves firm performance (Megginson and Netter, 2001), and those that confidently conclude that privatization improves performance (Djankov and Murrell, 2002; Shirley and Walsh, 2000).[4] In a recent survey of the evidence from transition economies, Estrin, Hanousek, Kocenda, and Svejnar (2009) draw on a number of studies, including the present one and a contemporaneous study by Brown, Earle and Telegdy (2006), and conclude that privatization to foreign owners has a positive effect, while the effect of privatization to domestic owners is ambiguous.

We examine the evolution of efficiency of industrial firms in two alternative prototypes of transition economies – the Czech Republic and Russia. The two countries constitute useful case studies because they maintained central planning and virtually no private ownership and FDI inflows until the start of the transition, both rapidly privatized most state assets, and yet they otherwise pursued very different paths in opening the economies to market forces.[5] 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 establishing institutions, rules and regulations that make a country eligible for accession to the European

[3] See e.g., Caves (1974) for one of the first papers in this literature; Terrell and Svejnar (1989) for evidence in Senegal; Aitken and Harrison (1999) for evidence in Venezuela; and Djankov *et al*. (2002) and Estrin et al. (2009) for evidence in transition economies.

[4] There is also a literature on the effects of nationalization (see e.g., Cole, 2009).

[5] 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 FDI.

Union. Russia represents the 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 harmonizing them with those of the European Union.[6] Unlike earlier studies, we have data for a relatively long period (nine years) after the start of the reforms and can hence explore issues and perform tests that could not be carried out earlier.

We use the efficiency of foreign-owned firms in each country as the benchmark for the world standard. This choice reflects the finding by Helpman, Melitz and Yeaple (2004) that it is the most efficient firms in advanced economies that engage in FDI. By the mid-1990s, foreign-owned firms were well established in all the major sectors of the two economies and it is therefore plausible that the best ones were operating at the world standard.[7] Moreover, using the performance of foreign-owned firms in each country as a proxy for the world efficiency standard is superior to using the performance of 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 by problems related to carrying out comparisons in the presence of wide exchange rate fluctuations and other cross-country conversion issues.

The performance of domestic firms in emerging markets may lag behind that of foreign firms for a number of reasons, including lower efficiency in generating output from inputs, inability to charge high prices due to lower product quality or inferior marketing, fewer intangible assets, higher cost of capital, more frequent location in highly competitive industries, more inefficient vertical integration, and smaller extent of outsourcing. In order to capture as many of these factors as possible, we focus on revenues of the firm as our dependent variable, examining the evolution in efficiency with which firms with different ownership generate revenues from inputs. Our approach thus allows for domestic firms to be catching up over time

[6] For example, in 1997 the Business Environment and Enterprise Performance Survey carried out by the World Bank and the EBRD (1999, 2002) 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.

[7] If the best foreign-owned firms were below the frontier, then we would underestimate the gap that domestic firms need to cover to catch up. Since we find a lack of catch-up *vis a vis* the foreign-owned firms, our results would be even stronger if the frontier were higher.

on account of any of the aforementioned factors. Since transition is a dynamic process, we do not presume that firms are in a technical or economic steady state, but rather that they are trying to improve their performance by discovering new methods of production, importing technologies, launching new products, learning new managerial and marketing techniques, and establishing their brand names.[8]

Our findings are based on comprehensive panel data drawn from the Registries of Industrial Enterprises of the Russian and Czech Statistical Offices. Our samples approach the populations of large and medium-sized industrial enterprises and cover the period of 1985-2000. Aside from Brown et al. (2006), no other study uses such comprehensive data on manufacturing firms with as many annual observations as we do.

The study by Brown et al. (2006) examines the effects of privatization in Hungary, Romania, Russia and Ukraine over the 1985-2002 period. Our study differs from Brown et al. (2006) in five important respects. First, we include data on both old and new firms rather than using only firms that existed under communism. As may be seen from Table 1, new firms represent a large share of all firms and including them hence provides a more accurate picture of what has happened in these economies. In particular, we are able to examine the nature of the gap between all private and state-owned firms and distinguish the privatization effect from the start-up effect on performance. Second, rather than estimating just the central tendency, we also examine the efficiency effects of ownership across the distribution of firms by efficiency, using quantile analysis. Third, unlike Brown et al. (2006), we handle more systematically the important issues of endogeneity of ownership and input choice, and we do so in several different ways. Brown et al. try to tackle the problem of endogeneity by allowing for firm-specific fixed effects (FE) or linearly time-varying firm effects (FE&FT). Their approach controls for input endogeneity to the extent that input use is correlated with fixed or linearly time-varying unobserved firm-specific effects. It also controls for the possibility that foreign firms may acquire domestic firms that are more efficient and have a different linear trend in the rate of

[8] While providing some evidence related to the reallocation of resources across firms (e.g., acquisitions), we do not examine this topic in the present paper.

change of efficiency. However, their method does not control for other unobserved types of productivity differences, such as nonlinear effects. Since the transition induced a highly nonlinear (U-shaped) performance in all the economies and industries, allowing only for linear effects may not be an adequate way to tackle endogeneity. Moreover, using FE or FE&FT increases considerably the noise-to-signal ratio in the data and makes it difficult to discern if statistically insignificant coefficients are caused by the absence of an effect or by the noise induced by the estimation procedure. We tackle the endogeneity of ownership in four alternative ways -- by using three different sets of instrumental variables (IVs) and a weighted matching (WM) method. We also handle the endogeneity of input choice by estimating random and fixed effects equations, as well as the Levinsohn and Petrin (2003) and Blundell and Bond (2000) models. Fourth, we check the robustness of estimated ownership effects by using different measures of foreign ownership and we control for the fact that foreign investors may locate in less competitive industries. Fifth, unlike Brown et al. (2006), we examine if the dynamics of firm efficiency varies with ownership and proximity to the efficiency frontier. Specifically, we estimate whether firms with different types of ownership have different probabilities of moving to the frontier, converge to different steady state levels of efficiency or converge to their steady state level at different speeds.

We first estimate the average efficiency effects of the four different types of ownership (foreign, domestic private, state, and mixed) during the entire 1992-2000 period, checking the robustness of our results with several estimation methods. We next allow the efficiency of firms with different ownership to vary linearly and quadratically over time and also estimate the efficiency effects of ownership over three sub-periods characterizing the early (1992-94), middle (1995-97) and mature (1998-2000) transition.[9] Our findings for the entire 1992-2000 period are

[9]In these three sub-periods market institutions increasingly take hold and different shocks occur. In Russia problems such as the overvalued ruble, lack of enterprise restructuring and non-payment of liabilities diminished by 1998, but the country experienced a financial crisis in August of that year. (Interestingly, the effects of this crisis were relatively short as the value of the ruble stabilized and GDP growth resumed within two quarters.) The 1998-2000 period in Russia is hence already one of relatively mature transition. In the Czech Republic, mass privatization, price liberalization and macro stabilization were completed by 1995. A recession set in 1996-1997 but the 1998-2000 period was one of renewed economic growth and mature reforms as the country was preparing for entry into EU.

sobering: while the average efficiency effect of foreign ownership relative to state ownership (our base) is positive and large in both countries, the effect of domestic private and mixed ownership compared to SOEs is only about 0-11% in the Czech Republic and it is negative (about 3-8% in our preferred specifications) in Russia. Moreover, in the Czech Republic foreign owned firms experience a faster annual rate of increase in efficiency than all domestically owned firms, while firms with mixed ownership register a rate of increase that falls between that in foreign owned firms and SOEs or does not differ from that in SOEs. In Russia, all four types of firms experienced a U-shaped profile in efficiency change. In some estimation methods, non-state owned firms experience a deeper (more convex) U-shaped profile, with foreign firms' efficiency falling faster, reaching an earlier turning point and rising faster thereafter than all other types of firms. In examining how firms alter efficiency after changing ownership, we find foreign owners substantially improved efficiency relative to the SOEs, while firms with mixed and private ownership did somewhat better or not significantly better than the SOEs. Our results are similar to those of Brown et al. (2006) in the finding that foreign ownership improves performance, while domestic ownership improves it in CEE but worsens it in CIS. We differ from Brown et al. (2006), however, in that we find that the effect of privatizing to foreign owners is much larger in Russia than in the Czech Republic, while Brown et al. (2006) do not find these effects to be different across countries. Moreover, we show that estimates based on the three types of IVs yield larger coefficient estimates that those based on FE (and by implication also FE&FT) used in Brown et al. (2006).

In examining the relative performance of the firms with different types of ownership at various points of the distribution of efficiency, we find that: a) foreign firms are considerably more efficient than all three types of domestic firms at most levels of the distribution, b) the gap between the efficiency of the foreign firms and all three types of domestic firms is greatest at the top of the efficiency distribution, and c) compared to the Czech Republic, the efficiency gap between the foreign and domestic firms in Russia is much larger throughout most of the distribution and increases more rapidly from the worst to the best firms.

