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Bank performance, efficiency and ownership in transition countries

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Bank performance, efficiency and
ownership in transition countries



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All opinions expressed are those of the authors and do not necessarily reflect the views of the Bank of Finland.

John P. Bonin *, Iftekhar Hasan ** and Paul Wachtel ***

Bank performance, efficiency and ownership in transition countries

Abstract

Using data from 1996 to 2000, we investigate the effects of ownership, especially by a strategic foreign owner, on bank efficiency for eleven transition countries in an unbalanced panel consisting of 225 banks and 856 observations. Applying stochastic frontier estimation procedures, we compute profit and cost efficiency scores taking account of both time and country effects directly. In second-stage regressions, we take these efficiency measures along with return on assets as dependent variables with dummy variables for ownership type, a variable controlling for bank size, and dummy variables for year and country effects as explanatory variables. Methodologically, our results demonstrate the importance of including fixed effects, especially country effects, and also suggest a preference for efficiency measures over financial measures of bank performance in empirical work on transition countries.

With respect to the impact of ownership, we conclude that privatization by itself is not sufficient to increase bank efficiency as government-owned banks are not appreciably less efficient than domestic private banks. Our results do support the hypothesis that foreign ownership leads to more efficient banks in transition countries. We find that foreign-owned banks are more cost-efficient than other banks and that they also provide better service, in particular if they have a strategic foreign owner. Moreover, the participation of international institutional investors is shown to have a considerable additional positive impact on profit efficiency, which is consistent with the notion that these investors facilitate the transfer of technology and know how to newly privatized banks. In addition, we find that the remaining government-owned banks are less efficient in providing services, which is consistent with the hypothesis that the better banks were privatized first in transition countries. Finally, efficiency declines with bank size, which could call into question government-orchestrated bank consolidation strategies. We conjecture that the presence of many small and efficient foreign greenfield operations in these transition countries may be responsible for this result.

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Bank performance, efficiency and ownership in transition countries

Tiivistelmä

Tässä työssä tutkitaan omistajuuden, erityisesti strategisen ulkomaisen omistajan, vaikutusta pankkien tehokkuuteen yhdessätoista siirtymätalousmaassa käyttäen 225 pankin ja 856 havainnon paneelidataa vuosilta 1996–2000. Tutkimuksessa lasketaan voitto- ja kustannusarvioita käyttämällä sekä aika- että maatekijät huomioon ottavaa stokastista rintamaestimointia. Toisen asteen regressiossa käytetään näitä tehokkuusmittareita yhdessä omistuksen tuoton kanssa selitettävänä muuttujana. Selittävinä muuttujina käytetään omistustyyppiä, pankin kokoa sekä vuosi- ja maaindikaattorimuuttujia. Tulokset osoittavat, että kiinteiden vaikutusten ja erityisesti maavaikutusten ottaminen huomioon on menetelmällisesti tärkeää. Lisäksi osoittautuu, että tehokkuusmittarit ovat parempia kuin rahalliset mittarit siirtymätalousmaiden pankkien empiirisessä tutkimuksessa.

Yksityistäminen sinänsä ei ole riittävä tae pankkien tehokkuuden parantamiseksi, sillä valtionpankit eivät ole tehottomampia kuin kotimaisesti omistetut yksityiset pankit. Tämän tutkimuksen tulokset tukevat sitä hypoteesia, että ulkomainen omistus johtaa pankkien toiminnan tehostumiseen siirtymätalousmaissa. Ulkomaalaisomisteiset pankit ovat kustannustehokkaampia ja tarjoavat myös parempaa palvelua, erityisesti jos niillä on strateginen ulkomainen omistaja. Kansainvälisten institutionaalisten sijoittajien mukanaololla on lisäksi huomattavan myönteinen vaikutus voittotehokkuuteen. Tämä käy yksiin sen kanssa, että nämä sijoittajat edesauttavat teknisen kehityksen ja tietotaidon siirtymistä hiljattain yksityistetyille pankeille. Suuret pankit ovat tehottomampia, mikä kyseenalaistaa valtiolliset yritykset yhdistää pankkeja. Monien uusien, pienien ja tehokkaiden ulkomaisten pankkien olemassaolo saattaa selittää tämän havainnon.

1 Introduction

Banking sectors in transition countries differ from their counterparts in many developing and emerging market countries by the high percentage of assets held in banks with majority foreign ownership. The change in foreign participation in banking in these countries from the early transition years to the later ones is dramatic. This paper investigates the impact of extensive foreign ownership on the performance of banks in eleven transition countries. These countries are four northern European countries, the Czech Republic, Hungary, Poland, and Slovakia, four southern European countries, Bulgaria, Croatia, Romania, and Slovenia, and the three Baltic countries, Estonia, Latvia, and Lithuania.

In 2000, the percentage of assets in banks with majority foreign ownership in these countries ranges from highs of 97.4% in Estonia and 84.1% in Croatia to a low of 15.6% in Slovenia (Keren and Ofer, 2002). In eight of the eleven countries, more than half of the assets are in banks having majority foreign ownership; in Slovakia and Romania 42.7% and 46.7% of assets are in banks having majority foreign ownership leaving Slovenia as the outlier in terms of foreign ownership. By contrast, in Latin America, only Chile had more than 50% of its banking sector controlled by foreign interests in 1999 and that number was only 53.6% (IMF, 2000). In the transition countries, the change in ownership structure over the last half of the decade has been remarkably rapid. In 1997, in only Hungary and Latvia were more than half of banking assets in majority foreign-owned banks. Moreover, Estonia and Croatia had only 28.8% and 3%, respectively, of their banking assets in majority foreign-owned banks in 1997.

How should we expect foreign ownership to affect the performance of individual banks in these transition countries? Claessens, Demirgüç-Kunt and Huizinga (2001) investigate performance differences between domestic and foreign banks in eighty countries, both developed and developing, over an eight-year period from 1988 to 1995. These authors find that foreign bank entry was followed by a reduction in both profitability and the overhead expenses of domestic banks. Hence, these authors suggest that foreign participation improves the efficiency of domestic banking. However, banking sectors in transition economies are different from their counterparts in the developed or the developing countries due to the legacies of central planning. How these differences may

affect the influence of foreign participation in the banking sectors of transition countries is the motivation for this paper.

Prior to the transition, banking sectors in the region were usually segmented functionally so that state savings bank, with an extensive branch network, collected household deposits, a state foreign trade bank handled all transactions involving foreign currency, a state agricultural bank provided short-term financing to the agricultural sector, and a state construction bank funded long-term capital projects and infrastructure development (Bonin and Wachtel, 1999). Domestic commercial transactions were handled by the National Bank until these responsibilities were hived off to newly created state banks, in some countries only one in others several or even many. Most countries started the transition with a small number of large fully government-owned banks and few if any private or foreign banks. Even by 1993, banks with majority government ownership controlled more than half of all banking assets in Hungary, Lithuania, Poland, and Slovakia.

