Essays on foreign ownership in transition banking

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Chapter 2

Foreign Ownership and Bank Efficiency: Does Sample Selection Matter?

2.1 Introduction

The recently observed rapid expansion of foreign banks into former socialistic economies (FSEs) has been largely fueled by economic reforms and special policies undertaken by local authorities aimed at attracting foreign direct investments into the financial sector (EBRD, 2005). One motivation for opening the borders is the expected improvement of bank performance in FSEs. A more efficient banking system is believed to facilitate financial intermediation and to contribute to the optimal allocation of financial resources in the real sector (Bonin and Wachtel, 2003).

But does foreign ownership indeed improve bank performance? Theoretical studies do not provide a straightforward answer to this question (Sengupta, 2007, Detragiache et al., 2008). On the one hand, foreign banks have better access to advanced information technologies and more expertise in comparison to their domestic peers. Foreign banks may also import better supervision and regulation practices and increase competition. In addition, they may be less vulnerable to political pressure and less inclined to lend to connected parties.

On the other hand, domestic banks have a better *know-how* of the domestic economy and understand the specifics of domestic legal systems, traditions, and other domestic institutions. They more easily carry out lending to opaque firms, which they can monitor better than foreign competitors.

In the absence of an unambiguous theoretical prediction on the relationship between foreign ownership and bank performance, a number of studies tried to address this question empirically using data on FSEs. Most of these studies employed efficiency frontier methodology to analyze the impact of foreign ownership on bank efficiency.[1] The empirical evidence seems to largely support the notion that foreign ownership has a positive impact on bank efficiency. Single-country studies report a positive impact for Hungary (Hasan and Marton, 2003), Croatia (Jemrić and Vujčić, 2002), and Poland (Nikiel and Opiela, 2002). Based on different sample periods and country coverage, most of the cross-country studies also find a positive association between foreign ownership and bank efficiency (see Table 2.1). Bonin et al. (2005) report that the participation of international investors adds considerably to cost efficiency of banks. Yildirim and Philippatos (2007) find that foreign banks are more cost efficient but less profit efficient relative to domestic private and state-owned banks. Fries and Taci (2005) use a unique database on banks compiled by the EBRD and provide a detailed ownership breakdown into five categories: greenfield foreign-owned, greenfield domestic-owned, privatized foreign, privatized domestic, and state-owned. Their estimation results suggest that privatized banks with majority foreign ownership are the most cost efficient, followed by greenfield banks (domestic and foreign).

There are two ways how one can reconciliate the mismatch between the ambiguous theoretical predictions and consensus in the empirical literature. One is to argue

[1] See Kumbhakar and Lovell (2000) and Coelli et al. (2005) for a textbook exposition of efficiency frontier methodology. Berger and Mester (1997) and Hughes and Mester (2008) review applications of the efficiency frontier methodology in the banking industry.

that in practice the advantages related to foreign ownership outweigh its disadvantages, leading to a positive overall effect of foreign ownership on bank efficiency. This is a popular interpretation provided in most empirical studies. Another possibility is to challenge the empirical findings on the ground of a possible endogeneity bias due to the *cream-skimming* (or *cherry-picking*) effect (Roll, 1986). According to this hypothesis, foreign investors may select the most efficient banks for acquisition, which makes the sample from which the individual observations are drawn non-random.[2] In other words, the *cream-skimming* effect implies that the positive impact of foreign ownership comes from the fact that those banks that were acquired by foreign investors were initially more efficient (i.e., the acquired banks would perform well even if they have had remained domestic). Surprisingly, this interpretation has been largely neglected in the literature.

The aim of this chapter is to assess the possible endogeneity bias in the relationship between foreign ownership and bank efficiency in FSEs. Our inquiry is motivated by previous indirect evidence on the selection issues associated with the decision of foreign banks to enter FSEs. For instance, Lanine and Vander Vennet (2007) show that foreign banks explicitly target large banks in FSEs in order to extract benefits from increased market power. Similarly, Poghosyan and De Haan (2008) document that the characteristics of target banks in terms of their size and performance depend on the macroeconomic environment and institutional background of host countries. In addition, some empirical evidence from developed economies (Berger et al., 1999) and developing economies (Lensink et al., 2008, Detragiache et al., 2008) suggests a negative association between foreign ownership and bank efficiency.

[2] Surveying the empirical literature on FDI in developing economies, Navaretti and Venables (2004) point out that much of the available empirical evidence "supports a statistical association between foreign ownership and productivity, but not a causal link". They also report that those studies that examine the causal relationship more carefully conclude that the impact of foreign direct investments is smaller and sometimes even insignificant. The reasoning is that if multinational corporations simply select high-performing firms in the host country for acquisition, the productivity advantages may not be related to ownership.

To evaluate the impact of endogeneity, we apply a two-step estimation method in the spirit of the Heckman (1979) procedure.[3] In this setup, the probability of acquisition (the propensity score) is estimated in the first step, and then used to control for the selection bias in the second step. This method has found wide-ranging applications in studies on ownership and total factor productivity of firms in many countries, including emerging economies (Djankov and Hoekman, 2000). We are not aware of any study that applies a two-step instrumental variable method for analyzing the relationship between foreign ownership and efficiency in the banking sectors of emerging countries. Our estimations support the *cream-skimming* hypothesis and suggest that foreign banks target more efficient banks in FSEs, which makes the empirical assessment of the relationship between foreign ownership and bank efficiency complicated. After correcting for the endogeneity bias, the impact of foreign ownership on bank efficiency becomes negative, which is in sharp contrast to most previous evidence.

The remainder of this chapter is structured as follows. Section 2.2 describes the two-step approach used in our empirical analysis and data. Section 2.3 discusses the estimation results, and the last section concludes.

2.2 Methodology and Data

In this section, we describe the two-step instrumental variable approach we propose for the investigation of the extent and significance of endogeneity bias due to the *cream-skimming* effect. Following previous empirical studies on the relationship between foreign ownership and bank efficiency in FSEs, we start by specifying a translog cost function for the stochastic efficiency frontier analysis. The estimation

[3] An alternative possibility would be to use a matching technique (non-parametric method), which allows to control for the selection bias by examining pairs of observations with similar observable characteristics. Using this procedure, one is able to proxy for the unobservable counterfactual, i.e., compare the performance of the acquired bank with its performance if it had not been acquired. However, this method requires a large number of observations on matched bank pairs and is unsuitable in many applications (including ours).

results from this non-instrumented specification are then compared to our two-stage instrumental variable outcomes. Different impact of foreign ownership obtained in these two specification indicates a bias due to the *cream-skimming* effect.