Overall, the average gap between the foreign and domestically owned firms is not only not closing – it is increasing over time. The results also suggest that privatization to domestic owners did not have a major efficiency-enhancing effect during the first post-privatization decade. Moreover, the estimates for the three sub-periods 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. These results are buttressed by our estimates of conditional ($\beta$) convergence, which show that in both countries foreign owned firms converge to a higher steady state level of efficiency than the three types of domestic firms and that in Russia the foreign firms are also converging faster than the domestic ones.

Are our findings driven by differences in the starting positions of foreign and domestic firms or by differences in the rates at which they raise efficiency over time? We find that existing foreign firms are more efficient than foreign startups, a finding which is consistent with the fact that foreign firms improve their efficiency with experience (over time). Some estimates also suggest that foreign startups are more efficient than domestic startups, but others suggest that this is not the case. Domestically owned startups appear to be more or equally efficient as existing domestic firms in the Czech Republic, but they are less or equally efficient as existing domestic firms in Russia. Finally, we demonstrate that foreign firms tend to acquire somewhat more efficient domestic firms rather than acquiring less efficient firms and turning them around.

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 examine the key 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 the key stylized facts by estimating the differences in efficiency across ownership types and examining how these differences have changed over time at the mean and at various points in the ownership-specific efficiency distributions.

As we show in Table A1 of the web appendix, we use industrial firms with 100 or more employees in at least one year. We restrict the firm size because the data on smaller firms are not fully representative.[10] 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 a year in Russia. In the Czech Republic, employment in these firms covers between 86% and 100% of total employment in firms with more than 100 employees. The Russian sample represents between 70% and 94% of total employment outside the legally defined small firms.

We have carefully examined the data, removed inconsistencies in variable definitions and measurement units, and standardized as much as possible the classification of industry and ownership across the two countries. For example, we made the industry categories comparable between the two countries by recoding the 5-digit OKONKh Russian Classification of Industries and the 2-digit NACE Czech Industry Classification into 2-digit ISIC codes. The definitions of the variables are provided in the web appendix Table A2 and discussed further below. We have also improved the panel nature of the data by using information from previous years and from other registries to find firms that changed their identification number. In particular, in the early 1990s firms that changed their legal status could also change their identification number. We matched these firms to their parent firms by using previous year's information on name, address, and values of variables.

### *2.1. Average Efficiency Gaps for 1992-2000*

Our principal results are derived from an overall translog revenue function, which in our data statistically dominates more restrictive functional forms:

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

[10] We carried out baseline estimations on data including the smaller firms and the estimates were not materially different.

where $y_{it}$ represents the revenue of firm $i$ in period $t$, $x_{ikt}$ is a vector of $k$ inputs, $Z_{it}$ is a vector of ownership categories, $I$'s and $T$'s denote sets of dummy variables for industries and years, respectively, $v_i$ are unobserved time-invariant firm-specific effects, and $\varepsilon_{it}$ is an independently distributed error term.[11] The baseline specification allows efficiency to vary across types of ownership, industries and time.

As mentioned earlier, we use revenue as our main dependent variable in order to capture the change in firm performance in a number of dimensions, including improved productive efficiency and ability to charge higher prices on account of marketing and improved product and brand development, differences in intangible assets and the cost of capital, location in more or less competitive industries, efficiency of vertical integration, and the extent of outsourcing. In order to control for time-varying differences in revenue across industries, we deflate each firm's revenue by a two-digit industry-specific producer price index. We hence focus on how efficiently firms generate sales revenue, taking into account inputs and industry-level price. This is equivalent to total factor productivity but broader in that it also captures improvements in pricing within industry and the other aforementioned aspects of revenue generation. Note that our approach is in fact identical to most productivity analyses using firm-level data since very few of these studies have firm-level prices. We emphasize that this traditional approach to measuring performance allows for the efficiency of different types of firms to vary on account of any of these factors.

In most of our analysis, we use two inputs: capital and labor. For capital, we use the average nominal 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. Ideally, we would like to include material inputs as a regressor, but we do

[11] As we discuss in the web appendix Table A2, we also include several dummy variables to control for potential outliers and major events.

not have information on this variable for the entire 1992-2000 period in Russia. However, we report robustness checks of our ownership effects for the entire Czech and smaller Russian data set in which material inputs are included in estimation.

We use four categories of firm ownership: private (domestically owned), state, mixed, and foreign. In Russia, the 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 majority 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 (and often do) have minority ownership by foreign investors. In order to enhance cross-country comparability, we collected additional data for Russia on ownership categories that are comparable with those in the Czech Republic.[12]

As may be seen from Table 1, whether measured by the number of firms, share of employment, or share of output, both countries display a pattern of declining state and rising private ownership during the 1990s. However, the share of firms with foreign ownership is much smaller in Russia despite the more inclusive definition of this category. For example, in 2000 the Russian share of foreign firms is about one-fifth of the share in the Czech Republic. In both countries the average foreign firm is larger in terms of both employment and output than the

[12] In particular, this dataset covers the same firms but for 10.3% of foreign firms we do not have data on the exact share of foreign ownership and hence assign them into a separate (unknown) ownership category during estimation.

average domestic firm. Note, however, that in the mid 1990s foreign firms in Russia included relatively small firms, so that the foreign share in the number of firms exceeded the foreign share in employment and output. When we measure foreign ownership in a comparable way to the Czech Republic, we find in the web appendix Table A6 that the share of majority foreign-owned firms in Russia is on average only 1.13% (i.e., much less than the share reported in Table 1).

In examining the share of new firms in Table 1, we observe that new private firms played a strong part from early on in the Czech Republic and increasingly so in Russia. In particular, firms established after 1992 constitute the vast majority of foreign firms in each country and also the vast majority of domestically owned private firms in the Czech Republic. Among the domestically owned firms in Russia, the new firms constitute less than one-quarter in 1996 but over one-third in 2000.

*Endogeneity Issues*

As with any estimation, endogeneity of regressors is an important issue. The complication in analyses of privatization is that the common problem of input endogeneity is entwined with the potential correlation between ownership types and the unobserved firm-specific efficiency. 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 $\forall\ t > s$. Unobserved firm-specific productivity could determine the ownership type by influencing the governments' decisions to privatize or investors' decisions to acquire the firm. Moreover, potential new owners may respond to past productivity shocks. Thus, ownership enters equation (2) as a predetermined variable that may be correlated with past shocks ($\varepsilon_{is}$) and with firm-specific

unobservables ($v_i$) but not with present errors – $E(Z_{it}\varepsilon_{is}) \neq 0$ for $\forall \ \ t > s$, $E(Z_{it}v_i) \neq 0$, and $E(Z_{it}\varepsilon_{it}) = 0$.

Under these conditions, the OLS and random effects (RE) estimators may be biased and inconsistent. The fixed effects (FE) and first difference (FD) estimators allow for the correlation of $Z_{it}$ with $v_i$ but aggravate the measurement error by increasing the noise-to-signal ratio (e.g., Griliches and Hausman, 1986), thus often leading to insignificant estimates of ownership effects.[13] In addition, the first differencing equation makes ownership endogenous as $E(Z_{it}\varepsilon_{i-1}) \neq 0$ leads to $E(Z_{it}-Z_{it-1},\ \varepsilon_{it}-\varepsilon_{it-1}) \neq 0$. We therefore do not generate FD estimates and treat the FE estimates with caution.

To address the endogeneity of inputs, several treatment methods have been proposed, including the Blundell-Bond (2000) system GMM estimator (henceforth BB), the Olley-Pakes (1996) investment proxy estimator and the Levinsohn-Petrin (2003) intermediate input proxy estimator (henceforth LP). Of these, we use the BB and LP methods.

There are no similar methods to treat the problem of endogeneity in ownership. Interestingly, largely because of the lack of valid instruments for ownership, the most common practice in the privatization literature has been to use OLS, RE or FE estimators.[14] We use three IV approaches and the WM method to address the issue of potential endogeneity of ownership.

Our first IV approach exploits the fact that we have information on the firms' supervisory ministries under central planning. These ministries were in charge of specific SOEs for many years (decades). With the regime change in the early 1990s, the ministries lost control over the firms in their jurisdiction and were no longer informed about their performance. In particular, they were no longer able to give binding orders, transfer resources and obtain detailed

[13] 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 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. RE estimates use within and cross sectional information and are hence less affected by this problem.

[14] See Hanousek et al. (2007) for an exception.

information about the performance of the firms in the rapidly changing environment.[15] Yet, the individual ministries were key in determining the timing, extent and nature of privatization during the 1990s. In Russia there were over one hundred independent ministries (aggregated to thirty seven in our data) operating at the federal, regional and municipal levels of government. Given their independence and different regional jurisdictions, their privatization decisions were quite idiosyncratic – e.g., the federal ones were more likely to be motivated by maximizing the revenues from privatization and the local ones by generating employment.