The initial situation was different in Croatia and Slovenia, which were republics of Yugoslavia prior to 1991. Since the 1950s, Yugoslavia had a two-tier banking system consisting of a National Bank and individual commercial banks that were not state-owned but rather owned collectively under the Yugoslavian system of self-management. Croatia and Slovenia each had only one main bank. However, the establishment of internal company banks in the late 1970s in these countries led to excessive numbers of small unhealthy banks. Hence, even though concentration ratios were high, the banking sectors contained many small and undercapitalized banks. The major banks in both countries were weakened considerably when their foreign currency deposits at the National Bank of Yugoslavia in Belgrade were blocked after secession. This policy of the Yugoslavian, mainly Serbian, government left Croatian and Slovenian banks with a serious currency mismatch problem because they had loans denominated in foreign currency and no foreign currency deposits. Government rehabilitation policies to resolve this problem in both countries led to bank nationalization. Therefore, government-owned banks were created in Slovenia and Croatia as part of a bank-restructuring program. Majority-government-owned banks held 58.9% and 47.8%, respectively, of all banking assets in Croatia and Slovenia by 1993.

As former republics of the Soviet Union, the three Baltic countries, i.e., Estonia, Latvia, and Lithuania, have legacies similar but not identical to those of the Central

European countries. Soviet-style banking was not only segmented in the manner described above but it was centralized in Moscow. The banking sectors in the small Baltic republics were a mixture of Soviet banking, e.g., branches of the state savings bank, and smaller republic banks. Secession left banking in disarray; connections with the Russian banking system were not severed immediately and entry of small, undercapitalized banks added to the fragility of the financial system. In 1993, Estonia had only one bank with majority foreign ownership, three government-owned banks, and 17 other private banks for a total of twenty-one banks in a country of 1.5 million people. In the fall of the previous year, three of Estonia's largest banks holding about 40% of all banking assets were declared insolvent and, in 1993, eight small commercial banks were closed for failing to meet quite minimal capital requirements (Bonin, Mizsei, Szekely and Wachtel, 1998). The first priority in the Estonian transition was to deal with the financial and banking crises attributable mainly to the legacies of the Soviet past. The other Baltic countries faced similar problems; in essence, the banking sectors of the Baltic countries were recreated during the transition.

In this paper, we investigate the effect of ownership, especially majority foreign ownership, on bank performance in eleven transition economies using the BankScope database. In the next section, we review the literature on bank performance in transition economies. Section 3 describes the cleaning of the data required to construct our unbalanced panel of banks from 1996 to 2000. In this section, we also develop the ownership typology, characterize the distribution of bank observations across time, country and ownership category, and present descriptive statistics. Section 4 describes our methodology for calculating bank efficiency scores from stochastic frontier estimations of cost and profit functions that include country and year effects, presents alternative specifications, and discusses choices among them. In section 5, we present second-stage regressions that use efficiency measures and a financial performance variable, return on assets (ROA), as dependent variables. The explanatory variables are dummies for ownership type, with domestic private ownership as the excluded category, a variable to control for bank size, and country and year fixed effects. The robustness of the ownership results is discussed in this section. In the concluding section, we draw policy implications from our results and make suggestions for further work.

2 Bank performance in transition countries: The literature

The banking literature on transition countries concludes that ownership matters; in particular, government ownership of banks is argued to be less efficient than private ownership (Bonin, Mizsei, Szekely and Wachtel, 1998). As government-owned banks are privatized by sales of shares to foreign owners, Buch (1997) asserts that the foreign investors bring state-of-the-arts technology and human capital to domestic banks that are encumbered by the legacies of the centrally planned era. In addition, many foreign greenfield operations that were opened at the beginning of the transition or even before have grown quickly to become moderately sized banks in their host countries by the second half of the 1990s. If foreign-owned banks use modern technology from, and rely on the human capital of, their parent banks, they should perform better than government-owned or domestic private banks in transition countries. In addition, private banks should perform better than government-owned banks.

Several recent studies employ financial measures to examine empirically the impact of foreign bank entry and ownership on banking sectors in transition countries. Using averages across ownership classes from 1996 to 1998, IMF (2000) reports that return on equity is significantly higher for foreign banks than for domestic banks in Hungary, Poland and the Czech Republic. Drakos (2003) examines net interest margins from 1993 to 1999 in eleven transition countries, nine of which are countries considered in this paper. This author finds that interest margins decrease significantly over time for the entire group of banks and that ownership matters in that, somewhat surprisingly, government-owned banks set narrower interest margins than other banks. Drakos concludes that foreign entry increases the performance of the banking sector, both directly and indirectly, in these transition countries. Fries and Taci (2002) analyze bank performance in sixteen transition countries from 1994 to 1999 and conclude that, although foreign ownership is not correlated with stronger real growth in lending, a greater presence of foreign banks in the financial sector has a positive spillover effect on real growth in loans. In a related paper, Fries, Neven, and Seabright (2002) examine the effects of financial sector reform on the performance and competition of the banking sectors. In countries that have made significant progress on financial reforms, these authors find that banks make reasonable margins on loans, offer competitive rates on deposits, and make negative returns on equity,

on average. In countries that have not proceeded very far in reforming their financial sectors, banks achieve high rates of return on equity but mainly at the expense of depositors, who are held hostage to low, sometimes negative, real returns on their accounts for lack of alternatives. Hence, the empirical literature on banking in transition countries finds relatively strong competitive effects of foreign bank entry.

The relationship between bank performance and ownership is also examined in several recent papers that estimate bank efficiency in a single country. For Hungary from 1993 to 1998, Hasan and Marton (2003) use stochastic frontier analysis (SFA) and find that relatively more efficient foreign banks created an environment that forced the entire banking system to become more efficient. For Polish banks from 1997 to 2000, Nikiel and Opiela (2002) use a different efficiency estimation method, the distribution-free approach, and find that foreign banks servicing foreigners and business customers are more cost-efficient but less profit-efficient than other banks in Poland. For Croatia in 1994 and 1995, Kraft and Tirtiroglu (1998) use SFA and show that new banks are less efficient but more profitable than both old privatized banks and state banks. For Croatia from 1995 to 2000, Jemric and Vujcic (2002) use data envelopment analysis (DEA) and find that foreign banks and new banks are more efficient. From these single-country studies, a positive relationship between foreign ownership and bank performance is beginning to emerge.

