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Hermes, Niels; Meesters, Aljar

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Financial liberalization, financial regulation and bank efficiency: a multi-country analysis

Niels Hermes* and Aljar Meesters

Faculty of Economics and Business, University of Groningen, Groningen, The Netherlands

This article investigates the impact of financial reforms on bank efficiency. More specifically, we distinguish between two different types of financial reforms, i.e. financial liberalization measures and measures of the quality of bank regulation and supervision (i.e. financial regulation), and study their relationship to bank efficiency separately. Moreover, we analyse whether the impact of financial liberalization on bank efficiency is conditional on the quality of regulation and supervision of the banking system. We apply stochastic frontier analysis to calculate bank efficiency at the individual bank level and use a new and detailed database that measures different aspects of financial reforms. The data-set consists of 87 312 bank-year observations covering 61 countries for the period 1996–2005. Overall, we show that the impact of financial liberalization policies on bank efficiency is conditional on the extent to which bank regulation and supervision has been adopted and developed.

Keywords: financial liberalization; financial regulation; banks; efficiency; stochastic frontier analysis

JEL Classification: G18; G21

I. Introduction

Over the past few decades, many countries have implemented financial reform policies. These policies aim at enhancing competition, improving resource allocation and building more efficient financial institutions by making them less state-directed and by exposing them to increased market competition. These policies should ultimately contribute to enhanced economic growth (Bumann *et al.*, 2013).

For this reason, financial reforms have been fiercely promoted by, among others, the International Monetary Fund and the World Bank. Yet, there is no general consensus about whether these policies help improving the efficiency of banking institutions.

On the one hand, it has been argued that the elimination of government control and intervention will restore and strengthen the price mechanism, and will improve the conditions for market competition, resulting in more efficient allocation of scarce

*Corresponding author. E-mail: c.l.m.hermes@rug.nl

financial resources (Hermes and Lensink, 2008). Competitive pressure stimulates banks to become more efficient by reducing overhead costs, improving bank management, improving risk management and offering new financial instruments and services (Denizer *et al.*, 2007). Moreover, if domestic financial markets are opened up to foreign competition, this will further increase pressures to reduce costs, whereas at the same time, new banking and risk management techniques as well as new financial instruments and services may be imported (Claessens *et al.*, 2001).

On the other hand, several researchers have pointed out that financial reforms may also adversely affect bank efficiency. Stiglitz (2000), among others, argues that financial reforms as such do not solve the problem of asymmetric information, preventing financial intermediation from becoming more efficient in a liberalized market. Others have made the point that financial reforms may actually increase information problems. When financial markets become liberalized and competition is increased, this may lead to a reduction of relationship lending, since borrowers may have more opportunities and will look for the cheapest way of financing their investment. This destroys information capital, increases asymmetric information and reduces the efficient allocation of funds by banks (Boot, 2000).

More competition in financial markets may also reduce profit margins and increase financial fragility. Hellmann *et al.* (2000) argue that financial reforms reduce the franchise value of banks, which makes them more prone to financial disruption and stimulates their moral hazard and risk-taking behaviour in order to try to remain profitable under the pressure of falling interest rate margins. Financial reforms may even trigger banking crisis if it leads to excessive risk-taking under the pressure of increased competition (Demirgüç-Kunt and Detragiache, 1998, 2000; Kaminsky and Reinhart, 1999). Increased risk-taking and the consequent increase in the number of failures of banks may ultimately trigger a bank run (Diamond and Dybvig, 1983), in which case economically viable banks may also be affected. Clearly, under these circumstances bank efficiency is hurt.

One potentially important way to curb the adverse effects of financial reforms on the stability and efficiency of banks is to install bank regulation and supervision (i.e. financial regulation).¹ Bank regulation and supervision aims at reducing the moral hazard behaviour and risk-taking by banks. Several researchers point out that financial liberalization in combination with a weak regulatory and supervisory structure has adverse effects on growth. They thus argue that successful liberalization depends on the quality of the existing regulatory and supervisory framework (McKinnon, 1991; Mishkin, 1999; Andersen and Tarp, 2003).² In this article, we explicitly investigate this argument.