2.2.1 Stochastic efficiency frontier model

Cost efficiency measures the relative performance of a bank by comparing its current level of costs to the efficiency frontier for a given technology. Since technologically feasible cost frontiers are not observable, in practical applications the measurement of cost efficiency is based on deviations from minimal costs observed in a sample (Aigner et al., 1977). Following Kumbhakar and Lovell (2000), we start from a general form of the cost function for the i^{th} bank in country j and year t specified as:

$$\log TC_{ijt} = f(Y_{ijt}, X_{ijt}, G_{jt}, t) + v_{ijt} + u_{ijt}, \tag{2.1}$$

where TC_{ijt} is the total cost of the bank, Y_{ijt} represents the vector of outputs, X_{ijt} represents the vector of input prices, and G_{jt} is a vector of country-specific factors driving the cost frontier. The composite disturbance term is the sum of the technical inefficiency (u_{ijt}) and random error (v_{ijt}) components.[4] The term $u_{ijt} \geq 0$ captures the deviations from the best-practice costs due to technical or allocative inefficiency of the input usage. It is by definition nonnegative and is assumed to be drawn from a zero-truncated normal distribution: $u_{ijt} \sim N^{+}(\mu_{ijt}, \sigma_u^2)$, with the conditional mean parameter μ_{ijt} (i.e., the mean of the non-truncated distribution) which we explain below. The random error term v_{ijt} captures the stochastic variability of the frontier and is assumed to be i.i.d., $v_{ijt} \sim N(0, \sigma_v^2)$. We assume an explicit dependence of the cost function on time, which should capture the impact of technological advancement that is otherwise unobservable in our model.

[4] The general specification (2.1) assumes that inefficiency and random error terms are multiplicatively separable from the other variables.

Following other related papers, we apply a semi-logarithmic second-order expansion of the function $f(\cdot)$ to obtain the well-known translog specification of the cost function (2.1), enriched by country-specific factors. In order to reduce the number of second-order terms in the regression equation, we assume a linear dependence between $\log TC$ and the country-specific factors. Thus the country-specific variables operate as linear cost frontier modifiers, and reflect changing operating conditions within which the banks optimize their operations. This leaves us with the following model specification:[5]

$$\begin{aligned}
\log \frac{TC_{ijt}}{X_{ijt,1}} &= \beta_0 + \sum_{s=2}^{S} \beta_s \log \frac{X_{ijt,s}}{X_{ijt,1}} + \sum_{l=1}^{L} \gamma_l \log Y_{ijt,l} + \\
&+ \frac{1}{2} \sum_{s=2}^{S} \sum_{l=2}^{S} \delta_{sl} \log \frac{X_{ijt,s}}{X_{ijt,1}} \log \frac{X_{ijt,l}}{X_{ijt,1}} + \\
&+ \frac{1}{2} \sum_{s=1}^{L} \sum_{l=1}^{L} \psi_{sl} \log Y_{ijt,s} \log Y_{ijt,l} + \sum_{s=2}^{S} \sum_{l=1}^{L} \omega_{sl} \log \frac{X_{ijt,s}}{X_{ijt,1}} \log Y_{ijt,l} + \\
&+ \tau_1 t + \frac{1}{2} \tau_2 t^2 + \sum_{s=2}^{S} \tau_s^X t \log \frac{X_{ijt,s}}{X_{ijt,1}} + \sum_{l=1}^{L} \tau_l^Y t \log Y_{ijt,l} + \\
&+ \sum_{n=1}^{N} \xi_n G_{jt,n} + v_{ijt} + u_{ijt}. \qquad (2.2)
\end{aligned}$$

In our model, we employ two outputs and two input prices. Variations of this specification have been employed in other related studies to analyze different aspects of bank efficiency in emerging countries.[6]

We are further interested in knowing what factors influence the inefficiency term u_{ijt}. While the country-specific factors constitute a given economic environment for the banks, and thus cannot form a source of individual bank's inefficiency, u_{ijt} can depend on bank-specific variables, like financial and ownership structure. In order to capture these effects, we specify a linear relationship for the conditional mean μ_{ijt}

[5] Specification (2.2) imposes homogeneity in prices by dividing the total cost TC_{ijt} and prices $X_{ijt,s}, s \geq 2$ by price $X_{ijt,1}$, i.e., by taking the first input as *numeraire*. The symmetry of second partial derivatives in input prices and in output quantities implies $\delta_{sl} = \delta_{ls}$ and $\psi_{sl} = \psi_{ls}$.

[6] For example, Fries and Taci (2005) employ a variant of specification (2.2) with two outputs and one input price, Yildirim and Philippatos (2007) and Rossi et al. (2004) assume three outputs and three inputs, Lensink et al. (2008) use two outputs and two input prices.

of the inefficiency term u_{ijt} (Battese and Coelli, 1995):

$$\mu_{ijt} = \lambda_0 + \sum_{m=1}^{M} \lambda_m Z_{ijt,m} + \alpha FDI_{ijt}, \tag{2.3}$$

where Z_{ijt} is a vector of bank-specific control variables, and FDI_{ijt} is a binary variable which is 0 if the bank is domestically-owned, and 1 if it is foreign-owned. The control variables Z_{ijt} include indicators of the bank's market power, diversification of activities, and stability. The residual inefficiency is the part of inefficiency not captured by the conditional mean described by the observable variables.

2.2.2 Instrumenting foreign ownership

In equation (2.3) it is assumed that foreign ownership is exogenous. This assumption is not plausible in the presence of the *cream-skimming* effect, which suggests that foreign investors tend to acquire the best firms (Navaretti and Venables, 2004). This means that the decision on purchasing a bank will depend on the investor's assessment of the bank's future potential in terms of cost efficiency. Mathematically speaking, the foreign ownership dummy variable is stochastically dependent on the residual inefficiency, which leads to an endogeneity problem. Consequently, the estimated coefficients, including α, will be biased and inconsistent.

In order to avoid the endogeneity bias, one has to select a set of country- and bank-specific instruments and pursue a two stage estimation approach widely used in the treatment effect literature. The instruments are supposed to be correlated with variable FDI and independent of the residual inefficiency term. In the first stage, one has to estimate a probit model linking the dummy variable FDI_{ijt} and instruments:

$$P_{ijt} = Prob(FDI_{ijt} = 1 | I_{ijt}) = \Phi(\theta' I_{ijt}), \tag{2.4}$$

where $\Phi(.)$ is the cumulative distribution function of a Normal distribution, and

$I_{ijt} = (Z'_{ijt}, W'_{ijt})'$ is a vector of explanatory variables containing the bank-specific controls Z_{ijt} from equation (2.3), and instrumental variables W_{ijt}.

The predicted values P_{ijt} from equation (2.4) represent the estimated probabilities that the bank will be purchased by a foreign investor based on observed bank-specific and other characteristics (I_{ijt}). In the second stage, FDI_{ijt} in specification (2.3) is substituted by P_{ijt}. Since P_{ijt} is a function of instruments, which are independent of the residual inefficiency, the endogeneity bias vanishes and the estimate of parameter α becomes more accurate.[7] By using the instrumental variable method in this form, we assume that the impact of foreign ownership does not vary with the probability of selection and that there is no essential heterogeneity present in the data (Heckman et al., 2006).[8]

In order to evaluate the expected effect of foreign ownership, we notice that the mean of the truncated normal distribution conditional on the observables is:

$$E\left(u_{ijt} \mid Z_{ijt}, P(I_{ijt})\right) = \tilde{m}_{ijt} + \sigma_u \frac{\phi\left(\frac{\tilde{m}_{ijt}}{\sigma_u}\right)}{\Phi\left(\frac{\tilde{m}_{ijt}}{\sigma_u}\right)},$$

where

$$\tilde{m}_{ijt} = \lambda_0 + \sum_{m=1}^{M} \lambda_m Z_{ijt,m} + \alpha P(I_{ijt}).$$

Differentiating this expression with respect to $P(I_{ijt})$, we get the (marginal) effect of foreign ownership:

$$\Delta(Z_{ijt}, P(I_{ijt})) = \frac{\partial E\left(u_{ijt} \mid Z_{ijt}, P(I_{ijt})\right)}{\partial P(I_{ijt})} =$$

[7] We are aware of the fact that the predicted values P_{ijt} contain the prediction error, and substituting these into equation (2.3) without subsequently adjusting the standard errors of the resulting parameter estimates leads to an underestimation of these errors. However, the parameter estimates themselves remain consistent and unbiased (Pagan, 1984), which makes us confident to use this approach.