Two recent multi-country studies consider the relationship between ownership and efficiency in transition countries. Grigorian and Manole (2002) use DEA to estimate bank efficiency in seventeen countries from 1995 to 1998; in addition to our eleven countries, these include Russia and five other countries that were former Soviet republics. These authors find strong evidence that foreign controlling ownership is associated with greater efficiency and some weak evidence that improving prudential rules is also associated with greater efficiency. Yildirim and Philippatos (2002) estimate efficiency with both SFA and the distribution free approach using data from 12 transition countries from 1993 to 2000; compared with our eleven countries, these include Russia and Macedonia but exclude Bulgaria. These authors find that foreign majority owned banks are more cost efficient but less profit efficient than other banks in these transition countries. As the threshold for determining foreign control of a bank, Grigorian and Manole (2002) take a 30% stake held by foreign owners as a group whereas Yildirim and Philippatos (2002) use a majority foreign stake in their analysis. As we argue below, the latter is preferable for transition countries. Neither study takes account of country or time effects in the estimations or in

the regression analysis even though Yildirim and Philippatos (2002) find significant country differences in profit and cost efficiency.

Our multi-country study differs from the two mentioned above in three ways. First, to investigate in more detail the ownership effect on bank performance in transition economies, we divide majority foreign-owned banks into two categories, namely, banks with and without a single strategic foreign investor. In our classification, a bank with a strategic foreign investor is both majority foreign owned and controlled by a single owner. Hence, our threshold for foreign control is significantly higher than the one used by Grigorian and Manole to take account of the special characteristics of banking in transition economies. Although a group of foreign owners may hold a 30% stake, the controlling owner could well be the government with its large residual stake or even inside management in the absence of any dominant outside owner.¹ Second, to account for possible systematic variation across countries and time, we control for these effects directly in the frontier estimations of the efficiency scores. Third, we investigate the separate impact of the participation of international institutional investors on bank performance.

During the early stages of several privatizations of large banks in transition countries, the European Bank for Reconstruction and Development (EBRD) took a temporary ownership stake when the government was divesting itself gradually of full ownership. This strategy was intended to bridge the transfer of ownership to a strategic foreign owner, who would eventually purchase the EBRD's stake. During this period, the International Finance Corporation (IFC) and various international investment funds also took ownership stakes in these banks. As shareholders, international institutions were involved in arranging the transfer of technology and know-how to banks in transition countries. In addition, the participation in ownership of a high profile international institution or investment fund conferred a quality signal and, thus, enabled the bank to attract better clients, to hire more highly trained personnel, and to access cheaper sources of funding. To investigate the influence of international institutional investors, we identify the banks in our sample that have such shareholders and examine the additional impact of this participation on bank performance.

¹ When Bank Slaski was initially privatized in Poland, ING and the Polish government held roughly equal stakes so that the bank's management was able to pursue its own strategies by pitting one owner against the other (Abarbanell and Bonin, 1997)

3 The data and the ownership typology

Academic research has made widespread use of the bank financial statements provided by Thompson's BankScope and Bureau van Dijk for close to ten thousand banks around the world from the early 1990s. However, the data for banks from less developed and transition countries require substantial editing before a reliable sample can be constructed. Careful review of these data is needed to avoid double counting of institutions, to choose the most appropriate accounting standards, and to exclude non-bank financial institutions of various kinds. As an example of the first problem, the large banks in Hungary are listed four times each in the data set and multiple listings are common for the previously state-owned banks in both Poland and the Czech Republic. As an example of the second problem, many banks in transition countries have two entries, one using International Accounting Standards (IAS) and the other using domestic accounting practices. As an example of the third problem, two automobile finance companies in Hungary, Opel Bank and Porsche Bank, are included in the data set and designated as commercial banks. In addition, multiple entries often reflect different levels of organizational consolidation so that care must be taken in choosing an individual bank observation.

For our sample, we select eleven relatively advanced transition countries. Our preliminary investigations indicated that the bank data for the other transition countries, mostly notably those from the former Soviet republics, are less accurate and represent very different institutional structures and experiences. To choose the bank observations in these eleven countries, we use the following criteria. First, the consolidated bank or bank holding company is used whenever more than one set of accounts is provided. Second, IAS data are used wherever available and, if these are not available, inflation-adjusted local accounting standards data are used. If the only data available are local standards nominal data, we use these. In some instances where IAS data are available for only one or two years and substantially more data are available using local standards, local standards data are used. Third, central banks, government development banks, investment banks, export-import banks and cooperative banks are excluded from the sample.

One aspect of the BankScope data that has attracted little attention to date is the information on the ownership structure of each bank. The major individual owners, as of 1999, are listed by name, country of origin, and percentage ownership stake. Although the

ownership information is often incomplete, we are able to determine the nature of the controlling interest in virtually all cases. However, we are unable to consider changes of ownership during the data period because the BankScope data provides ownership information for only one year, 1999. Although financial data are available beginning in 1993, the early years include only a handful of institutions even in the most advanced transition countries. Consequently, we use data for 1996 to 2000 for broader coverage and because the observations reflect more accurately the available ownership information.² The final data set is an unbalanced panel due to missing data for some years for some banks.

We divide ownership into four mutually exclusive and collectively exhaustive categories, namely, majority government ownership, majority domestic private ownership, strategic foreign ownership, and other foreign majority ownership.³ Starting with the group of banks having majority foreign ownership, we identify those with a strategic foreign owner, who is defined as either a single majority owner or a single controlling owner. Banks with a strategic foreign owner may be greenfield operations set up in a transition country or domestic banks in which a single foreign owner purchases a controlling stake most commonly during the privatization of a government-owned bank. The remaining banks in which the foreign owners together hold more than 50% of the shares, although no one of these has a controlling stake, are considered to have other foreign majority ownership. The BankScope data also allow us to identify the share ownership of international financial institutions, e.g., EBRD or IFC, or internationally sponsored investment funds, e.g., the U.S. enterprise funds.

Our final data set consists of 225 banks from eleven countries for a total of 856 bank-year observations for which we have both ownership status and financial information. The number of banks from each country and the number of bank-year observations are shown in Table 1. No one country dominates our sample; Polish banks make up about 17% of the sample while Croatia and Hungary each account for about 14% of the bank

² Former government-owned banks that are designated as foreign-owned banks in 1999 but were privatized after 1996 were being prepared for privatization during this period so that the ownership designation does not do serious injustice to the data.