The contrasting views on the relationship between financial reforms and bank efficiency call for an in-depth empirical analysis. Yet, the available evidence provides mixed results on the existence and direction of the relationship. A further evaluation of the available studies shows that many of them focus on just one or a few countries, leaving open the possibility that for one country bank efficiency improves after reforms, while for another the opposite is found (see, e.g. Bhattacharyya *et al.*, 1997; Gilbert and Wilson, 1998; Hao *et al.*, 2001; Kumbhakar *et al.*, 2001; Maudos *et al.*, 2002; Isik and Hassan, 2003; Kumbhakar and Sarkar, 2003; Ataullah *et al.*, 2004; Patti and Hardy, 2005; Ataullah and Le, 2006; Denizer *et al.*, 2007). Only a few studies analyse the relationship between financial liberalization and bank efficiency using a multi-country setting (see, e.g. Williams and Nguyen, 2005; Hermes and Vu, 2010; Williams, 2012; Andries and Capraru, 2013). At the same time, however, the number of countries included in these studies remains rather limited. Moreover, several studies focus on just one or a few dimensions of financial reforms. In particular, no study has looked at the specific impact of financial regulation on bank efficiency.

We contribute to the existing empirical literature in three important ways. First, we use a multi-country sample. Our data-set consists of 87 312 bank-year observations for 61 developed and emerging economies covering the period 1996–2005. Second, we have detailed information on several dimensions

¹ In the remainder of the text, we will use the terms ‘financial regulation’ and ‘bank regulation and supervision’ interchangeably.

² Examples are Chile and Argentina. In the early 1980s, these countries experienced the negative effects of financial liberalization. The same holds for Mexico (in 1994–1995) and the countries affected by the Asian crisis (1997/98).

of financial reform policies over a long time period. This allows us to investigate the impact of both financial liberalization and bank regulation measures on bank efficiency separately. Third, and most importantly, we analyse the interaction between financial liberalization, bank regulation and bank efficiency. With this analysis, we test whether successful financial liberalization depends on the quality of the existing regulatory and supervisory framework. To the best of our knowledge, this is the first study that explicitly investigates the relationship between financial liberalization, financial regulation and bank efficiency in a multi-country setting.

The remainder of the article is organized as follows. [Section II](#) discusses the data we have on financial reform policies. In [Section III](#), we explain the methodology we use to measure bank efficiency and discuss the empirical model specification. In [Section IV](#), we present a description of the data followed by a discussion of the results of the empirical analysis of the relationship between bank efficiency and financial reforms in [Section V](#). The article ends with a summary and conclusions in [Section VI](#).

II. Measuring Financial Reforms

In this article, we use a data-set for measuring financial reforms created by Abiad *et al.* (2010). The financial reforms data-set takes into account seven different dimensions of financial market policies for a set of 91 developed and developing countries during the period 1973–2005. The first six dimensions refer to financial liberalization measures; the last dimension refers to bank regulation and supervision mea-

sures. The seven dimensions of financial market policies considered are as follows:

- (1) *Credit controls and reserve requirements*: focuses on directed credit towards favoured sectors or industries, ceilings on credit towards sectors and high reserve requirements.
- (2) *Interest rate controls*: deals with direct interest rate controls by the government, or interest rate controls through the use of floors, ceilings and interest rate bands.
- (3) *Entry barriers*: deals with licensing requirements for newly established domestic financial institutions, entry barriers for foreign banks and restrictions on certain types of banking practices, such as specialized bank services or establishing universal banks.
- (4) *State ownership in the banking sector*: refers to the share of the banking sector assets controlled by state-owned banks.
- (5) *Restrictions on international financial transactions*: refers to capital account controls and restrictions, transaction taxes and the use of multiple exchange rates.
- (6) *Securities market policies*: relates to policies with respect to the auctioning of government securities, the establishment of securities markets, tax incentives related to investments in securities and policies regarding the openness of markets to foreign investors.
- (7) *Prudential regulations and supervision of the banking sector*: refers to (1) the adoption of risk-based capital adequacy ratios based on the Basel standard³; (2) the independence of the banking supervisory agency; and (3) the conduct and coverage of supervisory oversight.^{4,5}

³ Adopting risk-based capital adequacy ratios based on the Basel standard is considered to be better in terms of the quality of bank regulation and supervision and their impact on bank efficiency, because adopting these capital adequacy ratios reduces moral hazard and risk-taking behaviour of banks. This in turn reduces the overall riskiness of the bank and increases its ability to efficiently allocate financial resources.