[8] Since specification (2.4) relies on distributional assumptions regarding the functional form of the interdependence between *FDI* and the instruments, for the sake of robustness we also run a simple OLS regression instead of the probit model in the first stage, and cross-check the results. Also, the OLS regression is free of the nonlinearity effects present in the probit model and offers a more robust way of testing the validity of the instruments.

$$= \alpha \left(1 - \frac{\tilde{m}_{ijt}}{\sigma_u} \frac{\phi\left(\frac{\tilde{m}_{ijt}}{\sigma_u}\right)}{\Phi\left(\frac{\tilde{m}_{ijt}}{\sigma_u}\right)} - \left(\frac{\phi\left(\frac{\tilde{m}_{ijt}}{\sigma_u}\right)}{\Phi\left(\frac{\tilde{m}_{ijt}}{\sigma_u}\right)} \right)^2 \right).$$

Averaging out across the sample, we get an estimate of the average unconditional impact of foreign ownership on the studied banks. Alternatively, we could calculate the effect of foreign ownership in discrete form as:

$$\begin{aligned} \tilde{\Delta}(Z_{ijt}, P(I_{ijt})) &= E\left(u_{ijt} \mid Z_{ijt}, P(I_{ijt}) = 1\right) - E\left(u_{ijt} \mid Z_{ijt}, P(I_{ijt}) = 0\right) = \\ &= \alpha + \sigma_u \left(\frac{\phi\left(\frac{\tilde{m}_{ijt}|_{P(I_{ijt})=1}}{\sigma_u}\right)}{\Phi\left(\frac{\tilde{m}_{ijt}|_{P(I_{ijt})=1}}{\sigma_u}\right)} - \frac{\phi\left(\frac{\tilde{m}_{ijt}|_{P(I_{ijt})=0}}{\sigma_u}\right)}{\Phi\left(\frac{\tilde{m}_{ijt}|_{P(I_{ijt})=0}}{\sigma_u}\right)} \right). \end{aligned}$$

We defer the derivation of these formulas to the Appendix.

2.2.3 Data and descriptive statistics

Our data set is composed of annual bank-level data from selected European and post-Soviet emerging economies, which is taken from the BankScope database of Bureau van Dijk. Our sample covers the period from 1993 to 2004, and includes 20 countries: Albania (AL), Armenia (AM), Azerbaijan (AZ), Bulgaria (BG), Belarus (BY), Czech Republic (CZ), Estonia (EE), Georgia (GE), Croatia (CR), Hungary (HU), Kazakhstan (KZ), Latvia (LV), Lithuania (LT), Moldova (MD), Poland (PL), Romania (RO), Slovenia (SI), Slovakia (SK) and Ukraine (UA). To make the data set representative and mitigate the impact of temporary bank appearances, we restrict our sample by including only those individual banks that were present in the sample for at least 4 years. The selection process results in a sample with 1924 observations for 305 individual banks. The composition of banks in terms of the time spell is quite even: 55 banks were present for 4 years, 54 banks for 5 years, 42 banks for 6 years, 50 banks for 7 years, and 104 banks for 8 years, which amounts to 220, 270, 252, 350, and 832 observations, respectively.

Table 2.2 displays the distribution of banks and observations across countries

and years. The table also summarizes the distribution of banks by ownership structure.[9] Foreign banks[10] are predominant (more than 50%) in 10 (mainly Central and Eastern European countries (CEEC)) out of 20, while countries where most banks are domestically-owned are mainly former-USSR countries.[11]

For the analysis of the banks' performance, banks are modeled as firms producing two outputs (loans and deposits) using two inputs (physical capital and labor). Loans (Y1) are measured as the total amount of loans given out by the bank, and deposits (Y2) as the total amount of deposits attracted. The price of physical capital (X1) is defined as the ratio of non-interest expenses to total assets, while the price of labor (X2) is measured as the ratio of total expenses on personnel over total assets.[12]

Apart from output and input prices data for individual banks and ownership indicators, we also employ data on other important country- and bank- specific correlates of cost efficiency. Among the country-specific correlates, we introduce the logarithm of per capita GDP (G1), the risk-free interest rate (G2), and the EBRD index of banking sector reform (G3).[13] These variables serve as cost function modifiers, and should represent inter-country economic and institutional differences influencing the available cost frontier. We prefer this approach to using country dummy variables, since the latter approach does not explain the sources of differences between the countries.

[9] The BankScope database provides data on current ownership structure only. We complemented the database by collecting the missing historical ownership data from webpages of individual banks, public databases, and other sources, and combined them with the data provided by Hein Bogaard and Anita Taci. The cross-validation of data allows us to achieve a substantial level of ownership data precision.

[10] A bank is defined as foreign if the share of foreign stakeholders exceeds 50% of the total equity outstanding.

[11] This stylized fact provides evidence that foreign investors acquired banks in relatively more advanced CEE economies (with a higher degree of economic development and better established market institutes) more frequently, which serves as a first empirical justification for the foreign entry based on country-specific characteristics.

[12] Taking a ratio over the total number of bank employees would be a better proxy for labor costs, but in the absence of data on the total number of employees this is not possible. Yildirim and Philippatos (2007), Rossi et al. (2004), Fries and Taci (2005), and Lensink et al. (2008) also take the ratio over total assets for measuring labor costs.

[13] To ensure consistency of our data set, we use country-specific variables available in various volumes of the EBRD "Transition Reports".

Further, we hypothesize that the accession to the European Union may have a positive impact on the production opportunities in the acceding countries. Thus we want to measure whether EU accession itself is a significant cost frontier modifier, in addition to the indirect impacts through improvement in institutional factors and economic conditions. Since EU accession is a gradual process, we include the EU accession trend variable (G4) that is defined as:

$$G_{jt,4} = \min\left\{\max\left\{\frac{t - \text{EU application}_j}{\text{EU accession}_j - \text{EU application}_j}, 0\right\}, 1\right\}, \tag{2.5}$$

where *EU application*$_j$ is the year when country j submitted its application to the European Union, and *EU accession*$_j$ is the year when it actually entered the EU. For countries which filed the application but have not entered the EU by the end of our sample, we use the expected year of entry.[14] For countries which have submitted the application, (G4) is zero for years before the submission, then gradually grows to one at the year of accession, and is one for years after the accession.[15] For countries which have not submitted an application, we set $G_{jt,4}$ to zero for all years.

The bank-level correlates serve as explanatory variables for the conditional mean of the inefficiency term μ_{ijt}. The net interest margin (Z1) proxies the degree of competition the bank faces (larger net interest margin indicates more market power). The ratio of other operating assets to total assets (Z2) measures the diversification of the individual bank's operations. The ratio of net loans to total assets (Z3) captures the ability to transform deposits into loans. Finally, the ratio of equity to total assets (Z4) serves as an (inverse) indicator of the bank's leverage. The descriptive statistics of the data in thousands of US dollars (except for the ratios) are summarized in Table 2.2.