³ If the percentages in the data do not add to 100%, we infer the characteristics of the remaining owners because we are interested only in the type of majority owner. If the data provide such information, as is usually the case, an assumption about residual owners is irrelevant. If there is no majority owner and the stakes do not add up to 100%, we assume that there are unreported domestic private owners so long as some private ownership is indicated. If no private ownership is indicated, we attribute the residual to the largest category of owners reported. In this way, we allocate 100% of the bank's shares to foreign, government or private owners for each observation.

observations. The observations are spread relatively evenly over the last three years in the sample; only the first year has significantly fewer observations both in total and in Romania, Bulgaria and Lithuania. After 1996, the number of observations in each country is relatively stable except for Romania in 1997.

The percent of bank-year observations in the four ownership categories is shown by total and by country in Table 1. About 53% of the observations in the sample correspond to banks with a strategic foreign owner while another 7% are majority foreign owned. Only 10% of the observations pertain to banks in which the government retains a majority stake and about 30% observations represent banks that are majority-owned by domestic private investors. In addition, about 9% of the observations come from banks having an international institutional investor. Virtually all, over 92%, of the banks with an international institutional investor have majority foreign ownership and about 75% of these observations involve banks with a single strategic foreign owner. This is consistent with the notion that these international institutional investors are involved in facilitating the bank privatization process.

Strategic foreign ownership, measured as a percentage of the bank-year observations, is highest in Estonia, Hungary, the Czech Republic and Slovakia. By comparison, Croatia and Slovenia have percentages well below 50% for any type of foreign ownership in 1999.⁴ The dramatic change in bank ownership in the 1990s in these eleven transition countries is evidenced by the small percentage of bank-year observations in which the government holds a majority stake by 1999. Only in Slovenia is this percentage above 15%. Domestic private ownership is above 50% of the bank-year observations in Latvia, Croatia and Slovenia. International institutions and international investment funds hold banks' shares in all countries, except for Latvia and Slovenia. Banks in Bulgaria, Estonia, and Romania have the highest participation rates of international institutional investors.

Descriptive statistics for bank characteristics and financial performance measures are reported in Table 2. The average value of bank assets, measured in 1993 U.S. dollars, is over one billion and the coefficient of variation is more than two. Taking other balance sheets characteristics as percentages of assets, loans are 42.8%, deposits are 76.4%, equity is 12.7%, and non-interest expenditure is 6.9%. Finally, the average net interest margin is

⁴ By the end of 2000, all but one of the largest ten banks in Croatia had attracted a strategic foreign owner. However, the privatization of Croatia's banks was slow due to the necessary state rehabilitation after

5.5% with a coefficient of variation of less than one. Turning to financial performance measures, the mean rate of return on assets (ROA) is 1% with a coefficient of variation of more than 5 and the mean return on equity (ROE) is 3.6% with an extremely large coefficient of variation. Thus, the standard measures of financial performance, namely ROA and ROE, exhibit significantly more variability across the sample than do other balance sheet characteristics.

The banking literature suggests that increased competition leads to smaller profit margins and lower returns. The literature on banking in transition countries recognizes that the standard financial performance measures are often higher, the less reformed is the banking sector and the less developed is the regulatory procedures (Fries, Neven, and Seabright, 2002). In addition, these measures are sensitive to the strategies used to write off, and provision for, bad loans. Hence, using ROA and ROE as measures of bank performance in transition countries is fraught with difficulties. For this reason, we estimate stochastic cost and profit frontiers in the next section to develop efficiency measures of bank performance.

4 Efficiency measures of bank performance

Stochastic frontier analysis (SFA) has been applied widely to banking and other industries since its introduction by Aigner *et al.* (1977). Recent econometric developments are summarized in Kumbhakar and Lovell (2000); Berger and Mester (1997) discuss applications to banking. SFA starts with a standard cost or profit function and estimates the minimum cost or maximum profit frontier for the entire sample from balance sheet data. The efficiency measure for a specific bank observation is its distance from the frontier. We illustrate the methodology using cost efficiency first and discuss its application to the profit function later.

Suppose that total costs for the i -th bank in year t , TC_{it} , are given by equation (1) in which Y_{it} represents the various products or services produced by the firm and P_{it} represents the prices of inputs. The random disturbance term has two components; v_{it}

secession from Yugoslavia so that strategic foreign ownership was not prevalent in 1999. In contrast, most of

represents measurement error and other uncontrollable factors while u_{it} represents technical and allocative inefficiency aspects that can be influenced by management. Hence, we have:

$$TC_{it} = f(Y_{it}, P_{it}) + v_{it} + u_{it} \quad (1)$$

As is common in the efficiency literature, we use a translog specification for the cost function in (1) with the standard symmetry and homogeneity assumptions. For the profit function, the left hand side variable is total profit and the disturbance is specified to be

$v_{it} - u_{it}$. The SFA approach maintains that managerial or controllable inefficiencies, i.e., u_{it} , increase costs only above, or profits only below, the frontier or best-practice levels. However, random fluctuations, i.e., v_{it} , may either increase or decrease costs or profits from these benchmarks. Hence, the frontier itself is stochastic and the term u_{it} represent inefficiency or the distance from best practice.

Furthermore, the v_{it} terms are assumed to be identically distributed as normal variates with zero mean and variance equal to σ_v^2 . The u_{it} terms are nonnegative random variables distributed normally but truncated below zero. We assume that the u_{it} terms are distributed independently but not identically. Hence, for the i -th bank in year t , technical inefficiency, u_{it} , is assumed to follow a half normal distribution, i.e., $N(\mu_{it}, \sigma_{u_{it}}^2)$, in which both the mean μ_{it} and variance $\sigma_{u_{it}}^2$ may vary. Because structural conditions in banking and general macroeconomic conditions may generate differences in banking efficiency from country to country, we include both country effects and time effects in the estimation of the frontier. Specifically, in addition to the half normal specification with constant mean and variance, we estimate frontiers that allow for a mean shift or for a heteroscedastic variance. In each case, the mean or the heteroscedastic variance is specified by $z_{it} \delta$, where z_{it} is a vector of dummy variables for year and country effects.

Total costs are the sum of interest and non-interest costs. The output variables, Y_{it} , are total deposits, total loans, total liquid assets and investments other than loans and liquid assets. The input prices are the price of capital, measured by the ratio of non-interest expenses to total fixed assets, and the price of funds, measured by the ratio of interest

the large Slovenian banks remained domestically owned in 2000.

expenses to total deposits.⁵ The output variables and costs are normalized by total loans and the input variable is the ratio of the price of capital to the price of funds. Thus, the specification assumes homogeneity with respect to prices and constant returns to scale. In addition, we test for robustness with respect to the normalization and specification of the cost and profit functions by reporting results that include only three outputs, namely liquid assets, deposits and loans, and normalize costs and outputs by equity rather than loans. For these cases, the assumption of constant returns to scale is not imposed.