⁴ Appendix 1 in Abiad *et al.* (2010) provides a more detailed account of the definition and measurement of the three components of this dimension of financial reforms.

⁵ Each of the three components receives an equal weight in the final score of the bank regulation and supervision dimension. While other weightings could have been used, we have no *a priori* theory guiding us to choose a particular weighting scheme. For this reason, we have chosen to stick to using equal weightings. Here, we follow Abiad *et al.* (2010) who created the original data-set, along with several other researchers who also have made use of this data-set.

For the purpose of our analysis, only the first four of the six financial liberalization dimensions are related to bank efficiency. The dimension *Restrictions on international financial transactions* includes policies of a more general nature and it remains unclear how such policies affect bank efficiency. The dimension *Securities market policies* refers to policies affecting financial markets other than the banking sector.

For the first four of the above dimensions a country receives a score that runs from 0 to 3.⁶ For the four dimensions reflecting financial liberalization, the scores are interpreted as follows: 0 means that for a particular dimension of financial market policies the country is fully repressed; 1 means partial repression, 2 means largely liberalized and 3 means fully liberalized. Repression or liberalization of a certain dimension thus refers to the extent to which the government interferes with financial markets.

The interpretation of the score with respect to the dimension describing regulation and supervision of the banking sector is as follows: a 0 means that the country has put in place none of the three dimensions of regulation and supervision (i.e. capital adequacy ratios, independency of the central bank and a wide coverage of supervisory oversight); 1 means that the country has put in place one of the three dimensions of regulation and supervision; 2 means that the country has put in place two of the three dimensions of regulation and supervision; and 3 means that the country has put in place all three dimensions of regulation and supervision. For this dimension, more government intervention is interpreted as a positive reform policy, meaning that more regulation and supervision contributes to improving the efficiency of the banking system.

The financial reforms data-set we use in this article improves on the data used in earlier papers in a number of ways. First, most earlier papers take a crude measure of financial reforms, for instance, by taking a value of 0 for the years in which a particular financial market is not liberalized and a value of 1

from the year onwards when the market is officially liberalized. Yet, financial reform is a process, rather than just one event. Our data-set allows for identifying changes in financial market policies over time, as well as for quantifying the extent to which these policies contribute to reforming financial markets. Second, in several papers the analysis focuses on just one or a few dimensions of financial reforms. As our discussion of the data-set shows, however, financial reforms may consist of a range of different dimensions. These different dimensions may all affect bank efficiency. Therefore, all relevant dimensions should be taken into account when we aim at evaluating the impact of financial reform on bank efficiency. Finally, several studies focus on a single country case or a limited set of countries when investigating financial reform policies, whereas our data-set allows for a study using information from a large set of developed and emerging market economies.

III. Bank Efficiency Measurement and Model Specification

To analyse the impact of the financial reform policies, we need a measure of bank efficiency. In our analysis, we focus on the cost-efficiency of banks. Cost-efficiency is measured in terms of how close the actual costs of the activities of a bank are to what the costs of a best-practice bank would have been in case it produces identical outputs and input prices and under the same conditions. In other words, cost-efficiency measures the reduction in costs that could have been achieved if the bank is both allocatively and technically efficient. Since cost functions are not directly observable, inefficiencies are measured in comparison with an efficient cost frontier. Most studies on cost-efficiency use either data envelopment analysis or stochastic frontier analysis to calculate the efficient frontier. We use stochastic frontier analysis, since it controls for measurement errors and other random effects.⁷

⁶ A more detailed description of the coding system can be found in Abiad *et al.* (2010).

⁷ Data envelopment analysis does not allow for measurement error and luck factors. This technique attributes any deviation from the best-practice bank to technical inefficiency.

Basically, two approaches towards using stochastic frontier analysis can be distinguished. First, the two-step stochastic frontier analysis estimates the efficient cost frontier and the equation measuring the inefficiencies (i.e. deviations from the frontier) in two separate steps (Aigner *et al.*, 1977; Meeusen and Van Den Broeck, 1977). Second, the cost frontier and the inefficiency equation can be estimated simultaneously (Wang and Schmidt, 2002). We use the second approach, because the two-step approach assumes that the efficiency term is independent and identically exponentially distributed in the first step, while in the second step the efficiency terms are assumed to be normally distributed and dependent on the explanatory variables. This means that the two-step approach yields biased coefficients (Wang and Schmidt, 2002).