In our first IV estimator, we use ministry categories (along with year dummies) to estimate a binary (probit) ownership model for each ownership type and then apply the fitted ownership probabilities from the probit as instruments for actual ownership categories; the model is hence exactly identified.[16] The chi-squared-test values of the ministry dummy variables in the first stage equation (reported in Table 2) indicate that they are very good predictors of the ownership categories. The predicted probabilities have 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). Since new firms do not have a supervisory ministry from the communist era, we assign them a separate dummy variable that reflects the common licensing and other conditions that they have to fulfill to start business. At a more informal level, we also check that ministries that would be expected to be associated with particular types of ownership changes indeed are more likely to be associated with them than others. For example, we find that shifts from state to foreign ownership are more likely to be observed in ministries dealing with firms (e.g., ministries of industries) than those dealing with strategic institutions (e.g., ministries of foreign affairs or interior).

[15] 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.

[16] Besides fitted ownership probabilities, the first stage includes all the second stage variables. To preserve space, the full 1st stage results are reported in the web data appendix.

While idiosyncratic ministries that lost control over firms but approved privatization projects are appealing instruments, one might wonder if firms of each ownership type under different ministries were not systematically different, thus inducing correlation between ministry dummies and the error term. As a result, we also use an IV procedure in which we instrument ownership with time-varying regional data on the outcome of regional elections and the rate of unemployment. The arguments for using these two variables as IVs are that (a) regional leaders from right-of-center (reform-oriented) parties are more likely to privatize and attract new private firms (domestic and foreign) than leaders elected from the left-of-center (communist-type) parties; and (b) in regions where unemployment is higher, there will be more resistance to privatization and lower probability of entry of new private firms.[17] For both countries we have collected data on the outcomes of regional elections and on regional unemployment rate (seven regions in the Czech Republic and eighty nine regions in Russia). For the Czech Republic, we also use the municipal share of seats in the Czech parliament and the percentage of seats held by Communist-type Parties for each municipality. In Russia, political variables include four dummy variables indicating whether the current regional governor is a former regional administrator with no party affiliation or whether he/she represents the communist-type parties, reform-oriented parties, or other parties. In both countries, the chi-squared-test values for the unemployment rate and political variables in the first stage equation are high and statistically significant (see Table 2 and web appendix tables A8-A11 for complete 1$^{st}$ stage results).

Of course, while the unemployment rate and political variables are in many respects appealing as IVs, one might imagine scenarios where they are correlated with the error terms in the main regression in other ways than only via ownership. A right-leaning government might for instance implement policies that affect productivity of firms and not just affect productivity by increasing the likelihood of privatization. High unemployment might influence local economic conditions in ways other than by influencing privatization probabilities. Both variables

[17] See Gupta, Ham and Svejnar (2008) for a political economy model that high unemployment regions delayed privatization. Jurajda and Terrell (2009) provide empirical evidence for four transition economies (Bulgaria, Czech Republic, Hungary and Ukraine) that foreign direct investment is more likely to flow to regions with high human capital and low unemployment than to regions with low human capital and high unemployment.

could also in principle be affected by the productivity of local firms. In view of the fact that one could imagine situations where the industry IVs (supervising ministries) and the regional IVs (unemployment and political variables) are correlated with the error term, we have also used the interaction between the supervising ministries and the regional characteristics (unemployment and political variables) as a third set of IVs. For these IVs it is much harder to think of stories that would imply correlation between them and the error term in the main regression.

Finally, in addition to using the three IV approaches, we also employ the matching and impact evaluation methods pioneered by Rosenbaum and Rubin (1983). In our context, we consider private firms (domestic, foreign and mixed) as a treatment group and state-ownership as the control group. Rosenbaum and Rubin (1983) showed that if treatment is randomized conditionally on the observed covariates, then it is randomized conditional on the (scalar) propensity score, i.e., the conditional probability of treatment given the observed covariates. A large econometric literature has subsequently developed various matching techniques.[18] Based on recent work by Busso (2008), we use a weighted matching (WM) technique. In this approach, state-owned firms at time *t* that have similar characteristics as firms that are private (domestic, foreign or mixed) at time *t* are given more weight in the estimation as they are seen to be a better "match" or "control" group. Specifically, we estimate the conditional probability of being in a control group, $\hat{p}(X_{it})$, for each firm in each year using a multinomial logit model (where 0 = state-owned; 1 = foreign private; 2 = domestic private; 3 = mixed) with observed firm characteristics such as firm size (log of inputs), industry, ministry, party in power in the region, and regional unemployment rate. We follow the standard empirical approach of trimming observations with extreme values of the propensity score outside the interval [0.01, 0.99] (Crump et al., 2008). We compute $\omega_{it} = 1/\hat{p}_{it}$ for each observation in the control group and $\omega_{it} = 1/(1-\hat{p}_{it})$ for each observation in the treatment group, and then apply the propensity score

[18] For example: pair matching shares, nearest-neighbor matching, kernel matching, etc.

weights to the estimating revenue equation with firm fixed effects and firm-clustered standard errors.[19]

Overall, we note that our use of the three sets of IVs and the WM approach represent a step in the right direction, given that we use entire populations of medium and large industrial firms and most other studies in this area have not used the IV or WM approach. Moreover, while future studies may use randomized experiments and hence be even better identified, they are likely to suffer from the problem of having small samples with limited external validity. As usual, the reader should make his/her judgment on the basis of the full evidence presented in this and other papers.

*Basic Findings for Average Gaps*

The estimates of average efficiency effects by ownership for the Czech Republic and Russia during 1992-2000 are reported in Table 2.[20] The ownership coefficients are for private, mixed and foreign firms relative to the SOEs, which serve as the base. Robust standard errors clustered at the firm level are shown in parentheses.[21] In order to assess the robustness of our baseline model estimates, we report coefficients from seven different estimators: pooled OLS; random effect (RE) estimator; FE estimator; RE estimator with ministries as IVs (IV1-RE), RE estimator with regional political variables and the unemployment rate as IVs (IV2-RE), RE estimator with the interaction of ministries and regional variables (political variables and the unemployment rate) as IVs (IV3-RE), and the WM estimator described above. All seven methods yield a broadly similar pattern of results.

First, firms with foreign ownership are found to be significantly more efficient than the SOEs, with the differential in all but the FE estimate being greater in Russia than in the Czech Republic. The true efficiency differences are likely to be below the biased OLS estimates and

[19] The WM estimates are based on 1993-2000 data in order to have a sufficient number of foreign owned firms for matching.
[20] The complete sets of translog coefficients are available upon request.
[21] Note from Table 1 that the number of SOEs decreases over time but remains sufficiently large for SOE to be usable as the base. This permits us to avoid 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 naturally wants to compare the alternatives.

above the FE estimates, which are most affected by the measurement error driven attenuation bias. Since the WM method uses firm fixed effects, the WM estimates are close to FE estimates (0.15 in the Czech Republic and 0.22 in Russia); yet they are preferred over OLS because of the more balanced definitions of control and treatment groups along observable dimensions. We consider the WM estimated as our lower bound for the true efficiency differences due to the potential attenuation bias. For the endogeneity reasons outlined above, we also prefer the IV-RE estimates that yield an average foreign-SOE efficiency premium for the 1992-2000 period of approximately 35% in the Czech Republic and 65-67% in Russia. The lower (WM) estimates for Russia are relatively close to those obtained by Brown et al. (2006), whereas the IV-RE estimates are higher.

Second, firms with foreign ownership are on average much more efficient than both domestic private firms and firms with mixed ownership. The differences in coefficients are statistically significant at the 1% level.

Third, within each country, firms with private and mixed ownership generate similar efficiency coefficients in most estimates. In the Czech Republic, these two types of firms are in most estimates found to be 7-13% more efficient than the SOEs, except for the insignificant WM estimates. In Russia, the OLS estimates suggest that the mixed and private firms are 16-19% more efficient than the SOEs, the RE estimates suggest that they are indistinguishable from the SOEs, and the FE, WM, and three IV-RE estimates show the mixed and private firms to be 3-8% less efficient than the SOEs.

*Robustness Checks*

In addition to presenting estimates derived from several methods, we perform a number of robustness tests reported in web appendix tables A3-A6. First, we test whether ownership effects are sensitive to the use of a Translog production function and re-estimate the effects with a Cobb-Douglas specification. The OLS results presented in the first two columns of the web appendix Table A3 indicate that the differences in the ownership effects across these two specifications are small (although statistically significant with the *p*-values for the $\chi^2$ test being

0.00). Since the F-tests in Table A3 indicate that the Translog specification is preferred, we continue with this specification.