The estimated profit functions are identical to the cost functions except that total costs are replaced by total profit on the left-hand-side of the equation. Our approach follows Pulley and Humphrey (1993) and Berger *et al.* (1996) by assuming that firms have some market power in output markets. Hence, profits are a function of both input prices and output quantities but the bank chooses input quantities and output prices. This contrasts with the standard approach of perfectly competitive output markets in which revenues are a function of input quantities and output prices but the bank chooses its output quantities based on given prices. Assuming that output quantities are exogenous, i.e. banks choose output prices, allows us to adopt this widely used non-standard approach. Furthermore, it has the practical advantage that output price data are not needed.

Total profit is measured by net profit earned by the bank. Following the literature, we add a constant amount to profit for all banks to avoid having negative net profits for any bank observation so that we may take logarithms of all profit function variables. The stochastic frontiers for cost and profit are estimated using the LIMDEP program developed by Greene. Summary statistics for estimates of the stochastic frontiers with normalization by loans are shown in Table 3. The first column of the table presents the standard specification without year and country effects. The second column reports the stochastic frontier statistics with year and country effects entered directly into the cost or profit function. In the third column, we impose a mean shift, which is determined by year and country effects, on the inefficiency term, μ_{it} . The last specification allows for

⁵ Although separate measures are available for cost associated with employees and office-related operating expenses, we do not have information on the number of employees. Hence, we follow Hasan and Marton (2003) and use a broad measure for the price of all inputs, namely, the ratio of non-interest expenses to assets.

heteroscedasticity in the variance of inefficiency, $\sigma_{u_{it}}^2$, determined by year and country effects.⁶

The value of the log likelihood function is shown in the first row. A likelihood ratio test indicates that the standard specifications, (1) and (5), are inferior to any of the specifications in which year and country effects are included. The next two rows report some parameters of the estimated frontiers, namely the ratio of the standard deviation of the inefficiency component of the disturbance to the random component (σ_u / σ_v) and the standard deviation of the composite disturbance (σ). The fourth row contains the proportion of the variance in disturbance that is due to inefficiency, $\lambda = \sigma_u^2 / \sigma^2$. For both cost and profit functions, estimates of λ are three-quarters or more; inefficiency is more important than stochastic variation in the frontier itself. Since the cost and profit frontiers are translog functions, efficiency is defined as e^{-u} , where u is the estimated inefficiency. Hence, efficiency is always positive and it is equal to one for the best practice or zero inefficient bank. Thus, individual bank efficiency is measured relative to best practice. The last row reports the mean efficiency from each frontier estimate.

From Table 3, specification (4) for cost and specification (8) for profit have the highest log likelihood values. Hence, in the next section, we take the efficiency scores from these specifications as dependent variables in regressions to investigate the effect of ownership on bank performance. As a robustness check, we use the efficiency scores from specifications (1) and (5) that do not include country and year effects in the regressions. In this case, we create a dependent variable by dividing the efficiency scores by the relevant country mean score for each bank because the log likelihood values indicate that fixed effects matter.

⁶ The specification in the last column also includes year and country effects in the actual cost or profit functions because the frontier estimates do not converge if these effects are not included.

5 The effects of ownership on bank performance in transition countries

In this section, we examine empirically the effects of ownership on bank performance using ROA and efficiency scores. A cursory glance at Table 2 shows differences in the means of financial performance measures and bank characteristics by ownership category. Regarding average size, majority government-owned banks are almost twice as large as foreign-owned banks having a strategic owner. Foreign greenfield banks are included in the latter category so that their relatively small size may explain this result. Interestingly, the average size of foreign banks without a strategic investor is almost as large as that of government banks, perhaps reflecting their recent status as state-owned banks. As expected, private domestic banks are substantially smaller, on average, than all other banks.

Taken as ratios to assets, average bank lending is almost equal across ownership groups, except for majority government-owned banks with a ratio that is five percentage points lower. On the deposit side, variation is also relatively small with strategic foreign-owned banks having the highest average deposit-to-asset ratio and majority government-owned banks having the lowest. Hence, after adjusting for size, government-owned banks tend to make fewer loans and collect less in deposits than banks in the other ownership groups. Interestingly, majority foreign-owned banks with or without a strategic owner have a higher average deposit-to-asset ratio than all other types of banks indicating that foreign-owned banks are active in retail banking in these transition countries. Regarding equity, domestic private banks have the highest mean value relative to assets, followed by foreign-owned banks having a strategic owner. Government-owned and other majority foreign-owned banks have similar average equity-to-asset ratios that are about 3% below the mean for domestic private banks. Interestingly, banks having an international institutional investor have a mean average equity-to-asset ratio that is almost as high as domestic private banks. Finally, the average non-interest expenditure to asset ratio in government-owned and private banks is above that measure in foreign-owned banks of either type by at least 2%. Banks with an international institutional investor have a somewhat higher average ratio of non-interest expenditure to assets than all foreign-owned banks, which may reflect the higher cost of upgrading the human and physical capital of

the previously state-owned banks after recent privatization. Regarding the bank performance measures, foreign banks with a strategic owner earn an average ROA that is at least twice the ROA for all other ownership categories. In addition, banks with international participation earn twice again as high an average ROA compared with all foreign-owned banks having a strategic investor. When ROE is considered, majority government-owned banks have the highest average followed by foreign-owned banks with a strategic investor. The mean ROE for other foreign-owned banks is negative, which may reflect the weak situation of banks involved recently in the privatization process. Nonetheless, banks in which an international institutional investor participates have an average ROE about twice as high as foreign-owned banks with a strategic investor. Hence, institutional investors participate mainly in banks that deliver a high return on their investment, which may justify the higher cost ratio found for these banks. Finally, the average net interest margin does not differ much across ownership groups or by international institutional participation.⁷

Although the comparisons of means across ownership categories provide some insights into the effects of ownership on bank performance, we pursue this issue further by taking ROA and several efficiency measures as dependent variables in second-stage least squares regressions. The explanatory variables include the ownership groups, with domestic majority private as the omitted category, the log of assets to represent the non-linear effect of size on performance, and international participation to capture the incremental effect of a foreign-owned bank having an international institutional investor. We use White's correction for heteroscedascity so that the standard errors will be consistent estimates. In addition, we include both year and country dummies in the regressions to insure that we have controlled properly for these fixed effects. Table 4 reports the coefficients and t-statistics of the regression results followed by the adjusted R^2 . In the final three rows of this table, we report the adjusted R^2 statistics for regressions in which we include first only country dummies, then only year dummies, and finally neither dummy so that the last row records the adjusted R^2 statistics for regressions having no dummies to account for fixed effects. The coefficients on the ownership dummies are not affected substantively by the exclusion of year or country effects.