The general model we use specifies a stochastic cost frontier with the following properties:

$$\ln C_{i,t} = C(y_{i,t}, \mathbf{w}_{i,t}, q_{i,t}; \boldsymbol{\beta}) + u_{i,t} + v_{i,t} \quad (1)$$

$$u_{i,t} \sim E(\sigma_{u,i,t}) \quad (2)$$

$$v_{i,t} \sim iidN(0, \sigma_v^2) \quad (3)$$

$C_{i,t}$ is the total cost bank i faces at time t and $C(y_{i,t}, \mathbf{w}_{i,t}; \boldsymbol{\beta})$ is the cost frontier. $y_{i,t}$ represents the logarithm of the output of bank i at time t , $\mathbf{w}_{i,t}$ is a vector of the logarithm of input prices of bank i at time t , $q_{i,t}$ are bank-specific control variables and $\boldsymbol{\beta}$ is a vector of all parameters to be estimated. The term $v_{i,t}$ captures measurement errors and random effects, e.g. good and bad luck, and is distributed as a standard normal variable. $u_{i,t}$ captures cost inefficiency and is exponentially distributed.⁸ Since we

aim at analysing which factors determine bank inefficiency, we allow the model to shift in the exponential distribution according to the following specification:

$$\sigma_{u,i,t} = \sqrt{\exp\left(\delta_0 + \sum_n \delta_n \mathbf{z}_{n,i,t}\right)} \quad (4)$$

where $\sigma_{u,i,t}$ can be interpreted as the expected inefficiency of bank i at time t . $\mathbf{z}$ represents the vector of n variables that determines the expected inefficiency of bank i at time t . The deltas represent the coefficients. Equations 1 and 4 are solved in one step by using maximum likelihood.⁹

The assumption of exponentially distributed inefficiencies is based on previous empirical research. Often a truncated normal distribution is assumed (see, e.g. Fries and Taci, 2005; Lensink *et al.*, 2008). Yet, in our case this assumption would lead to a nonconverging likelihood optimization routine. Meesters (2014) shows that nonconvergence may occur if the true distribution of the inefficiencies is exponential. In particular, he shows that if the true distribution of the inefficiencies is exponential, some of the parameters in the model may diverge to plus or minus infinity, which means their ratio may be equal to σ of Equation 4. This happens to be the case for our data-set.

For the specification of the cost function we use the model developed by Sealey and Lindley (1977), who state that a bank acts as an intermediary between funders and borrowers. The cost function has a translog specification. Using such a specification leads to a better fit of the frontier than the standard Cobb–Douglas specification (Kumbhakar and Knox Lovell, 2000). We impose homogeneity of degree one in prices. The cost function can be specified as follows¹⁰:

⁸ Thus, the total costs a bank faces are never lower than the costs of the frontier. For a graphical representation of the frontier and its dynamics, see Berger *et al.* (1993). The authors show how inefficiency is determined by both technical and allocative inefficiencies.

⁹ We use the functional form of the model as described in Equation 4, because this allows us to estimate the model in Stata using the *uhet* option in the frontier command (StataCorp, 2009). Using the exponential specification ensures that $\sigma_{u,i,t}$ never becomes negative.

¹⁰ A complete list of all variables and abbreviations used in the analysis in this article can be found in Table A1.