The instruments W_{ijt} used in the first-stage estimation of the propensity score

[14] These countries are Bulgaria and Romania, which (as expected) have entered the EU in 2007.
[15] These countries are Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia, which have entered the EU in 2004.

have to be linked to the foreign investor's decision to purchase the bank but have to be independent of the cost inefficiency of the given bank, after controlling for bank-level correlates. We therefore exclude direct measures of the bank's profitability and cost structure. The included instruments are the ratio of the population to the number of banks in the given country, the risk free interest rate, the ratios of deposits to loans and of assets to the net interest revenue for the given bank, the time index, and the time index squared.[16]

2.3 Estimation Results

The results of our empirical estimations using the parametrization of Battese and Coelli (1995) are summarized in Tables 2.3 and 2.4. The first two columns of the tables represent specifications with instrumented foreign ownership variables, using a probit model and OLS, respectively. The third column contains the results of the specification without instruments. Whenever we do not state explicitly otherwise, we refer to the probit instrumental variable specification.

2.3.1 Cost frontier specification

Looking first at the translog time-varying cost function component of the model, we find that most coefficients are highly significant and relatively similar in all three specifications. This confirms the appropriateness of the time-varying cost function model. The marginal effects evaluated at variable means are larger than one for both outputs. This means that a one percent increase in any of the outputs is accompanied by a more than one percent increase in costs. The sensitivity of total costs to loans and deposits is largely comparable (the elasticities given by the marginal effects are equal to 1.54 and 1.56, respectively). In addition, the coefficient of the cross–product

[16] Naturally, the independence of the instruments of the residual inefficiency after controlling for the bank-level correlates is at least to a certain degree a matter of faith. We subject the instruments to a series of validity tests that we discuss below. However, these are all based on the assumption that at least some of these instruments are valid.

term between deposits and loans is negative and statistically significant. This signals possible economies of scope in production of two types of banking services and is consistent with findings by Fries and Taci (2005) and Lensink et al. (2008).

The negative marginal effect of time confirms a downward shift in the cost frontier over time as a result of improvements in available production technology. However, the coefficient is insignificant with a relatively high standard error, implying that there may be substantial differences among the individual countries.

At the country-level, we do not find any significant association between the level of economic development measured by per capita GDP and total costs. This finding is consistent with results by Fries and Taci (2005), but differs from those by Lensink et al. (2008) who report a significant negative association between per capita GDP and banking costs.

Similarly to Fries and Taci (2005), we find that the level of nominal interest rate has a positive and significant impact on scaled total costs: a 1 percentage point increase in the risk-free interest rate in the economy leads to an increase in total costs by 0.6%. The EBRD index of banking sector reform has a positive and significant impact on total costs. Fries and Taci (2005) explain the positive association between banking sector reforms and banking costs by the fact that banks in the studied emerging economies are moving from defensive restructuring of the banking operations (cost cutting) to operating strategies based on service improvements and innovation, which requires a higher level of spending.

The significant negative coefficient of the EU accession trend confirms the positive impact of EU accession on the productivity of the banking sector. Even after controlling for the benefits linked to institutional and economic development and for the evolution of technology over time, we still find that entering the EU shifts the available cost frontier downward. The estimated gain in cost efficiency due to EU accession is almost 10%.

2.3.2 Inefficiency analysis

We find a significant negative association between banking costs and our proxy for the market power of a bank, i.e., the level of the net interest margin (difference between implicit rates for lending and borrowing).[17] This result indicates that banks with greater market power are able to reduce their costs, possibly due to economies of scale and scope. It is consistent with the findings by Grigorian and Manole (2006) and differs from those by Fries and Taci (2005) and Yildirim and Philippatos (2007).

We proxy the degree of diversification of banking activities by the ratio of other operating income to total assets and find that it is significant and negatively associated with banking costs. This is in line with the findings of previous studies and indicates that banks with a greater variety of banking services tend to perform better. Similarly, banks that are more active in terms of loan provision, proxied by the ratio of net loans to total assets, are also significantly more cost efficient, which might be due to economies of scale.

Finally, banks that allocate a greater share of their assets to their capital for stability reasons sacrifice in terms of cost efficiency.

2.3.3 Impact of ownership

Contrary to other cross-country panel data studies (e.g., Yildirim and Philippatos, 2007, Fries and Taci, 2005, Bonin et al., 2005, and Lensink et al., 2008), we do not find a significant association between foreign ownership and cost efficiency in our non-instrumented model (see the specification without instrumental variables in Table 2.3).

In order to check for the presence of the *cream-skimming* effect, we first estimate

[17] We believe the net interest margin is a better proxy for market power of a particular bank than the share of the top largest banks' assets in the total banking assets – a popular indicator employed in related work. The net interest margin provides a qualitative measure on how banks benefit from their position in the market in terms of price setting, while market share measure can be distorted by specific characteristics of banking sector regulation in a particular country.

a probit model for the decision of foreign investors to acquire domestic banks. In the probit specification, we use the exogenous variables from our model, and add the instruments described above.

After instrumenting for foreign ownership, we find a substantial change in the impact of foreign ownership on cost efficiency (see Table 2.3, columns 1 and 2). The coefficient of the *FDI* variable becomes significantly positive, which implies that there is a negative relationship between foreign ownership of a domestic bank and cost efficiency. This suggests that foreign investors do not improve, but rather worsen cost efficiency. The insignificant coefficient in the specification without instrumental variables is caused by the fact that the less favorable performance in terms of cost efficiency is partly offset by the fact that foreign investors tend primarily to acquire banks with high residual efficiency that is not captured by our efficiency correlates. These two effects (worse cost efficiency under foreign ownership and the endogeneity of the foreign ownership variable) work in opposite directions, making the coefficient of FDI in the non-instrumented model insignificant. The negative impact of foreign ownership on cost efficiency is uncovered in the instrumental variable specification, and confirms the *cream-skimming* hypothesis. Since *cream-skimming* is related to the residual efficiency not captured by observable quantities, it may be partially caused by insider information of foreign investors about the acquired domestic banks.

This finding supports the evidence by Lanine and Vander Vennet (2007) that "large Western European banks have targeted relatively large and efficient CEEC banks with an established presence in their local retail banking markets". In addition, the empirical finding has its theoretical justification in Detragiache et al. (2008), who show that in a world with imperfect competition and informational asymmetries foreign entry can lead to diminishing efficiency of the banking sector.

The quantitative impact of foreign ownership on the cost efficiency, averaged out over the sample, is $\Delta = 0.39$ (and $\tilde{\Delta} = 0.40$ in the discrete version), which means

that foreign-owned banks are 39% less cost-effective than their domestic counterparts with the same observable characteristics. This seems to be a lot, and it is likely to be a composed effect of lower cost efficiency, the pursuit of expansionary strategies, the focus on higher-quality services, and possibly tighter accounting standards. It also does not mean that higher cost makes the foreign-owned banks less competitive, as long as these higher cost can be offset by higher revenues.

2.3.4 Inefficiency scores

Figure 2.1 presents estimated average inefficiency terms in both models (without instruments and with instruments using the first-stage probit model) for the set of countries under consideration. It can be observed that both specifications produce comparable inefficiency scores.