⁷ This result differs from Drakos (2003), who finds lower net interest margins in government-owned banks.

Taking the ROA regression in Table 4 first, no ownership variable is significant and only bank size has a significant coefficient indicating that ROA increases with bank size. Moreover, virtually all the variation in ROA is explained by the country and year dummies as indicated by the changes in the adjusted R^2 statistics reading from the last row upward. Hence, we conclude that country and year effects are important explanations of the considerable variation in financial bank performance measures in transition countries so that excluding these fixed effects in any empirical analysis is unwise. We are not surprised to find no statistically significant effect of ownership on ROA because financial measures provide mixed signals about bank performance in transition countries due to the undeveloped and evolving nature of the banking sectors. Hence, we turn now to the relationship between efficiency and ownership.

Six regressions are reported in Table 4, three each for cost and profit efficiency. Specifications (4) and (8) from Table 3 take account of country and year effects directly in the frontier estimations while the standard specifications (1) and (5) do not. In addition to the estimated efficiency scores, we report regressions where the dependent variable is the efficiency score for each bank divided by the average efficiency score for the country in which the bank is located to compute bank efficiency scores relative to the relevant country mean. Taking the cost efficiency from specification (4), a comparison of the adjusted R^2 at the bottom indicates that using the scores unadjusted for country averages leaves the overwhelming amount of variation to be explained by country dummies. Moreover, omitting year and country effects from the frontier estimation as in specification (1) leaves a substantial amount of variation to be explained by year dummies even when the dependent variable takes account of country effects because it is normalized for the country mean. However, if this normalized variable is used in specification (4), the addition of dummy variables has no discernible impact on the adjusted R^2 statistics. Similar statements can be made for the profit efficiency regressions. These results justify our inclusion of the fixed effects directly in the frontier estimations and indicate that country effects are particularly important in the second-stage regressions as well. Hence, the preferred regressions for cost and profit efficiency are found in the third and sixth columns of Table 4; both the frontier estimates and the second-stage regressions include country and year effects and the dependent variable is the efficiency score of each bank relative to the relevant country mean.

From the literature on banking in transition countries, we expect government-ownership to have a negative impact on both measures of bank efficiency. In addition, the literature suggests that foreign ownership, especially by a strategic investor, should have a positive effect on bank efficiency. Moreover, we expect the participation of an international institutional investor to have an additional positive impact on efficiency because such an investor facilitates the transfer of technology and know how to the newly privatized bank. Regarding bank size, we are agnostic because its effect depends on economies of scale and scope. Taking bank size first, the coefficient of the log of assets in all the regressions is negative and highly significant indicating that smaller banks are more efficient in these transition countries. In contrast, we find that larger banks have higher returns. Hence, our position that financial measures may not be appropriate measures of bank performance in transition countries is supported.

As expected, the sign of the coefficient on government ownership is negative in all six efficiency regressions in Table 4, although no coefficient is significant at the 5% level. Hence, government-owned banks are less efficient than domestic private banks, the omitted category, but not significantly so. The government ownership coefficients in the cost efficiency regressions are larger than their standard errors, providing some mild support for the proposition that government-owned banks are less cost-efficient than domestic private banks. However, we find no discernible evidence that government ownership makes a difference to profit efficiency relative to private domestic ownership.

Turning to the impacts of foreign ownership and the participation of international institutional investors on bank efficiency, both have a significant positive effect on cost and profit efficiency in the preferred regressions, although the coefficient for strategic foreign ownership is not significant for profit efficiency. Looking across specifications, the significant positive impact on efficiency of having majority foreign ownership relative to private domestic banks is robust for both efficiency measures. However, the positive impact of an international institutional investor is robust at the 5% significance level for profit efficiency only and that of the strategic foreign owner is robust by the same criterion for cost efficiency only. Hence, we find strong statistical evidence for a positive impact, relative to domestic private banks, of having majority foreign ownership on both measures of efficiency and of having a strategic foreign owner on cost efficiency. We also find strong statistical support that having an international institutional investor generates an additional positive impact on profit efficiency.

Regarding the magnitude of these effects from the regressions using specifications (4) and (8) relative to the country mean, majority foreign owners increase cost efficiency by over 8% and profit efficiency by about 7% relative to domestic private banks.⁸ Having a strategic foreign owner improves cost efficiency by almost 6% but increases profit efficiency by less than 3% compared to domestic private banks. Moreover, the participation of an international institutional investor provides an additional increase of more than 4% in cost efficiency and about 9% in profit efficiency. Virtually all banks having an international institutional investor are foreign owned and three-quarters of these have a strategic foreign investor. The combination of having both a strategic foreign investor and an international institutional investor yields increased cost efficiency of 10% and augments profit efficiency by almost 12%. Banks having majority foreign owners, but no strategic investors, and an international institutional investor are 13% more cost-efficient and 16% more profit-efficient than private domestic banks. These results suggest that international institutional investors are important facilitators in the restructuring of the newly privatized formerly government-owned banks in these transition countries.

As an additional robustness check, we estimate the frontiers with outputs and costs or profits normalized by equity. Although the data on equity for banks in transition countries are subject to considerable measurement error, equity controls for differences in risk taking by banks, which could alter behavior even though it would not be accounted for otherwise in the frontier specifications. The statistics for the cost and profit estimations that maximize the respective likelihood functions are given in Table 5 along with the coefficients from the second-stage regressions using these efficiency estimates as dependent variables. A comparison of the cost efficiency results in Table 5 and the corresponding result in Table 3, specification (3), indicates that the statistics for the cost frontier estimations differ only slightly between the two normalizations. A similar comparison between the profit frontier in Table 5 and specification (8) of Table 3 indicates some differences for the profit estimations.

The ownership regressions in Table 5 correspond to the cost and profit regressions in Table 4 using bank efficiency scores from specifications (4) and (8) respectively. Taking

⁸ A similar result is found for specification (4) using bank efficiency scores. In the cost efficiency regression in Table 4, the coefficient on other foreign ownership is 0.0536. The proportional effect is found by dividing 0.0536 by its mean of 0.777 to yield 0.0690. This number can be compared directly to the coefficient of 0.0857 in the preferred regression because the mean of the relative-to-country-average efficiency score is one by definition.

cost efficiency first, the only important change is the insignificance of the coefficient on majority foreign ownership, which had been significantly positive in all the regressions in Table 4. Hence, the robustness of this result may be questioned.⁹ The positive and significant coefficient on strategic foreign ownership and the negative and significant coefficient on bank size are robust to the normalization. Turning to profit efficiency, the impact of a strategic foreign owner is smaller while the positive coefficient for majority foreign owners retains its significance and magnitude. The other coefficients remain relatively unchanged in magnitude and significance. Hence, normalizing by equity rather than loans has no appreciable effect on the result that smaller banks are more efficient, that having a strategic foreign investor increases cost efficiency relative to domestic private banks, that having majority foreign investors augments profit efficiency, and that the participation of an international investors has an additional positive effect on profit efficiency. However, the result that majority foreign ownership also makes banks more cost-efficient than domestic private banks is not robust to this change.