Second, we test for sensitivity of the coefficients on ownership to restricting the coefficients on inputs to be the same in all industries. In column 3 of Table A3 we report the estimates from a regression that allows the coefficients on inputs to vary by industry (at the two-digit ISIC level) in the OLS translog specification. The $\chi^2$ test indicate that this change in specification does not alter the estimated ownership effects in the Czech Republic (*p*-value is 0.68) but reduces them somewhat in Russia (*p*-value is 0.00).

Third, the data for Russia (but not the Czech Republic) permit us to check the sensitivity of our findings to different levels of aggregation of industry in the coding of the industry dummy variables. We find that the estimated coefficients on ownership from a specification including four digit ISIC dummies to control for heterogeneity across industries are similar to those obtained when using two digit ISIC dummies.[22] Hence, controlling for heterogeneity at the two versus four digit ISIC level does not appear to affect our findings.

Fourth, we test whether the relatively high efficiency of foreign-owned firms is being driven by industries where there is a higher share of foreign firms or less competition. As we show in the last two columns of Table A3, this is not the case. When we include the interaction of the ownership variables with the Herfindahl-Hirschman index (HHI), the OLS coefficients on foreign ownership declines slightly but remain large and significant in both countries. The same result is obtained when we add the interaction of ownership variables with the output share of foreign firms in the given industry.[23]

Fifth, we test whether the results are sensitive to the exclusion of material inputs and the use of revenue rather than value added as the dependent variable. We re-estimate equation (1) with the Czech data for the entire 1992-2000 period and with a large subset of Russian firms for the 1996-2000 period using value added as the dependent variable, where value added is defined

[22] The results are available from authors upon request.

[23] For detail on the values of the Herfindahl-Hirschman index and the output share of foreign firms in each industry, see Tables A3 and A4 in Sabirianova, Svejnar and Terrell (2005a).

as sales revenues minus the cost of material inputs. The web appendix Table A4 shows that in the Czech Republic there is little change in the estimated coefficients on ownership in all specifications, with the exception of the RE and FE estimates for mixed firms, which are insignificant. Because the data on material inputs are available in Russia for a smaller number of firms (about 12,000 firms per year) and fewer years, for comparability purposes in Table A4 we report for these firms estimates based on both revenue and value added. Both specifications yield broadly similar estimated coefficients of ownership. Thus, we conclude that our results are not very sensitive to omitting material inputs and to the use of revenue as the dependent variable.

Sixth, with the entire dataset for the Czech Republic and a large subset of the Russian data we are able to check whether using the LP method to control for endogeneity of inputs changes our results. In the last column of Table A4 we report the LP estimates based on value added for the Czech Republic and the LP estimates based on value added and revenue for Russia. Given the design of Table A4, the Czech LP results based on revenue cannot be easily reported in tabular form and hence we report the coefficient estimates and associated standard errors here: 0.117** (0.011) for foreign, 0.001 (0.014) for mixed and 0.033** (0.010) for private ownership. These estimates, together with those reported in Table A4, indicate that in both countries the LP estimates are broadly similar to those generated by the other methods. The LP estimates based on revenue are similar to the WM estimates in the Czech Republic and come close to the RE estimates in Russia (although the coefficients on mixed and private ownership are statistically significant). The LP estimates based on value added are similar to the FE, RE and IV-RE estimates in the Czech Republic, and the RE estimates in Russia (though the coefficient on private ownership is positive and significant).[24]

Seventh, we also generate estimates using the Blundell-Bond system GMM estimator. We use the first four lags of levels and differences in inputs and ownership as instruments for differences and levels, respectively. In addition, we use either ministries (BB-IV1) or political variables and unemployment (BB-IV2) as instruments. Web appendix Table A5 shows that

[24] Interestingly, the LP estimates based on value added generate higher effects of foreign ownership than those based on revenue.

within each country, the two sets of instruments yield very similar results, suggesting that the efficiency effect of foreign ownership is the greatest, followed by mixed and private ownership, relative to the SOEs. In both the Czech Republic and Russia the BB estimates resemble most the OLS results reported in Table 2.

Eighth, we test the extent to which the differences in ownership effects in the two countries arise from different definitions of what constitutes a foreign-owned firm. In the web appendix Table A6, Panel A, we present the results for Russia with three separate categories of foreign ownership indicating whether foreign investors have a majority, minority, or unknown share of ownership.[25] The results show that majority foreign ownership has a much higher effect on firm efficiency than minority foreign ownership. Moreover, in all estimations the estimated coefficients on mixed ownership are much smaller than those on minority foreign ownership. Combining them to approximate the category of mixed ownership as it is defined in the Czech data yields a foreign-mixed differential that is much larger than that in the Czech Republic. Thus, using a more similar definition of different types of ownership in the two countries suggests that the effect of foreign ownership is much larger in Russia, relative to the Czech Republic, than was discernible from the different definitions used for the overall sample in Table 2.[26]

Finally, to the extent that small firms behave differently from large firms, the unweighted regressions in Table 2 give excessive importance to small companies. For instance, large foreign firms could more likely be subsidiaries of multinationals and as a result be more efficient than small foreign firms. We have therefore re-estimated the regressions in Table 2 with all observations weighted by employment. The coefficients are similar to, but smaller than, those in Table 2. Overall, the weighted regression results suggest that the differentials in efficiency exist for firms of all sizes, but are greater among the smaller firms.[27]

[25] Because of too many categories of ownership to be instrumented, we do not use IV methods in this particular case. We do not know the share of foreign investors in 35% of all foreign firms.
[26] Panel B of appendix Table A6 also shows that the effect of the majority foreign ownership relative to other categories is much larger in Russia than that in the Czech Republic.
[27] Results are available from authors upon request.

### *2.2. Changes in the Efficiency Gaps over Time*

We next ask to what extent the average gap between the foreign and domestically owned firms is closing over time -- i.e., are domestic firms catching up to the world standard? This of course depends on how quickly domestic and foreign firms improve their efficiency. In general, foreign firms start their operations in emerging markets with limited local knowledge and their efficiency rises over time as they acquire this knowledge. Domestic firms in turn enter the transition with a lack of knowledge of the market economy, as well as a lack of western managerial and technical know-how. Their efficiency should increase as they acquire this knowledge. The question is whether foreign or domestic firms improve their efficiencies at a different rate over time.

In order to answer this question, we first augment the basic specification by interacting the ownership dummy variables with a linear and quadratic time trend. This approach examines the evolution of efficiency of firms with different types of ownership irrespective of how long a firm has been in a given type of ownership. The results with a linear trend, reported in Table 3, suggest that the average gap between the foreign and domestically owned firms is increasing over time in both countries. In our preferred (IV and WM) specifications, the foreign owned firms experience a faster annual rate of increase in efficiency than SOEs by 4.4-5.5 percentage points in the Czech Republic and 4.2-6.7 percentage points in Russia. It is interesting that in the Czech Republic the efficiency of the SOEs and private domestic firms is increasing at about 2.1-4.1% annually, while in Russia it is trending downward by 1.9-2.6% a year.

We also estimate the quadratic specification. The results for the Czech Republic are not reported because the linear specification statistically dominates the quadratic one. In Russia, the quadratic specification is statistically superior and thus reported. Table 3 indicates that all four types of firms in Russia display a U-shaped trend in efficiency. The FE, RE, IV3-RE, and WM estimates suggest that non-state owned firms experience a deeper (more convex) U-shaped trend,

with foreign firms' efficiency falling faster, reaching an earlier turning point and rising faster thereafter than all other types of firms.[28]

While the average foreign-domestic efficiency gap is rising over the sample period in both countries, we do find important differences in the evolution of the gap depending on the position of the firm in the efficiency distribution. We estimate the revenue function separately for the early, mid- and late transition periods of 1992-94, 1995-97 and 1998-2000, allowing the efficiency of firms with different types of ownership to change over the three periods, and we compare domestic and foreign firms at corresponding percentiles of their respective efficiency distributions in different time periods. 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

$$Q_\theta[\ln y_{it} \mid X_{it}, Z_{it}] = X_{it}\beta_\theta + Z_{it}\rho_\theta, \qquad (3)$$

where $Q_\theta$ is the $\theta^{\text{th}}$ quantile of $\ln y_{it}$ conditional on the covariates $X$ and $Z$. The estimated coefficients $\rho_\theta$ give the relative efficiency of firms with different ownership at the $\theta^{\text{th}}$ 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 efficiency as $\varphi_i = \rho + v_i$ for each ownership type, with $E(\varphi_i) = \rho$ and $E(v_i) = 0$. The idiosyncratic errors ($\varepsilon_{it}$) are excluded from the measure of firm-specific efficiency in order to reduce the effect of transitory productivity shocks and statistical noise.

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

[28] We also augmented the basic specification by interacting the ownership dummy variables with a linear and quadratic time trend measured as the number of years that a firm has been in the current ownership category since the regime change in 1991. As in the case of a calendar time trend, the quadratic specification is statistically superior in Russia; however, in the Czech regressions the quadratic terms are all insignificant. The results are broadly similar to ones reported in Table 3.