The overall average inefficiency is 0.45, indicating that banks are, on average, operating 45 % above the optimal cost frontier.[18] The results among the countries vary substantially. The worst performer is Albania, but otherwise the economically less developed countries do not underperform. The Visegrád countries (Czech Republic, Hungary, Poland, and Slovakia) show above-average inefficiency, with the Czech Republic showing the highest level of cost inefficiency in this group. This is consistent with the findings of previous studies. Incidentally, these are the countries which were very successful in attracting foreign direct investments into their banking systems.

Otherwise, it is rather difficult to spot any discernible pattern. Baltic countries fare quite well, with Estonia and Lithuania being among the best performing countries. However, Latvia shows a cost efficiency level comparable to the sample average. Banks in the Commonwealth of Independent States (CIS) exhibit middle range inefficiencies, with two well-performing outliers: Belarus and Georgia, the lat-

[18] All levels and differences are reported in logarithmic form.

ter being the best performing country in the sample. The three analyzed countries of the former Yugoslavia – Slovenia, Croatia, and Macedonia – are better than average in terms of cost efficiency. Bulgaria is among the top performers, while its neighbor Romania lags significantly behind.

2.3.5 Robustness checks

In order to check the robustness of our results, we perform several additional estimations and tests for validity of instruments.

First, as we have already mentioned, we instrumented the foreign ownership variable with both a probit and an OLS regression. As seen in Tables 2.3 and 2.4, the coefficients do not change substantially, and their significance remains approximately the same. Also the average inefficiencies for individual countries (available from the author upon request) remain almost unchanged.

Second, we want to make sure that the results are not characteristic only to our particular selection of banks. In the original estimations, we selected only banks that are present in the sample for at least 4 years. In order to verify the results, we create another data set with banks that appear in the sample for at least 5 years. The quantitative results change only slightly, and the qualitative properties remain valid.

We estimate the model with quantities expressed in USD using the nominal exchange rates. In order to investigate the role of possibly misaligned nominal exchange rates, we estimate the model also with quantities denominated in USD in terms of purchasing power parity (PPP). We find only minor changes compared to our base model; in particular, the coefficient at the logarithm of GDP per capita becomes significant. When expressed in PPP, GDP per capita is positively linked with banking costs (higher GDP implies higher costs, which is consistent with the findings of Yildirim and Philippatos, 2007).

These findings suggest that the decision to use nominal or PPP-implied exchange rates can play a role in studies on the relationship between GDP per capita and the banking costs. However, our other results, most importantly the decomposition of the cost inefficiency estimate, are virtually unchanged. The choice between nominal and PPP-implied exchange rate does not change our conclusion about the role of *cream-skimming* in the evaluation of the impact of foreign ownership on cost efficiency.

Finally, we check the validity of our instruments. First, we implement the test procedure from Stock and Yogo (2002) and Stock et al. (2002) to determine whether the instruments are weak or not. Using the results of the first-stage OLS regression (right column of Table 2.5), we calculate the F-statistic corresponding to the hypothesis that the coefficients of all instruments are zero. With the value of the F-statistic, F=24.54, we reject the null hypotheses of weak instruments outlined in Stock et al. (2002).[19]

Further, since we have more instruments than endogenous variables, we can test the overidentifying restrictions. Under the null of exogenous instruments, the Hansen-Sargan statistic is χ^2-distributed with 5 degrees of freedom. In our case, the value of the Hansen-Sargan statistic is 8.93 (p-value is 0.112) and we thus cannot reject the null of exogenous instruments at conventional confidence levels.

Finally, we split the instruments into two halves and use only one half of the instruments for instrumenting the foreign ownership dummy variable, while including the other half as exogenous explanatory variables (see Table 2.6). The fact that the coefficients of the instruments used as exogenous variables are insignificant strengthens our confidence that we are using a set of valid instruments in our estimations.

[19] These null hypotheses are as follows: (i) the relative bias of the estimator in the second-stage regression is larger than 10% of the bias of the non-instrumented estimator, and (ii) the size of the 5% t-test for $\alpha = 0$ is larger than 15%. Table 1 in Stock et al. (2002) suggests that the *rule of thumb* for the rejection of the weak instruments hypothesis is the estimate of the first-stage F statistic that is larger than 10, which is the case in our estimations.

2.4 Conclusions

We address the issue of foreign ownership and bank efficiency in former socialistic emerging economies. We employ the instrumental variable approach to tackle the sample selection problems caused by the possibility of *cream-skimming*. Our main observation is that the instrumental variable approach makes the coefficient of the impact of foreign ownership on bank efficiency positive and highly significant. This finding indicates the presence of *cream-skimming*, i.e., foreign investors target the most efficient banks for acquisition. The coefficient of the foreign ownership variable becomes significant in both probit and linear regression specifications, which implies robustness of the result with respect to the distributional assumptions and nonlinearities present in probit model.

The quantitative evolution of the impact of foreign ownership shows that foreign-owned banks are about 39% less cost-efficient than their comparable domestic counterparts. However, this number includes both the pure cost inefficiency, as well as possibly increased costs due to expansionary strategies, or focus on higher-quality services.

Furthermore, our estimations suggest that emerging countries that started negotiations on EU accession and eventually became (or will soon become) EU members experienced a downward shift in the cost frontier. This result documents that improved discipline resulting from the obligations related to the EU accession, together with benefits coming from technological and market spillovers, improves the technology of the banking sector in the accession countries.

The comparison of inefficiency scores provides evidence that the most advanced emerging countries (Czech Republic, Hungary, Poland, Slovakia) and Albania have the most inefficient banks. This result suggests that opening the financial sector for foreign entry does not necessarily improve the performance of banking institutions. Drawing parallels with the previous findings on a downward shift of the cost frontier

due to the EU accession, we interpret this result as the inability of the emerging markets that have recently entered the EU to accommodate the improved technological possibilities and fully enjoy the gains stemming from productivity improvements.

We would like to emphasize, however, that the negative association between foreign ownership and cost efficiency should not be confused with the contribution of foreign ownership to the stability of financial systems in emerging markets. The results should be rather interpreted as evidence of inefficient use of inputs by foreign-owned banks given the input prices and other country- and bank-specific characteristics. In other words, foreign-owned banks in emerging economies might be more active in terms of providing, say, more credits to local clients or extending banking services within their local networks in emerging markets (Giannetti and Ongena, 2005, Giannetti and Ongena, 2008). As was mentioned in Detragiache et al. (2008), a possible reason why this is not happening is that foreign-owned banks prefer stability to efficiency, and engage in activities with either top–ranked domestic clients, or foreign firms and governmental organizations to ensure safety of their operations.

In addition, we do not want to necessarily associate the negative impact of foreign ownership on cost efficiency with underperformance. After entering the new market, the foreign owner can follow strategies related to long-term success and development, which may be costly in the short-run. These include aggressive expansion in the market, or deep modernization and restructuralization, which usually require additional spending. However, this does not change our conclusion about foreign banks targeting primarily more efficient domestic banks.

To conclude, the results of our estimations suggest that opening domestic financial systems for foreign entry should not be regarded as a panacea for policymakers in emerging economies. To enjoy full benefits from foreign acquisition, the countries should develop appropriate strategies to diminish the impact of the *cream-skimming* effect.