In summary, we find no discernible effects of ownership on a financial measure of bank performance but significant and substantial effects of both foreign ownership and the participation of international institutional investors on bank efficiency. Regarding domestic banks, we find some evidence that government ownership affects cost efficiency adversely, although this effect is statistically insignificant, but we find no discernible effect of government ownership on profit efficiency. Majority foreign ownership without a strategic investor has a robust significant positive effect on profit efficiency but its significantly positive effect on cost efficiency is sensitive to whether the normalization is done by loans or equity. Strategic foreign ownership has a significant positive impact on cost efficiency but its positive impact on profit efficiency is not significant. With regard to the impact of foreign ownership, our results are consistent with those found by Nikiel and Opiela (2002) for Poland. However, they differ from those of Yildirim and Philippatos (2002), who find that majority foreign-owned banks are significantly more cost, but less profit, efficient than other banks in these transition countries.¹⁰ We find evidence that having an international institutional investor leads to an additional increase in bank efficiency but only the impact on profit efficiency is significant. Therefore, relative to

⁹ This category has the fewest observations so that the standard errors are quite large and the coefficients are likely to be somewhat unstable.

domestic private banks, international institutional investors appear to generate revenue-driven efficiencies while majority foreign investors impart cost-driven efficiencies.

6 Conclusion

Foreign participation in the banking sectors of these eleven transition countries has increased dramatically in the second half of the 1990s; the literature suggests that foreign ownership should result in better performing, more efficient banks. To examine this issue empirically, we take a sample of eleven transition countries and focus on bank efficiency scores derived from frontier estimations of both cost and profit functions. In contrast to previous empirical work, we include country and year effects directly in the frontier estimations as well as in the second-stage regressions. Our methodological results have two important implications for empirical work. First, investigating ownership effects using only financial performance measures, such as ROA, are likely to be misleading because we find that virtually all of the variation in ROA in our sample is attributable to country and year effects. The only other significant coefficient in the regression is bank size; this positive coefficient indicates that larger banks have higher ROAs even though the results using efficiency measures come to the opposite conclusion regarding bank size and performance. Second, country effects continue to have an important role to play in explaining variation in efficiency measures even after they have been included, with year effects, directly in the frontier estimations. For this reason, we create a measure of bank efficiency relative to its country of operation to use as a dependent variable in second-stage regressions.

To investigate the impact of ownership on bank efficiency in these transition countries, we consider four mutually exclusive and collectively exhaustive categories. We report regressions containing ownership dummies with domestic private ownership as the omitted category. In all regressions, we include a variable reflecting bank size, which has a negative and consistently significant sign, and dummies for country and year fixed effects. Finally, we include a dummy variable for the participation of an international institutional investor to probe the impact that such an investor has on facilitating bank restructuring

¹⁰ The fact that these authors do not control for country or year effects may explain the difference between

after privatization. Relative to domestic private banks, banks with majority foreign ownership but without a strategic foreign owner are more efficient by cost and profit measures while strategic foreign ownership improves only cost efficiency.¹¹ The magnitude of increased efficiency from foreign ownership is 6% or higher. Having an international institutional investor provides an additional increase in profit efficiency of 9%, which is consistent with our finding that these investors choose banks that generate considerably higher rates of return.

Our results have the following policy implication. First, private ownership by itself is not sufficient to insure bank efficiency in transition countries because we find no statistically significant evidence of an adverse effect of government ownership relative to private domestic ownership. Second, foreign owners are more successful in imparting cost-driven efficiencies than profit-driven ones. In addition, foreign-owned banks, in particular those with a strategic foreign owner, collect more deposits and make more loans, adjusted for size, than domestic private banks so that these banks provide better service as well. Third, after adjusting for size, government-owned banks make fewer loans, collect fewer deposits, and have higher non-interest expenditures than majority foreign owned banks. Hence, the banks remaining to be privatized in these transition countries are less efficient and provide less service at a higher cost than those already privatized, which is consistent with the hypothesis that the better banks were privatized first in these transition countries. Fourth, the participation of an international institutional investor has a considerable additional positive impact on profit efficiency. Although we cannot determine causality, our results suggest that these investors play an important role in facilitating the restructuring of formerly government-owned banks. Finally, efficiency appears to decrease nonlinearly with bank size, which is a puzzling result. Many transition countries have embarked on bank consolidation schemes based on the presumption that their banks are too small by international standards to be efficient. Our results suggest taking a more cautionary approach to government-orchestrated bank consolidation.¹²

As an important caveat, we do not differentiate between privatized banks and foreign greenfield banks because we include both in the category of strategic foreign ownership.

their results and ours.

¹¹ We present only the statistically significant results for the purpose of drawing policy conclusions.

¹² Bonin and Leven (1996) present a critical perspective on government-orchestrated bank consolidation in Poland.

Foreign greenfield banks are significantly smaller than newly privatized banks so that the inverse relationship between efficiency and bank size may be due mainly to the presence of many small and efficient foreign greenfield operations in our sample. Furthermore, we are unable to draw direct comparisons between the banks that are currently government-owned and those that were previously government-owned but have been privatized to strategic foreign owners. Hence, separating foreign greenfield banks from newly privatized foreign-owned banks would yield not only important insights into the effects of privatization on bank efficiency but also clarify our result concerning efficiency and bank size in transition countries. However, a complete analysis requires the collection of ownership information for each bank in each year so that changes can be tracked over time. This extension is left for another paper.