$$\begin{aligned}
\ln\left(\frac{TC_{i,j,t}}{PLABOR_{i,j,t}}\right) = & \alpha_i + \beta_1 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right) + \beta_2 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right)^2 + \beta_3 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right) \\
& + \beta_4 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln(LOANS_{i,j,t}) + \beta_5 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln(OTHER_{i,j,t}) \\
& + \beta_6 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln(OBA_{i,j,t}) + \beta_7 \ln\left(\frac{PFUND_{i,j,t}}{PLABOR_{i,j,t}}\right) Time\ trend \\
& + \beta_8 \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right) + \beta_9 \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right)^2 + \beta_{10} \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln(LOANS_{i,j,t}) \\
& + \beta_{11} \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln(OTHER_{i,j,t}) + \beta_{12} \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right) \ln(OBA_{i,j,t}) \\
& + \beta_{13} \ln\left(\frac{PCAP_{i,j,t}}{PLABOR_{i,j,t}}\right) Time\ trend + \beta_{14} \ln(LOANS_{i,j,t}) + \beta_{15} \ln(LOANS_{i,j,t})^2 \\
& + \beta_{16} \ln(LOANS_{i,j,t}) \ln(OTHER_{i,j,t}) + \beta_{17} \ln(LOANS_{i,j,t}) \ln(OBA_{i,j,t}) \\
& + \beta_{18} \ln(LOANS_{i,j,t}) Time\ trend + \beta_{19} \ln(OTHER_{i,j,t}) + \beta_{20} \ln(OTHER_{i,j,t})^2 \\
& + \beta_{21} \ln(OTHER_{i,j,t}) \ln(OBA_{i,j,t}) + \beta_{22} \ln(OTHER_{i,j,t}) Time\ trend \\
& + \beta_{23} \ln(OBA_{i,j,t}) + \beta_{24} \ln(OBA_{i,j,t})^2 + \beta_{25} \ln(OBA_{i,j,t}) Time\ trend \\
& + \beta_{26} Time\ trend + \beta_{27} Time\ trend^2 + u_{i,j,t} + v_{i,j,t}
\end{aligned} \tag{5}$$

In Equation 5, $TC_{i,j,t}$ represents total costs for bank i in country j at time t and α_i is the bank-specific constant term. These costs include labour, interest and other costs. The cost function specifies three outputs: *LOANS*, *OTHER* and *OBA*. *LOANS* measures the total value of loans, *OTHER* measures the total value of all other income earning assets held by the bank and *OBA* measures the off-balance sheet activities of the bank. *LOANS*, *OTHER* and *OBA* are taken in logs. Additionally, the cost function specifies three input prices: *PLABOR*, *PFUND* and *PCAP*. *PLABOR* is the price of labour and is measured as the total personnel costs divided by the number of employees. *PFUND* is the price of funds and is defined as total interest costs paid by the bank divided by the sum of total deposits and other interest-bearing funding. *PCAP* measures the price of physical capital and is defined as total noninterest expenses minus personnel expenses over nonearning assets. In order to impose homogeneity of order one in prices – that is total costs double if all prices double – all prices and total costs are divided by the price of labour.

We use a translog specification of the cost function. This demands including the individual input and output variables, the square of these variables, as well as combinations of these variables in the cost function. We add a time trend and the time trend squared to the specification of the cost function. The time trend variables are also interacted with the input and output variables. Moreover, we control for time invariant differences between banks by adding a unique intercept α_i for each bank, i.e. we use a fixed-effect estimator.

As discussed in the introduction of the article, we investigate whether financial reforms contribute to improving bank efficiency. More importantly, we aim at investigating whether the relationship between financial liberalization and efficiency is conditional on the quality of bank regulation and supervision. To do so, we include financial liberalization measures based on the data-set discussed in Abiad *et al.* (2010) in Equation 4 as these measures may affect the expected average inefficiency of bank i at time t . Moreover, we include a measure of the quality of bank regulation and supervision, which is taken from the same data-

set. Finally, we include a number of control variables that may also influence the inefficiency of a bank.

To be precise, we estimate the following set of versions of the inefficiency equation:

$$\sigma_{i,j,t}^2 = \exp(\delta_0 + \delta_1 FINLIB_{j,t} + \delta_2 GDPG_{j,t} + \delta_3 INFL_{j,t} + \delta_4 INTR_{j,t}) \quad (6)$$

$$\sigma_{i,j,t}^2 = \exp(\delta_0 + \delta_1 REGULATION_{j,t} + \delta_2 GDPG_{j,t} + \delta_3 INFL_{j,t} + \delta_4 INTR_{j,t}) \quad (7)$$

$$\sigma_{i,j,t}^2 = \exp(\delta_0 + \delta_1 FINLIB + \delta_2 REGULATION_{j,t} + \delta_3 GDPG_{j,t} + \delta_4 INFL_{j,t} + \delta_5 INTR_{j,t}) \quad (8)$$

$$\sigma_{i,j,t}^2 = \exp\left(\delta_0 + \delta_1 FINLIB_{j,t} + \delta_2 REGULATION_{j,t} + \delta_3 FINLIB_{j,t} * REGULATION_{j,t} + \delta_4 GDPG_{j,t} + \delta_5 INFL_{j,t} + \delta_6 INTR_{j,t}\right) \quad (9)$$