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. In our case, the quantile and panel estimates yield very similar results. For the sake of brevity, we present the quantile estimates in a graphical form in Figure 1, with the corresponding point estimates for each sub-period and differences across sub-periods being reported in the web appendix Table A7. The results yield the following insights:

i) Foreign firms are considerably more efficient than all three types of domestic firms at most levels of the distribution of efficiency – from the best to (almost) the worst.[29] 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 ($90^{th}$ percentile) and smallest among the least efficient ones ($10^{th}$ percentile). An exception is the foreign-state efficiency gap in the Czech Republic during 1998-2000, when the relative efficiency of the worst (remaining) Czech SOEs actually drops and the foreign-state difference in efficiency becomes the greatest in the bottom decile.[30] The fact that these inefficient SOEs did not go out of business is consistent with the finding of Lizal and Svejnar (2002) that 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 likely also signs of the presence of soft budget constraints.

[29] We define the best (worst) firms as those in the upper (lower) decile of the distribution of efficiency in their specific ownership type. Tests of the difference in the coefficients between foreign and mixed and between foreign and private are not shown to conserve space. They are significantly different from zero in all cases except the foreign-mixed efficiency differential in the early transition (1992-94) in the bottom decile in Russia and most of the distribution in the Czech Republic, and also in the bottom decile 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.

[30] 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 (2008) models and empirical findings that better firms were privatized first.

iii) Compared to the Czech Republic, the gap between the foreign and domestic firms in Russia is much larger for most of the distribution and increases more rapidly from the worst to the best firms. For example, in the first period in Russia the foreign-state efficiency gap ranges from 0.134 in $10^{th}$ decile to 1.040 in the $90^{th}$ decile, while in the Czech Republic the corresponding differentials are 0.187 and 0.389.

iv) In Russia, the efficiency gap between foreign and domestic firms grows at virtually all points of the distribution from early to mid transition and the growth continues to be positive though smaller in mid to late transition. In the Czech Republic, there is generally no significant change in the foreign-domestic gap for mixed and private firms over time, but the foreign-state gap grows, especially at the bottom of the distribution in the presence of the soft budgets of SOEs discussed above.

In sum, we have carried out several tests of whether domestic firms approached 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 or counterpart firms at various parts of their respective efficiency distributions. 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 in the Czech Republic it remains generally unchanged for all firms except the SOEs, where the gap continues to grow, especially among the least efficient. Foreign firms are also increasingly displacing local firms in the top deciles of the efficiency distribution.[31]

[31] In Russia 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 one observes a more marked penetration of foreign owned firms and growing representation in the top decile 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.

## 3. Factors Affecting Evolution of Efficiency Gap

Why is the efficiency gap between foreign and domestic firms not closing over time and why is it larger in Russia than in the Czech Republic? With respect to the former, we focus on whether the gap results from initial differences between foreign and domestic firms and/or from differences in the evolutions of their efficiency over time. We also check the extent to which the gap is due to better domestic firms being acquired by foreign investors, which we surmise is the case from our comparison of different estimation methods in Table 2.[32] With respect to the question on the relative size of the foreign-domestic gap across the two countries, in an exploratory analysis not reported in detail here, we suggest that differences in the institutional and legal system, rather than achieved level of economic development or prevalence of western business practices, account for the larger gap observed in Russia than the Czech Republic.[33]

### *3.1. Startups*

We start with a nonparametric approach to compare the efficiency levels of new firms by ownership type. We use firm-specific estimates of efficiency calculated from standardized residuals of the translog function estimated separately for each year during the 1992-2000 period.[34] Based on its individual efficiency measure, each startup firm is categorized by whether

[32] We do not pretend to examine all the potential factors that can affect the relative efficiency of domestic and foreign firms. For example, we are not testing for potential "spillover" effects of having foreign firms in the same industries or regions.

[33] 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 institutional/legal structure, (b) the level of economic development, and (c) the western market/business culture. In order to do so, we focus on the Moscow and St. Petersburg regions of Russia. The Moscow region resembles the Czech Republic in that it is economically much more advanced (closer to the frontier) 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 viewed to have more of a western 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 business culture, respectively. Yet, the two regions share with the rest of Russia the legal and institutional environment, as well as the more closed nature of the Russian economy. To assess which effect dominates, we estimate the various measures of efficiency reported in Table 2 on data from firms located in the Moscow and St. Petersburg regions and check whether they resemble more those from the Czech Republic or Russia as a whole. We find that the parameter estimates for both Moscow and St. Petersburg are similar to those for Russia as a whole rather than those for the Czech Republic. This suggests that policies and institutional environment rather than the level of development or geographic proximity to western business culture determine the relative performance of foreign and domestic firms in the emerging market economies.

[34] We standardize the residuals because there may be year-to-year variation in the distribution of the residuals that reflects changes in inflation, or shocks to the economy, which need to be controlled for.

it enters in the bottom, middle or top third of the overall distribution of efficiency in each year. In both countries foreign startups turn out to have a higher (0.5) probability of entering in the top third of the distribution than any type of domestic startup (whose probability is 0.3). The only exception is in the Czech Republic, where firms with mixed ownership, a category that contains also firms with significant minority foreign ownership, have a similarly high probability of entering at the top third of the distribution.[35]

We also carry out two parametric tests. The first test consists of augmenting equation (2) with interaction terms between ownership dummy variables and a variable "startup," with the latter coded one in the first year of a firm's existence and zero otherwise. The coefficients on these interaction terms give the average efficiency of startups relative to existing firms in the same ownership category during the 1992-2000 period. The RE and WM estimates of these coefficients are given in the first two columns of each panel in Table 4.[36] These estimates show that in both countries the newly created foreign-owned firms are less efficient than existing foreign-owned firms. Domestically owned startups appear to be more or equally efficient as existing domestic firms in the Czech Republic, but they are less or equally efficient as existing domestic firms in Russia. By adding the coefficient on the interaction between a given ownership dummy and startup dummy to the corresponding base ownership coefficient, we obtain the efficiency of the startup of that ownership category relative to the average efficiency of an existing SOE. This then permits us to compare the relative efficiency of various startups. As may be seen from the tests at the bottom of Table 4, the RE estimates suggest that foreign owned startups are more efficient than all types of domestic startups in Russia, and that they are more efficient than private and state-owned startups in the Czech Republic. With the WM estimates one cannot reject the hypothesis that the efficiency of foreign owned startups is the same as that of their domestic counterparts.

[35] To conserve space, we have not included a table with all the probabilities. More detailed results are available on request.

[36] We do not carry out IV estimation because the specification would require a large number of instrumental variables.

Our second parametric test tackles the question of whether the relative performance of foreign and domestic startups changes over time. This test is based on a specification that adds to the above one the interaction of the startup with ownership and trend (calendar time). The coefficients on this Startup×Ownership×Time interaction indicate that in the Czech Republic the average efficiency of all types of startups is constant and hence not rising relative to one another. In Russia, we obtain the same results with the WM model, while the RE estimates suggest that the efficiency of domestic startups is rising (albeit from a relatively low level) and that of foreign startups remains constant.

### *3.2. Selective Acquisitions by Foreign Firms*

The various estimates in Table 2 suggest that foreign ownership increases the efficiency of the acquired firms. An interesting related question is whether foreign investors acquire ("cream") the more productive domestic firms or acquire and "turn around" the less productive ones. If they cream, then foreign investors reduce the average efficiency of the remaining domestic firms by downgrading their composition. If they acquire and turn around inefficient firms, the average efficiency of the remaining domestic firms improves as a result of the less efficient ones being privatized to foreign owners.

To test these hypotheses we estimate a probit model that shows whether the efficiency of a domestic firm in year *t*-1 affects the probability of the firm being acquired by a foreign firm in year *t*.[37] We control for the firm's ownership at *t*-1 and ownership interacted with calendar time, the logarithm of the firm's capital (to control for size), and industry, year and regional dummy variables.[38] The marginal effects from the probit, reported in Table 5, 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 its economic significance is limited in both countries. One standard deviation increase in domestic firm's efficiency leads to an increase in

[37] 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.

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

the mean annual probability of the firm being acquired by a foreign firm from 2.1% to 2.9% in the Czech Republic and from 0.4% to 0.5% in Russia. The results hence suggest that foreign investors "cream" but that the part of foreign firms' superior performance that can be explained by selective acquisitions of local firms is limited.[39] Our estimates reject the competing hypothesis that foreign investors select less efficient firms and turn them around.