Appendix

Derivations of the impact of foreign ownership on cost efficiency

In our setup, the cost inefficiency term has a truncated normal distribution $u \sim N^{+}\left(m, \sigma_u^2\right)$. Assume that there is a random variable $w \sim N\left(m, \sigma_u^2\right)$. The mean of this inefficiency term u is

$$\begin{aligned} E(u) &= E(w \mid w > 0) = m + \sigma_u E\left(\frac{w-m}{\sigma_u} \mid w > 0\right) = \\ &= m + \sigma_u E\left(\frac{w-m}{\sigma_u} \mid \frac{w-m}{\sigma_u} > -\frac{m}{\sigma_u}\right) \end{aligned}$$

Since $\frac{w-m}{\sigma_u} \sim N(0,1)$, we can further write

$$E(u) = m + \sigma_u \frac{\phi\left(-\frac{m}{\sigma_u}\right)}{1 - \Phi\left(-\frac{m}{\sigma_u}\right)} = m + \sigma_u \frac{\phi\left(\frac{m}{\sigma_u}\right)}{\Phi\left(\frac{m}{\sigma_u}\right)}$$

where the last fraction is the inverse Mills ratio. Since

$$m = \lambda_0 + \sum_{m=1}^{M} \lambda_m Z_m + \alpha P(I),$$

the (marginal) impact of foreign ownership on the expected inefficiency is

$$\begin{aligned} \frac{\partial E(u)}{\partial P(I)} &= \frac{\partial m}{\partial P(I)} \frac{\partial E(u)}{\partial m} = \\ &= \alpha \left(1 + \sigma_u \frac{\frac{1}{\sigma_u}\phi'\left(\frac{m}{\sigma_u}\right)\Phi\left(\frac{m}{\sigma_u}\right) - \frac{1}{\sigma_u}\left(\phi\left(\frac{m}{\sigma_u}\right)\right)^2}{\left(\Phi\left(\frac{m}{\sigma_u}\right)\right)^2}\right) \end{aligned}$$

Noticing that $\phi'(y) = -y\phi(y)$, we can complete the derivation by writing

$$\frac{\partial E(u)}{\partial P(I)} = \alpha \left(1 - \frac{m}{\sigma_u} \frac{\phi\left(\frac{m}{\sigma_u}\right)}{\Phi\left(\frac{m}{\sigma_u}\right)} - \left(\frac{\phi\left(\frac{m}{\sigma_u}\right)}{\Phi\left(\frac{m}{\sigma_u}\right)}\right)^2\right).$$

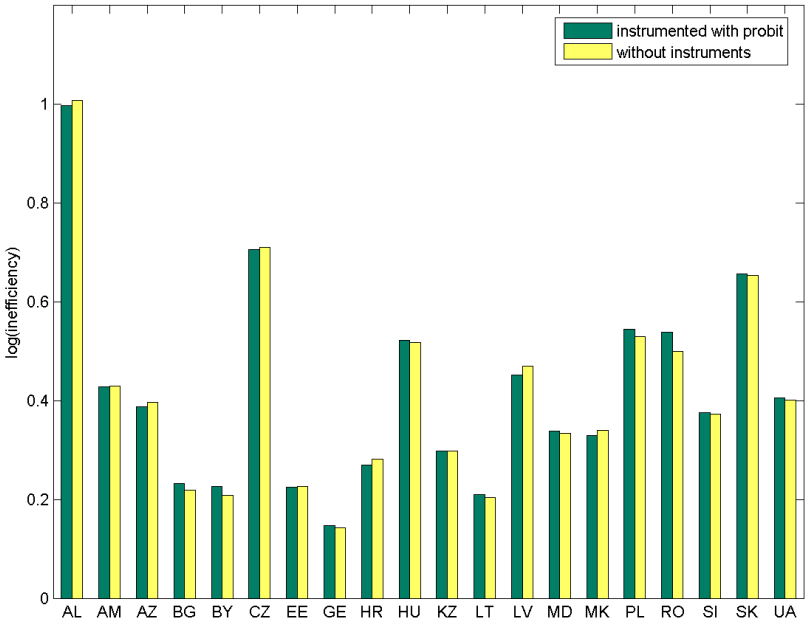

Figure 2.1. Average inefficiency scores for individual countries.

Notes: AL - Albania, AM - Armenia, AZ - Azerbaijan, BG - Bulgaria, BY - Belarus, CZ - Czech Republic, EE - Estonia, GE - Georgia, HR - Croatia, HU - Hungary, KZ - Kazakhstan, LT - Lithuania, LV - Latvia, MD - Moldova, MK - Macedonia, PL - Poland, RO - Romania, SI - Slovenia, SK - Slovakia, UA - Ukraine

Table 2.1. Summary of results from panel data studies on bank efficiency in FSEs

	Grigorian & Manole (2006)	Yildirim & Philippatos (2007)	Rossi, Schwaiger & Winkler (2004)	Bonin, Hasan & Wachtel (2005)	Fries & Taci (2005)
Sample	1995-1998	1993-2000	1995-2002	1996-2000	1994-2001
Number of banks	585	325	272	225	289
Number of observations	1074	2042	1070	856	1897
Number of countries	17	12	9	11	15
Method	DEA	SFA & DFA	SFA (Fourier)	SFA	SFA
Efficiency types	DEA(1)-profit generation DEA(2)-service provision	cost and profit	cost and profit	cost and profit	cost
Mean efficiency					
Cost	0.39-0.71	DFA-0.72; SFA-0.76	0.36-0.87	0.41-0.78	0.40-0.75
Profit	N/A	DFA-0.66; SFA-0.5	0.32-0.71	0.5-0.82	N/A
Country-level factors					
GDP growth	+	+	N/A	N/A	?
Inflation rate	?	N/A	N/A	N/A	N/A
Monetary depth	?	N/A	N/A	N/A	+
Stock market capitalization	+	N/A	N/A	N/A	N/A
Market concentration	+	−(cost); +(profit)	N/A	N/A	?
Banking sector reforms	+	N/A	N/A	N/A	+(level); −(squared)
Non-banking sector reforms	+	N/A	N/A	N/A	N/A
Interest rate	N/A	N/A	N/A	N/A	+
Bank-level factors					
Capitalization	+	−(cost); ?(profit)	N/A	+	+
Foreign ownership	+	+(cost); −(profit)	N/A	+	+
Total assets (in log)	N/A	+(cost); −(profit)	N/A	N/A	N/A
Share of loans	N/A	+(cost); −(profit)	N/A	N/A	N/A
Share of non-loan assets	N/A	N/A	N/A	N/A	−
Share of non-performing loans	N/A	N/A	N/A	N/A	−
Deposit market share of bank	N/A	N/A	N/A	N/A	+

Notes: +, − and ? indicate positive, negative, and insignificant impact on efficiency, respectively.