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Table 1. Frequency distributions by country

	Total	Bulgaria	CzechRep.	Estonia	Croatia	Hungary	Latvia	Lithuania	Poland	Romania	Slovenia	Slovakia
Number of Banks	225	18	25	3	30	30	20	8	35	21	18	17
Number of Observations	856	71	88	14	122	116	74	25	147	55	76	68
Observations by Year												
1996	132	7	15	2	20	21	12	2	25	2	13	13
1997	168	14	20	3	26	22	13	5	27	6	17	15
1998	187	16	20	3	26	22	16	5	32	16	15	16
1999	179	17	16	3	24	23	16	5	32	16	15	12
2000	190	17	17	3	26	28	17	8	31	15	16	12
Ownership: Percent of observations with majority ownership:												
Foreign with strategic	53.2	56.3	70.5	100.0	23.0	81.0	31.1	60.0	57.1	50.9	28.9	66.2
Other foreign	7.2	4.2	14.8	0	4.1	8.6	6.8	20.0	9.5	7.3	0	4.4
Government	9.9	14.1	5.7	0	10.5	1.7	4.1	0	6.8	10.9	18.4	14.7
Private	29.7	25.3	9.1	0	52.5	8.6	58.1	20.0	26.5	30.9	52.6	14.7
Ownership: Percent of observations with ownership interest from international organization												
	9.2	25.3	11.4	35.7	13.1	4.3	0	4.0	3.4	20.0	0	11.8

Table 2. Descriptive statistics

	Overall Sample (856)		Mean By Ownership Category				Mean for International Participation (79)
	Mean	Standard Deviation	Foreign Strategic Owner (455)	Other foreign majority (62)	Majority Government (85)	Majority Private (254)	
Return on Assets	0.010	0.053	0.014	0.005	0.001	0.007	0.028
Return on Equity	0.036	0.794	0.054	-0.018	0.077	0.003	0.106
Net interest margin	0.055	0.040	0.051	0.055	0.056	0.061	0.060
Loan to Asset Ratio	0.428	0.165	0.435	0.437	0.380	0.430	0.415
Deposit to Asset Ratio	0.764	0.126	0.780	0.762	0.729	0.745	0.752
Equity to Asset Ratio	0.127	0.072	0.124	0.109	0.115	0.141	0.139
Noninterest Expenditure to Asset Ratio	0.069	0.053	0.059	0.063	0.084	0.082	0.069
Total Assets (000s \$)	1,143,571	2,432,380	1,286,107	2,028,721	2,079,615	358,938	2,940,557

Number of bank observations in parentheses.

Table 3. Summary of stochastic frontier estimates with loan normalization

	Standard specification, data pooled without year and country effects	Year and country effects included	Mean shift, μ_{it} shifts with year and country effects	Heteroscedasticity, $\sigma^2_{u_{it}}$ shifts with year and country effects. Function also includes year and country effects
Translog Cost functions				
	(1)	(2)	(3)	(4)
Log Likelihood	-362.8	-292.6	-273.8	-237.7
σ_u / σ_v	2.05 (0.15)	1.71 (0.13)	2.84 (0.76)	1.86
σ	0.54 (0.02)	0.48 (0.02)	0.77 (0.19)	0.49
λ	.808	.745	.890	.776
Mean efficiency	.701	.735	.405	.777
Translog Profit functions				
	(5)	(6)	(7)	(8)
Log Likelihood	-957.4	-713.4	-759.1*	-573.4
σ_u / σ_v	2.20 (0.19)	3.03 (0.25)	6.01(1.25)	2.29
σ	1.11 (0.01)	0.90 (0.01)	2.74 (0.55)	0.84
λ	.828	.902	.973	.840
Mean efficiency	.501	.576	.819	.694

NOTES: Standard errors are shown in parentheses for the estimated parameters. In the heteroscedastic case, the statistics are based on the estimated variances averaged over the observations.

* This function did not converge; the reported estimates are the results after 100 iterations.

Table 4. Ownership effects on performance measures

	Return on Assets	Cost Efficiency			Profit Efficiency		
		(4)	(4) Relative to country average	(1) Relative to country average	(8)	(8) Relative to country average	(5) Relative to country average
Intercept	-0.0503 (2.6)	0.8759 (20.9)	1.1862 (18.2)	1.4917 (22.0)	1.1676 (26.8)	1.4874 (18.4)	1.5443 (15.8)
Foreign Strategic	0.0060 (1.3)	0.0376 (3.8)	0.0584 (3.8)	0.0733 (4.6)	0.0177 (1.7)	0.0276 (1.5)	0.0509 (2.2)
Other Majority Foreign	-0.0005 (0.1)	0.0536 (3.3)	0.0857 (3.4)	0.0677 (2.6)	0.0352 (2.1)	0.0702 (2.2)	0.1371 (3.6)
Government-owned	-0.0068 (1.0)	-0.0223 (1.5)	-0.0262 (1.2)	-0.0440 (1.9)	-0.0086 (0.6)	-0.0042 (0.2)	-0.0303 (0.9)
International Participation	0.0086 (1.3)	0.0204 (1.5)	0.0437 (2.0)	0.0364 (1.6)	0.0557 (3.8)	0.0909 (3.4)	0.1304 (4.0)
Log Assets	0.0035 (2.4)	-0.0112 (3.5)	-0.0180 (3.7)	-0.0430 (8.4)	-0.0233 (7.1)	-0.0415 (6.8)	-0.0465 (6.3)
Adjusted R ²	0.1062	0.5783	0.0396	0.1326	0.6111	0.0626	0.0973
Adjusted R ² :							
with country dummies	0.0759	0.5769	0.0362	0.1016	0.6073	0.0493	0.0606
with year dummies	0.0323	0.0445	0.0434	0.1217	0.0155	0.0563	0.0929
with no dummies	0.0086	0.0462	0.0408	0.0943	0.0165	0.0463	0.0594

All reported regressions include year and country dummies. The absolute values of the t-statistics are in parentheses.

The standard errors are consistent estimates with White's Heteroscedasticity correction.

The number in parentheses after efficiency is the specification in Table 3. specifications (4) and (8) are from the heteroscedastic SFA, while (1) and (5) are from the standard SFA specifications without year and country effects.

Table 5. Robustness tests with stochastic frontier estimates using equity normalization

	Translog Cost function with mean shift μ_{it} shifts with year and country effects	Translog Profit Function with year and country effects and Heteroscedasticity $\sigma^2_{u_{it}}$ shifts with year and country effects.
Frontier estimates		
Log Likelihood	-273.5	-517.3
σ_u / σ_v	2.83 (0.78)	4.48
σ	0.771 (0.202)	0.697
λ	.889	.817
Mean efficiency (Std. deviation)	.428 (.119)	.738 (.192)
Ownership regressions		
Intercept	0.5957 (14.5)	1.0915 (26.4)
Foreign Strategic	0.0281 (3.0)	0.0077 (0.9)
Other foreign	0.0242 (1.4)	0.0320 (2.1)
Government	-0.0244 (1.8)	-0.0042 (0.3)
International Participation	0.0161 (1.1)	0.0396 (2.6)
Log Assets	-0.0164 (5.5)	-0.0249 (7.6)
Adjusted R ²	.2288	.7055

Standard errors are shown in parentheses for estimated frontier parameters.
Ownership regressions include year and country dummies. Absolute value of t-statistics are in parentheses.
Standard errors are consistent estimates with White's Heteroscedasticity correction.

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