A question that also arises is whether our findings of superior performance of foreign firms do not result from the fact that foreign investors acquire firms in less competitive industries and the efficiency differential hence reflects monopoly rents. To examine this hypothesis, we enter a one-year lagged, two-digit Herfindahl index as an additional explanatory variable to the probit equation. As may be seen from Table 5, the marginal effect of the Herfindahl index is negative in both countries and statistically significant in the Czech Republic. Foreign firms hence tend to acquire firms in more rather than less competitive industries in the Czech Republic and the acquisitions are unrelated to the competitiveness in the industry of acquisition in Russia. The greater efficiency of foreign firms hence does not appear to be attributable to acquisition-related monopoly rents.

### *3.3. Efficiency Frontier and Convergence*

An important question is whether firms that are closer to the efficiency frontier are more likely to respond to market forces by improving their efficiency than those further from the frontier. We address this issue and also assess whether domestic and foreign firms converge to the same or different steady state level of efficiency and at a similar or different speed.

[39] Given that SOEs are the base and the linear time trend captures the interaction of state ownership and time, the estimates in Table 6 indicate that in the Czech Republic foreign investors are more likely to acquire domestic private firms than SOEs and that the probability of acquisitions rises for all types of firms (but fastest for SOEs) over time. In Russia, firms with mixed and private ownership have a lower base probability than a SOE of being acquired by a foreign firm, but their mean probability of being acquired by a foreign investor rises over time. 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.

The hypothesis advanced by Aghion *et al.* (2005 and 2008) and Acemoglu, Aghion, and Zilibotti (2002 and 2006) is that competition -- brought about by the introduction of the market system (in our case transition) and/or entry of new firms -- encourages learning and innovative behavior among incumbent firms that are near the technological frontier, but stifles learning and innovation 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 ones. 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, we assign firms to the bottom third, middle third and top third of the overall efficiency distribution on the basis of their individual estimated efficiency in every year.[40] 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 the market during the 1992-2000 period. These probabilities are reported in 3 x 4 annual transition matrices for each ownership category in Table 6, with the groups of origin being given by the row names and the groups of destination by column names.[41] Using the transition matrices for

[40] The measure of efficiency is again each firm's residual from an annual translog production function that is estimated without ownership variables. Note that we are using a relative measure of distance from the frontier, but that it is correlated with absolute distance.

[41] We have computed the transition probabilities using simple ratios of bins (i.e., for a given state, what is the fraction of transitions to another state). The corresponding standard errors are calculated in two ways: a) bootstrap and b) asymptotic, using (fraction*(1-fraction))/(number of observations). The two methods produce similar results. We have also obtained similar probabilities when we estimated a multinomial logit and used the associated standard errors.

the distance is useful because one can assess whether the distance to the frontier is likely to persist over time.[42]

The proximity to the frontier hypothesis is supported by the behavior of foreign firms in Russia and (to a lesser extent) in the Czech Republic. It is contradicted, however, by the behavior of all types of domestic firms in each country. As may be seen from Table 6, 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. 18.0% in Russia and 19.9% vs. 14.6% in the Czech Republic).[43] 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 transition probabilities are virtually indistinguishable within each of the three categories for domestically owned firms in Russia, and they are actually reversed in the Czech Republic. For example, 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 domestic ownership category (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.

Whereas we do find that exit rates are highest among the least efficient firms, we do not find that the exit rates of firms in the middle group of efficiency are higher than the exit rates of

[42] Note that since we carry out the ranking within the distribution of all firms, the fact that a given (e.g., domestic private) firm moves up across categories does not mean that a firm from the same group must move across the same categories down.

[43] The standard errors corresponding to the transition probabilities are very small, indicating that the differences in the transition probabilities that we discuss here are statistically significant at the 1% confidence level.

firms in the highest group. Hence, 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. The transition probabilities in Table 6 also support our findings in Tables 3 and 4 that foreign firms increase their efficiency more rapidly than domestic firms. 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. 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 adjusting slower than foreign firms.

Using the 3x3 sub-matrices reflecting the bottom, middle and top efficiency states in Table 6, we also calculate the stationary probability matrices of efficiency by ownership. With bootstrap standard errors being very 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 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.[44]

Given that our analysis does not reveal signs of convergence of domestic firms to the frontier, we examine directly whether this is because domestic firms converge to a lower (steady state) level of efficiency than the foreign firms or because they converge at a slower speed. In particular, we estimate a dynamic conditional convergence equation of the form

[44] 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.

$$\varphi_{ip} = Z_{ip}\kappa + \varphi_{ip-1}Z_{ip}\eta + I_{ip}\delta + P\nu + u_{ip}, \quad (4)$$

where $\varphi_{ip}$ 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 $p$), $\kappa$ proxies the steady state efficiency levels of firms with different types of ownership, $\eta$ 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).[45] Equation (4) 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 (4) 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). The OLS and IV estimates of $\kappa$, which may be seen in Sabirianova, Svejnar and Terrell 2005b, indicate that all three types of domestic firms are converging to the same steady state level (except possibly for the mixed firms in the Czech Republic). Foreign firms are converging to a higher steady state level: 0.11 to 0.23 log points in the Czech Republic and a 0.34-0.40 log points in Russia. The estimates of $\eta$ 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.

## 4. Conclusions

The Czech Republic and Russia represent important alternative models of transition and implementation of the market-oriented policies: the Central and East European (CEE) model and the Commonwealth of Independent States (CIS) model, respectively. The two models differ

[45] Although the two literatures do not cross-reference each other, equation (6) can be shown to be in the same class of functions as that estimated by Griffith, Redding and Simpson (2009) on British firms.

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 have developed market-oriented institutions and legal system. They hence provide alternative laboratories for testing the effects of the market-oriented development policies on efficiency of firms. We use large firm-level data sets from these two countries to examine whether market liberalization during 1992-2000 enabled local firms to converge in efficiency to the world standard, defined 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 development.

The CEE and CIS countries carried out large scale privatizations on the presumption that this would increase the efficiency of firms and speed up economic development. In both sets of economies, observers and analysts have pointed to success stories as well as evidence of mis-management and looting (tunneling) of firms. The Russian and Czech privatization schemes fit into the large scale privatization pattern, with the Russian scheme providing assets primarily to insiders and the Czech one to outsiders. Our estimates suggest that in the Czech Republic the efficiency of firms with domestic private and mixed ownership is quite similar and only slightly (about 10%) higher than that of the state-owned enterprises (SOEs). Depending on the estimation method, in Russia the efficiency of the domestic private and mixed ownership can be slightly higher or lower than that of SOEs. These results suggest that a principal justification for carrying out privatizations to domestic owners has not been borne out by performance during the first post-privatization decade.

FDI is widely viewed as a vehicle for development – operating through the higher efficiency of the multinationals and the positive "spillover" effects of foreign firms on domestic firms' efficiency. We find that foreign owned firms are much more efficient than domestic firms in both countries and that the gap between domestic and foreign firms is not closing – it has remained the same in the Czech Republic and has grown in Russia. One factor contributing to this gap appears to be that foreign-owned startups may be more efficient than domestic startups.

Foreign investors also tend to acquire more efficient domestic firms, although the magnitude of this effect is limited. Finally, we find that foreign owned firms are improving their efficiency more rapidly than domestic firms and are converging to a higher level of efficiency. It may be argued that we are observing the short term effects of FDI, as described in the Monge-Naranjo (2008) model. While this may be the case, our results cover an entire decade and thus provide sobering evidence on how quickly one may expect policies to start having the positive expected effect on development.

A growing literature is hypothesizing that market-oriented development policies are more effective in increasing efficiency and growth in firms and countries that are closer to the technological frontier, but that the policies are too overwhelming and may even cause failure in the less efficient firms and countries. Our study provides evidence related to this hypothesis at both the firm and country levels. At the firm level we find the hypothesis to be supported by the behavior of foreign owned firms but not by the three types of domestic firms. At the country level, we find that the foreign-domestic efficiency gap is much larger in Russia than the Czech Republic and that it is increasing in Russia while remaining relatively stable in the Czech Republic over the 1992-2000 period. This supports the hypothesis since in terms of its initial efficiency the Czech Republic is closer to the "frontier" than Russia.[46]

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.[47] In contrast, the Russian-style CIS economies are not standing up well to the

[46] Moreover, with EBRD (2000) reporting that 1992 Czech and Russian GDP per capita were $2,892 and $565, respectively, the evidence is that the level of GDP per capita in the Czech Republic was about five times higher than the level in Russia. Since in 1992 both economies had few foreign firms, the relative per capita GDP figures suggest that in 1992 the efficiency of Czech firms was on average much higher than that of their Russian counterparts. Moreover, the EBRD's transition indices shows that in 1992 markets were functioning much better in the Czech Republic than in Russia.

[47] Studies by Fabbri, Haskel and Slaughter (2003), Bernard and Jensen (2007) and Bernard and Sjoholm (2003) suggest that controlling for firm size and productivity multinational firms are more likely to close their plants than

challenge, which will become increasingly acute as globalization proceeds and the countries join the World Trade Organization and become more open. Our results indicate that future research needs to examine carefully the differential effect that development policies, FDI and globalization have on the performance of local versus foreign-owned firms.