Table 2.2. Descriptive statistics

	AL	AM	AZ	BG	BY	CZ	EE	GE	HR	HU	KZ	LT	LV	MD	MK	PL	RO	SI	SK	UA
Total # of obs.	40	42	58	4	40	176	40	42	231	108	103	69	112	56	44	248	126	110	108	167
Total # of banks	7	6	9	1	7	27	6	7	34	17	16	11	17	9	7	40	20	17	18	29
Ownership (%)																				
Domestic	22.5	30.9	87.9	0.0	60.0	23.9	42.5	54.8	71.0	20.4	76.7	50.7	58.9	67.9	81.8	43.5	37.3	73.6	28.7	61.7
Foreign	77.5	69.0	12.1	100.0	40.0	76.1	57.5	45.2	29.0	79.6	23.3	49.3	41.1	32.1	18.2	56.5	62.7	26.4	71.3	38.3
Independent variable																				
Total costs (C)	24.7	4.5	7.1	64.1	230.5	247.1	84.4	7.1	55.6	241.8	50.1	30.6	23.1	5.0	11.3	251.4	158.4	103.8	109.0	38.5
St. Dev.	40.0	2.8	13.2	21.7	518.9	412.6	120.8	6.4	102.4	366.7	77.2	35.4	31.1	3.6	19.6	389.4	341.8	155.4	145.0	66.7
Outputs																				
Total loans (Y_1)	30.7	11.5	35.5	554.9	822.0	1270.0	857.5	27.8	360.5	1236.6	294.2	274.5	167.8	19.7	31.1	1103.8	311.8	669.4	488.8	154.2
St. Dev.	31.2	9.1	77.6	375.3	2036.1	2046.4	1594.7	25.8	784.2	1976.7	579.6	522.7	344.9	16.9	32.2	1760.1	600.0	1117.3	606.6	287.0
Total deposits (Y_2)	338.9	31.3	68.5	874.1	1266.6	2635.6	1007.6	35.7	560.0	1869.4	340.3	401.9	299.5	26.0	59.0	1892.0	674.9	1002.3	1089.3	214.9
St. Dev.	524.4	25.9	147.8	292.5	3413.9	4397.1	1724.0	38.7	1215.4	2769.4	522.6	685.0	465.7	22.5	98.5	3097.1	1252.4	1515.1	1507.6	380.4
Input prices (%)																				
Non-interest expenses/total assets (X_1)	2.8	7.7	9.0	4.0	7.3	3.4	4.2	7.3	4.8	3.5	5.9	5.0	4.8	6.2	11.4	3.4	5.9	2.9	5.2	6.7
St. Dev.	2.5	6.1	6.3	0.1	2.4	4.6	2.4	2.2	4.7	1.9	2.9	5.4	5.2	2.9	12.0	1.8	4.3	1.0	12.8	4.2
Personnel expenses/total assets (X_2)	1.2	2.9	2.4	1.2	4.4	0.9	2.0	3.2	2.1	1.5	3.1	3.0	2.0	3.4	2.1	1.9	3.3	1.6	1.0	2.7
St. Dev.	0.7	1.8	2.1	0.1	2.0	0.5	0.9	1.3	1.0	0.8	2.4	1.4	1.3	1.2	0.4	0.9	2.0	0.4	0.4	1.7
Bank–specific correlates (%)																				
Other operating assets/total assets (Z_1)	1.6	6.4	7.8	3.3	7.4	2.0	3.3	5.5	2.9	2.3	6.0	3.6	3.2	7.3	6.0	2.3	4.1	2.4	3.7	6.5
St. Dev.	1.0	4.1	5.8	0.4	5.1	2.9	2.5	2.3	1.9	1.5	3.5	2.2	3.8	2.4	3.8	1.5	3.6	1.2	15.3	5.3
Net loans/total assets (Z_2)	22.3	37.5	42.2	47.4	52.5	39.3	51.9	54.1	50.2	50.2	50.6	49.7	36.0	47.6	46.4	46.6	38.1	53.0	42.8	52.3
St. Dev.	16.3	19.1	20.6	18.8	12.9	19.7	16.3	10.3	11.0	18.3	18.0	13.5	23.0	12.6	20.0	16.4	19.2	10.5	15.7	18.1
Net interest margin (Z_3)	4.3	12.5	6.9	6.2	10.3	3.0	5.0	15.7	5.3	5.0	7.7	5.2	4.5	11.1	7.3	5.2	9.3	3.7	3.3	9.6
St. Dev.	1.9	7.6	3.8	1.0	5.2	2.3	1.7	5.3	2.7	3.9	3.2	3.5	2.7	4.1	3.9	3.3	5.3	1.8	1.4	7.7
Cost to income ratio (Z_4)	88.4	51.2	75.5	57.8	75.7	82.6	76.5	53.7	74.8	71.7	63.8	91.6	83.1	57.4	50.9	69.2	79.4	65.5	82.0	60.8
St. Dev.	146.0	18.6	77.8	6.6	37.8	96.1	39.5	18.2	45.0	26.5	21.9	34.5	64.2	16.5	18.7	25.9	40.6	32.7	81.6	24.1
Equity/total assets (Z_5)	11.8	12.9	20.9	15.9	15.2	8.1	10.6	26.3	17.5	9.4	17.4	12.2	12.0	26.6	31.3	12.6	20.3	10.3	9.1	18.1
St. Dev.	13.9	7.8	16.3	0.7	8.3	6.5	5.1	12.7	13.0	4.4	13.9	11.0	13.1	14.5	13.2	12.6	11.5	3.6	8.2	10.7
Country–specific correlates																				
Interbank rate (G_1)	11.0	18.9	20.4	2.3	48.0	6.4	8.3	22.9	7.8	12.7	9.2	7.7	5.0	17.6	12.3	14.8	47.1	6.2	10.5	20.4
St. Dev.	5.8	10.7	2.0	1.1	30.5	4.7	5.8	9.6	5.4	4.4	6.6	4.7	5.2	8.9	5.2	7.2	39.2	2.9	7.1	18.2
Per capita GDP in USD (G_2)	1526.4	718.4	740.7	2329.5	1555.7	6695.7	4882.0	771.5	5095.9	5998.9	1694.1	3767.7	3557.2	479.6	2116.1	4545.2	2151.2	11253.9	4675.3	892.6
St. Dev.	475.5	178.5	160.4	631.7	428.7	1901.5	1755.2	174.4	1125.5	1868.8	499.9	1476.3	1162.1	137.8	346.3	946.5	620.4	2312.5	1415.3	232.8
Index of banking reforms (G_3)	2.3	2.3	2.2	3.3	1.4	3.4	3.6	2.4	3.3	4.0	2.6	3.0	3.3	2.3	2.8	3.2	2.7	3.2	3.1	2.1
St. Dev.	0.2	0.0	0.1	0.3	0.4	0.3	0.3	0.1	0.4	0.2	0.3	0.3	0.4	0.2	0.1	0.1	0.2	0.1	0.3	0.1
Index of economic freedom (G_4)	3.4	3.1	3.9	3.2	4.1	2.3	2.0	3.6	3.4	2.6	3.8	2.6	2.6	3.3	3.2	2.9	3.5	3.1	2.9	3.8
St. Dev.	0.2	0.4	0.4	0.2	0.1	0.1	0.3	0.3	0.2	0.3	0.2	0.4	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.2

Notes: AL - Albania, AM - Armenia, AZ - Azerbaijan, BG - Bulgaria, BY - Belarus, CZ - Czech Republic, EE - Estonia, GE - Georgia, HR - Croatia, HU - Hungary, KZ - Kazakhstan, LT - Lithuania, LV - Latvia, MD - Moldova, MK - Macedonia, PL - Poland, RO - Romania, SI - Slovenia, SK - Slovakia, UA - Ukraine