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 |
| **Shares of New Firms** | | | | | | |
| Foreign | … | 9.0 | 24.7 | 1.6 | 3.0 | 3.4 |
| Mixed | … | 9.9 | 6.5 | 2.6 | 8.8 | 7.4 |
| Private (domestic) | … | 42.9 | 43.7 | 1.8 | 7.7 | 17.2 |
| State | … | 3.2 | 1.3 | 6.4 | 4.3 | 5.7 |
| **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 observations | 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. New firms are firms that did not exist in 1992.

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

**Czech Republic**

| | OLS | FE | RE | IV1-RE | IV2-RE | IV3-RE | WM |
|---|---|---|---|---|---|---|---|
| Foreign | 0.420** | 0.270** | 0.309** | 0.349** | 0.346** | 0.349** | 0.146** |
| | (0.032) | (0.027) | (0.023) | (0.023) | (0.023) | (0.023) | (0.042) |
| Mixed | 0.111** | 0.086** | 0.101** | 0.100** | 0.098** | 0.100** | -0.013 |
| | (0.030) | (0.020) | (0.019) | (0.019) | (0.020) | (0.020) | (0.028) |
| Private | 0.133** | 0.113** | 0.109** | 0.069** | 0.068** | 0.068** | 0.033 |
| | (0.024) | (0.019) | (0.016) | (0.016) | (0.016) | (0.019) | (0.032) |
| No. of obs. | 19945 | 19945 | 19945 | 15646 | 15507 | 15507 | 14243 |
| No. of firms | 4654 | 4654 | 4654 | 3869 | 3780 | 3780 | 3853 |
| $R^2$ (overall) | 0.765 | 0.662 | 0.752 | 0.756 | 0.757 | 0.757 | 0.501 |
| 1st stage significance of instruments | … | … | … | $\chi^2$=376** | $\chi^2$=16** | $\chi^2$=153** | … |

**Russia**

| | OLS | FE | RE | IV1-RE | IV2-RE | IV3-RE | WM |
|---|---|---|---|---|---|---|---|
| Foreign | 1.023** | 0.163** | 0.433** | 0.663** | 0.675** | 0.652** | 0.218** |
| | (0.038) | (0.037) | (0.031) | (0.027) | (0.027) | (0.026) | (0.040) |
| Mixed | 0.157** | -0.049** | -0.004 | -0.080** | -0.067** | -0.060** | -0.029** |
| | (0.013) | (0.009) | (0.008) | (0.017) | (0.017) | (0.016) | (0.010) |
| Private | 0.190** | -0.061** | -0.003 | -0.084** | -0.068** | -0.056** | -0.035* |
| | (0.014) | (0.011) | (0.010) | (0.017) | (0.017) | (0.016) | (0.014) |
| No. of obs. | 152887 | 152887 | 152887 | 140219 | 139891 | 139,891 | 134384 |
| No. of firms | 26188 | 26188 | 26188 | 24510 | 24412 | 24,412 | 25411 |
| $R^2$ (overall) | 0.723 | 0.633 | 0.714 | 0.727 | 0.727 | 0.743 | 0.525 |
| 1st stage significance of instruments | … | … | … | $\chi^2$=1798** | $\chi^2$=615** | $\chi^2$=1658** | … |

**Notes**: The dependent variable is log of revenue. Coefficients are estimated effects of different types of ownership relative to state ownership. To account for arbitrary serial correlation, we report Arellano (1987) firm-clustered standard errors in parentheses; * 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. RE – random effects estimator, FE – fixed effects estimator, IV1 uses ministries under central planning as instruments, IV2 uses regional political influence and unemployment rate as instruments, WM – weighted matching estimator with propensity scores used as weights (described in the text). The $\chi^2$ test for the statistical significance of instruments in the 1st stage (probit) is reported for private vs. other. Other types of ownership produce similar results, which are not reported. WM estimates are for 1993-2000.

**Table 3: Time-Varying Effects of Ownership on Efficiency, 1992-2000**

**Czech Republic, Linear Trend**

| | FE | RE | IV1-RE | IV2-RE | IV3-RE | WM |
|---|---|---|---|---|---|---|
| Foreign | 0.138** | 0.203** | 0.110** | 0.107** | 0.114** | -0.020 |
| | (0.043) | (0.036) | (0.035) | (0.035) | (0.037) | (0.071) |
| Mixed | 0.122** | 0.105** | -0.052 | -0.048 | -0.041 | 0.016 |
| | (0.032) | (0.032) | (0.068) | (0.068) | (0.066) | (0.045) |
| Private | 0.194** | 0.179** | 0.059* | 0.057* | 0.060** | 0.059 |
| | (0.021) | (0.019) | (0.024) | (0.024) | (0.025) | (0.042) |
| Foreign × Time | -0.004 | -0.004 | 0.054** | 0.055** | 0.053** | 0.044** |
| | (0.009) | (0.008) | (0.009) | (0.009) | (0.010) | (0.013) |
| Mixed × Time | -0.036** | -0.025** | 0.041** | 0.041** | 0.039** | -0.004 |
| | (0.009) | (0.009) | (0.014) | (0.013) | (0.013) | (0.013) |
| Private × Time | -0.047** | -0.041** | 0.016 | 0.017* | 0.016* | -0.004 |
| | (0.007) | (0.006) | (0.008) | (0.009) | (0.009) | (0.009) |
| Time | 0.082** | 0.081** | 0.021** | 0.021** | 0.022** | 0.041** |
| | (0.007) | (0.006) | (0.008) | (0.008) | (0.008) | (0.009) |
| $R^2$ (overall) | 0.663 | 0.751 | 0.754 | 0.754 | 0.755 | 0.502 |

**Russia, Linear Trend**

| | FE | RE | IV1-RE | IV2-RE | IV3-RE | WM |
|---|---|---|---|---|---|---|
| Foreign | -0.161* | 0.179** | 0.381** | 0.378** | 0.395** | -0.169* |
| | (0.070) | (0.060) | (0.054) | (0.056) | (0.053) | (0.075) |
| Mixed | -0.012 | 0.021* | -0.050 | -0.052 | -0.030 | -0.024* |
| | (0.009) | (0.009) | (0.046) | (0.050) | (0.043) | (0.012) |
| Private | -0.022 | -0.002 | -0.136** | -0.132** | -0.085** | -0.021 |
| | (0.012) | (0.011) | (0.030) | (0.033) | (0.027) | (0.015) |
| Foreign × Time | 0.040** | 0.038** | 0.046** | 0.049** | 0.042** | 0.067** |
| | (0.012) | (0.011) | (0.009) | (0.009) | (0.008) | (0.013) |
| Mixed × Time | -0.035** | -0.027** | -0.015 | -0.012 | -0.015** | -0.010* |
| | (0.004) | (0.004) | (0.008) | (0.008) | (0.008) | (0.005) |
| Private × Time | -0.032** | -0.019** | 0.001 | 0.003 | -0.003 | -0.011* |
| | (0.004) | (0.004) | (0.005) | (0.005) | (0.005) | (0.005) |
| Time | -0.003 | -0.012** | -0.020** | -0.022** | -0.019** | -0.026** |
| | (0.003) | (0.003) | (0.005) | (0.005) | (0.004) | (0.004) |
| $R^2$ (overall) | 0.619 | 0.708 | 0.722 | 0.723 | 0.740 | 0.512 |

**Russia, Quadratic Trend**

| | FE | RE | IV1-RE | IV2-RE | IV3-RE | WM |
|---|---|---|---|---|---|---|
| Foreign | -0.043 | 0.260** | 0.940** | 0.930** | 0.892** | -0.030 |
| | (0.082) | (0.071) | (0.108) | (0.116) | (0.155) | (0.045) |
| Mixed | 0.009 | 0.048** | 0.457** | 0.275 | -0.077 | -0.001 |
| | (0.010) | (0.009) | (0.113) | (0.166) | (0.268) | (0.010) |
| Private | 0.066** | 0.096** | 0.100 | 0.098 | -0.008 | 0.064** |
| | (0.013) | (0.012) | (0.053) | (0.061) | (0.073) | (0.013) |
| Foreign × Time | -0.086** | -0.038 | 0.065 | 0.042 | -0.120* | -0.065** |
| | (0.033) | (0.031) | (0.058) | (0.061) | (0.066) | (0.020) |
| Mixed × Time | -0.060** | -0.045** | -0.146* | -0.054 | 0.052 | -0.036** |
| | (0.008) | (0.008) | (0.064) | (0.088) | (0.121) | (0.006) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Private × Time | -0.098** | -0.074** | 0.051 | 0.044 | 0.007 | -0.075** |
| | (0.009) | (0.009) | (0.031) | (0.033) | (0.027) | (0.007) |
| Foreign × Time$^2$ | 0.018** | 0.010** | -0.003 | -0.001 | 0.017** | 0.018** |
| | (0.004) | (0.004) | (0.007) | (0.007) | (0.007) | (0.003) |
| Mixed × Time$^2$ | 0.004** | 0.003* | 0.014 | 0.004 | -0.008 | 0.004** |
| | (0.001) | (0.001) | (0.007) | (0.010) | (0.014) | (0.001) |
| Private × Time$^2$ | 0.009** | 0.007** | -0.006 | -0.006 | -0.002 | 0.009** |
| | (0.001) | (0.001) | (0.004) | (0.004) | (0.003) | (0.001) |
| Time | -0.069** | -0.102** | -0.175** | -0.188** | -0.152** | -0.085** |
| | (0.010) | (0.009) | (0.031) | (0.040) | (0.050) | (0.005) |
| Time$^2$ | 0.008** | 0.012** | 0.023** | 0.023** | 0.018** | 0.007** |
| | (0.001) | (0.001) | (0.004) | (0.005) | (0.006) | (0.001) |
| $R^2$ (overall) | 0.626 | 0.711 | 0.732 | 0.733 | 0.728 | 0.515 |
| Significance of quadratic terms | F=97.4** | F=546.4** | $\chi^{2=}$1027.7** | $\chi^2$=1264.2** | $\chi^2$=675.7** | $\chi^2$=233.3** |

**Notes**: Number of observations and firms is the same as in Table 2. The dependent variable is log of revenue. Coefficients are estimated log effects of different types of ownership relative to state ownership. We report Arellano (1987) firm-clustered standard errors to control for arbitrary serial correlation; * 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. RE – random effects estimator, FE – fixed effects estimator, IV1 uses ministries under central planning as instruments, IV2 uses regional political influence and unemployment rate as instruments, WM – weighted matching estimator with propensity scores used as weights (described in the text). Time is time trend (1 in 1993). WM estimates are for 1993-2000.

**Table 4: Relative Efficiency of Startups by Ownership Type**

| | Czech Republic | | Russia | | Czech Republic | | Russia | |
|---|---|---|---|---|---|---|---|---|
| | **RE** | **WM** | **RE** | **WM** | **RE** | **WM** | **RE** | **WM** |
| Foreign | 0.305** | 0.156** | 0.445** | 0.231** | 0.303** | 0.155** | 0.451** | 0.230** |
| | (0.023) | (0.041) | (0.031) | (0.040) | (0.024) | (0.040) | (0.031) | (0.040) |
| Mixed | 0.088** | -0.014 | -0.012 | -0.032** | 0.089** | -0.013 | -0.009 | -0.032** |
| | (0.019) | (0.029) | (0.008) | (0.010) | (0.019) | (0.028) | (0.008) | (0.010) |
| Private | 0.092** | 0.032 | -0.009 | -0.033* | 0.092** | 0.031 | -0.006 | -0.034* |
| | (0.017) | (0.032) | (0.010) | (0.014) | (0.017) | (0.031) | (0.010) | (0.014) |
| $S_{For}$(=Startup*Foreign) | -0.064* | -0.164** | -0.165** | -0.267** | -0.108* | -0.204* | -0.181** | -0.205** |
| | (0.028) | (0.043) | (0.047) | (0.052) | (0.043) | (0.080) | (0.063) | (0.070) |
| $S_{Mix}$(=Startup*Mixed) | 0.090* | 0.030 | -0.015 | -0.061** | 0.107 | 0.106 | -0.079** | -0.076** |
| | (0.045) | (0.047) | (0.016) | (0.021) | (0.082) | (0.067) | (0.023) | (0.027) |
| $S_{Pri}$ (=Startup*Private) | 0.041** | -0.017 | 0.029 | -0.040* | 0.050** | 0.009 | -0.065** | -0.015 |
| | (0.013) | (0.020) | (0.015) | (0.018) | (0.018) | (0.033) | (0.025) | (0.028) |
| $S_{Sta}$(=Startup*State) | -0.026 | -0.041 | -0.165** | -0.142** | -0.022 | -0.009 | -0.172** | -0.142** |
| | (0.022) | (0.043) | (0.013) | (0.021) | (0.023) | (0.042) | (0.014) | (0.025) |
| $S_{For}$(=Startup*Foreign)× Time | … | … | … | … | 0.021 | 0.023 | 0.007 | -0.037 |
| | | | | | (0.013) | (0.026) | (0.020) | (0.024) |
| $S_{Mix}$(=Startup*Mixed) × Time | … | … | … | … | -0.008 | -0.043* | 0.027** | 0.007 |
| | | | | | (0.023) | (0.020) | (0.008) | (0.013) |
| $S_{Pri}$ (=Startup*Private) × Time | … | … | … | … | -0.008 | -0.014 | 0.029** | -0.009 |
| | | | | | (0.006) | (0.011) | (0.006) | (0.008) |
| $S_{Sta}$(=Startup*State) × Time | … | … | … | … | 0.029 | -0.019 | 0.015* | 0.000 |
| | | | | | (0.020) | (0.037) | (0.006) | (0.010) |
| $R^2$ (overall) | 0.752 | 0.504 | 0.714 | 0.526 | 0.752 | 0.505 | 0.714 | 0.526 |
| P-values: | | | | | | | | |
| Foreign+ $S_{For}$ = Private+$S_{Pri}$ | 0.001 | 0.698 | 0.000 | 0.581 | 0.251 | 0.335 | 0.000 | 0.375 |
| Foreign+ $S_{For}$ = Mixed+$S_{Mix}$ | 0.267 | 0.747 | 0.000 | 0.396 | 0.990 | 0.204 | 0.000 | 0.113 |
| Foreign+ $S_{For}$ = 0 | 0.000 | 0.895 | 0.000 | 0.574 | 0.000 | 0.607 | 0.000 | 0.751 |
| Private + $S_{Pri}$ = Mixed+$S_{Mix}$ | 0.358 | 0.981 | 0.036 | 0.447 | 0.520 | 0.493 | 0.613 | 0.129 |
| Private + $S_{Pri}$ = 0 | 0.000 | 0.703 | 0.242 | 0.001 | 0.000 | 0.423 | 0.006 | 0.098 |
| Mixed + $S_{Mix}$ = 0 | 0.000 | 0.764 | 0.138 | 0.000 | 0.020 | 0.196 | 0.000 | 0.000 |

**Notes**: Number of observations and firms is the same as in Table 2. The dependent variable is log of revenue. Coefficients are estimated log effects of different types of ownership relative to state ownership. We report Arellano (1987) firm-clustered standard errors to control for arbitrary serial correlation; * 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. RE – random effects estimator, WM – weighted matching estimator with propensity scores used as weights (described in the text). Startup=1 if firm is a startup at time *t*. WM estimates are for 1993-2000.

**Table 5: Marginal Effect of Domestic Firm Efficiency and Industry Competition on the Probability of Acquisition by Foreign Investors, 1993-2000**

| | Czech Republic | | Russia | |
|---|---|---|---|---|
| | d*F*/d*X* | d*F*/d*X* | d*F*/d*X* | d*F*/d*X* |
| $E_{t-1}$ (Efficiency) | 0.750** | 0.734** | 0.047** | 0.039** |
| | (0.087) | (0.096) | (0.010) | (0.009) |
| $Mixed_{t-1}$ | 1.634 | 0.936 | -0.193** | -0.205** |
| | (1.872) | (1.794) | (0.047) | (0.069) |
| $Private_{t-1}$ | 2.030** | 1.512** | -0.114* | -0.125 |
| | (0.509) | (0.575) | (0.052) | (0.069) |
| $Mixed_{t-1}$* Time | -0.297 | -0.122 | 0.080** | 0.079** |
| | (0.177) | (0.211) | (0.013) | (0.017) |
| $Private_{t-1}$* Time | -0.351** | -0.175 | 0.058** | 0.058** |
| | (0.113) | (0.138) | (0.013) | (0.018) |
| Time | 0.606** | 0.335 | -0.004 | -0.008 |
| | (0.097) | (0.125) | (0.010) | (0.006) |
| $lnK_{t-1}$ | 0.548** | 0.537 | 0.085** | 0.014 |
| | (0.060) | (0.068) | (0.006) | (0.026) |
| Herfindahl Index $_{t-1}$ | -- | -0.049** | -- | -0.008 |
| | | (0.009) | | (0.006) |
| No. of obs. | 14,424 | | 122,182 | |
| Pseudo $R^2$ | 0.111 | 0.157 | 0.146 | 0.168 |
| 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 efficiency (E) is obtained from the standardized residuals of the translog 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 6: 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 efficiency (E) obtained from the standardized residuals of the translog function estimated for each year separately (1992-2000), with industry dummies and controls for data anomalies included. Based on its individual E measure, a firm is then categorized each year by where it falls in the distribution of E'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.

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