Table 2.3. Panel estimation of stochastic efficiency frontier models

	Instruments – Probit	Instruments – OLS	Without Instruments
Independent variables			
Constant	0.8857***	0.8955***	0.7941***
	(0.1513)	(0.1478)	(0.1556)
$\log(y_1)$	0.4713***	0.4692***	0.5494***
	(0.0561)	(0.0518)	(0.0566)
$\frac{1}{2}(\log(y_1))^2$	0.2029***	0.2023***	0.1968***
	(0.0060)	(0.0060)	(0.0066)
$\log(y_2)$	0.6583***	0.6586***	0.5860***
	(0.0542)	(0.0488)	(0.0545)
$\frac{1}{2}(\log(y_2))^2$	0.2132***	0.2109***	0.2099***
	(0.0110)	(0.0105)	(0.0113)
$\log(\frac{x_1}{x_2})$	0.5097***	0.5097***	0.5126***
	(0.0404)	(0.0374)	(0.0422)
$\frac{1}{2}(\log(\frac{x_1}{x_2}))^2$	0.1774***	0.1776***	0.1784***
	(0.0084)	(0.0082)	(0.0086)
$\log(y_1)\log(y_2)$	-0.2071***	-0.2055***	-0.2027***
	(0.0066)	(0.0065)	(0.0069)
$\log(y_1)\log(\frac{x_1}{x_2})$	0.0306***	0.0288***	-0.0307***
	(0.0112)	(0.0108)	(0.0112)
$\log(y_2)\log(\frac{x_1}{x_2})$	-0.0497***	-0.0482***	0.0481***
	(0.0106)	(0.0105)	(0.0107)
t	-0.0039	-0.0040	0.0119
	(0.0184)	(0.0181)	(0.0189)
$\frac{1}{2}t^2$	0.0020	0.0019	0.0010
	(0.0017)	(0.0017)	(0.0018)
$t \cdot \log(y_1)$	0.0238***	0.0238***	0.0173***
	(0.0047)	(0.0045)	(0.0048)
$t \cdot \log(y_2)$	-0.0329***	-0.0329***	-0.0268***
	(0.0047)	(0.0045)	(0.0048)
$t \cdot \log(\frac{x_1}{x_2})$	0.0045	0.0045	-0.0056
	(0.0035)	(0.0032)	(0.0037)
Country-specific variables (cost frontier modifiers)			
Log per capita GDP (USD)	0.0162	0.0156	0.0124
	(0.0128)	(0.0129)	(0.0132)
Risk-free interest rate	0.0062***	0.0062***	0.0069***
	(0.0005)	(0.0005)	(0.0005)
EBRD Index of banking sector reform	0.0637***	0.0639***	0.0623***
	(0.0163)	(0.0162)	(0.0164)
EU accession trend	-0.0960***	-0.0935***	-0.0651*
	(0.0242)	(0.0231)	(0.0242)
Bank-specific variables (inefficiency correlates)			
Net interest margin	-0.0314***	-0.0324***	-0.0414***
	(0.0051)	(0.0051)	(0.0051)
Other operating income/total assets	-0.0266***	-0.0267***	-0.0308***
	(0.0047)	(0.0046)	(0.0048)
Net loans/total assets	-0.0246***	-0.0247***	-0.0254***
	(0.0013)	(0.0013)	(0.0015)
Equity/total assets	0.0049***	0.0049***	0.0057**
	(0.0013)	(0.0013)	(0.0014)
FDI^a	0.6534***	0.6410***	0.0319
	(0.1142)	(0.1149)	(0.0270)

Notes: the dependent variable is $\log(\frac{c}{x_2})$. Standard errors are given in parentheses. *, **, and *** stand for 10%, 5%, and 1% significance levels, respectively.

[a] Predicted probabilities $P(\cdot)$ of foreign ownership for first and second columns.

Table 2.4. Panel estimation of stochastic efficiency frontier models, cont.

	Instruments – Probit	Instruments – OLS	Without Instruments
Marginal effects			
$\log(y_1)$	1.5408***	1.5405***	1.4698***
	(0.0427)	(0.0428)	(0.0448)
$\log(y_2)$	1.5572***	1.5420***	1.6124***
	(0.0740)	(0.0710)	(0.0764)
$\log(\frac{x_1}{x_2})$	0.7162***	0.7165***	0.8454***
	(0.0099)	(0.0095)	(0.0100)
t	-0.0223	-0.0227***	-0.0327***
	(0.0193)	(0.0194)	(0.0195)
Variance parameters			
γ	0.8569	0.8546	0.8627
σ^2	0.1288	0.1288	0.1356
σ_v^2	0.1104	0.1100	0.1170
σ_u^2	0.0184	0.0187	0.0186
Number of observations	1924	1924	1924
Number of banks	305	305	305

Notes: marginal effects evaluated at variable means. Standard errors are given in parentheses. *, **, and *** stand for 10%, 5%, and 1% significance levels, respectively. $\gamma = \frac{\sigma_u^2}{\sigma^2}$ and $\sigma^2 = \sigma_v^2 + \sigma_u^2$

Table 2.5. First-stage regression results

	Probit	OLS
Inefficiency correlates		
Constant	-2.0711***	-0.2107
	(0.4415)	(0.1520)
Net interest margin	-0.0415***	-0.0150***
	(0.0082)	(0.0028)
Other operating income/total assets	-0.0150***	-0.0059***
	(0.0056)	(0.0023)
Net loans/total assets	0.0015	0.0005
	(0.0018)	(0.0006)
Equity/total assets	0.0018	0.0004
	(0.0027)	(0.0010)
Instruments		
Country population / number of banks	1.0754***	0.3905***
	(0.1871)	(0.0674)
Country risk-free interest rate	0.0042	0.0016
	(0.0029)	(0.0011)
Deposits / loans	-0.0023	-0.0005
	(0.0014)	(0.0003)
Assets / net interest revenue	0.0020**	0.0005**
	(0.0008)	(0.0002)
t	0.2716***	0.0912***
	(0.0874)	(0.0304)
$\frac{1}{2}t^2$	-0.0173**	-0.0055*
	(0.0087)	(0.0030)

Notes: the dependent variable is *foreign ownership*. Standard errors are given in parentheses. *, **, and *** stand for 10%, 5%, and 1% significance levels, respectively.

Table 2.6. Tests of instrument validity

	Regression 1	Regression 2
Constant	1.0120***	0.9853***
	(0.0459)	(0.0410)
Foreign ownership	0.5299**	0.5071***
	(0.2128)	(0.1026)
Net interest margin	-0.0116***	-0.0120***
	(0.0035)	(0.0026)
Other operating income/total assets	-0.0084***	-0.0087***
	(0.0019)	(0.0017)
Net loans/total assets	-0.0146***	-0.0147***
	(0.0005)	(0.0004)
Equity/total assets	0.0019***	0.0018***
	(0.0007)	(0.0007)
Instruments		
Country population / number of banks	0.0387	
	(0.1024)	
Country risk-free interest rate		3.7×10^{-4}
		(8.0×10^{-4})
Deposits / loans	3.8×10^{-4}	
	(2.4×10^{-4})	
Assets / net interest revenue		8.0×10^{-5}
		(1.6×10^{-4})
t	-0.0083	
	(0.0081)	
$\frac{1}{2}t^2$		-5.9×10^{-4}
		(5.5×10^{-4})

Notes: the dependent variable is $\log(inefficiency)$. Standard errors are given in parentheses. *, **, and *** stand for 10%, 5%, and 1% significance levels, respectively.

Regression 1: Excluded instruments for foreign ownership: Country risk-free interest rate, Assets / net interest revenue, $\frac{1}{2}t^2$.

Regression 2: Excluded instruments for foreign ownership: Population / number of banks, Deposits / loans, t.