In this set of equations, σ reflects the expected mean of the inefficiency distribution for bank i in country j at time t . The higher this expectation, the more likely it is that the bank is inefficient. The variable *FINLIB* in Equation 6 is our aggregate measure of financial liberalization based upon a principal component analysis of four dimensions of financial liberalization available in our data-set (i.e. credit controls, interest rate controls, entry barriers and state ownership of banks). We use this approach since we are interested in the overall effect of financial liberalization, rather than the effect of individual reform measures, since we have no *a priori* theory explaining why different reform policies would have a different impact. Moreover, it allows us to solve the problem of multicollinearity between the different measures.¹¹ We expect this variable to have a negative relationship to σ , since this would indicate that financial liberalization policies help improving the

efficiency of banks (i.e. the expected inefficiency σ is reduced).

The quality of bank regulation and supervision is measured by *REGULATION*, which is included in Equation 7. As explained in Section II, this variable measures the quality of banking regulation and supervision in a country, using the score on prudential regulations and supervision of the banking sector as provided in our data-set. It refers to the coverage of supervisory oversight, the independency of the banking supervisory agency and the extent to which a country has adopted risk-based capital adequacy ratios based on the Basel standard. In Equation 8 we include *FINLIB*, as well as *REGULATION*, in order to examine to what extent they are simultaneously fostering bank efficiency. Finally, in Equation 9, we take the interaction of both variables to see if the relationship between financial liberalization policies and bank efficiency is conditional on the quality of bank regulation and supervision.

The control variables we include in all four equations are measures of the GDP growth rate (*GDPG*), the annual inflation rate (*INFL*) and the real interest rate (*INTR*). The first measure controls for macroeconomic conditions; the next two variables are measures of the financial market conditions in a specific country. *GDPG* serves as a proxy for measuring the overall level of economic growth. The growth rate of economic development may positively influence the quality and the skill levels of banks (Claessens *et al.*, 2001). *INFL* is included to capture potential inefficiencies due to price (high interest margin) and nonprice (excessive branches) behaviour of banks (Grigorian and Manole, 2002). *INTR* is used as a control variable in the cost function since interest costs are an important part of total banking costs (Fries and Taci, 2005).

We aim at estimating a true fixed effects stochastic frontier analysis model as suggested by

¹¹ Table A2 provides the details of the principal component analysis. The table shows that the first component covers 41% of the variation of the underlying measures. Moreover, the eigenvalue for the first component is 1.63, which is well above that of the second component (1.04). We therefore only use the first component in the estimations presented in the tables below.

Greene (2005a, b), using bank-specific fixed effects. Yet, given that we use an extensive data-set with more than 15 000 banks and more than 87 000 observations, the number of parameters becomes too large, meaning that we are not able to estimate the model.¹² Instead, we use the approach suggested by Polachek and Yoon (1996) and estimate the model in two steps. In the first step, a fixed effects model is estimated. From this model we obtain asymptotically consistent estimates for the fixed effects, assuming that they are uncorrelated with the efficiency effects. These fixed effects are then used as estimates for α_i in the second step. In the context of our study, this approach has the additional advantage of stressing the heterogeneity between banks in terms of inefficiency over the differences in inefficiency at the country level. Therefore, the focus is more on the influence of liberalization over time on banks rather than on comparing banks in one country with those in another country. This mitigates the problem we may have in comparing the efficiency of banks from different countries, which may have different financial systems.

Since we use a two-step approach to estimate the fixed effects, SEs obtained from the maximum likelihood procedure will be biased. To overcome this problem, we use a double bootstrap procedure on the estimation of the fixed effects and the estimation of the stochastic frontier analysis parameters. We use 1000 bootstrap replications for calculating the SEs.

IV. Data

Our data-set contains information for 87 312 bank-year observations covering 61 developed and emerging economies for the period 1996–2005. The bank level data are taken from financial statements of banks provided by BankScope. Due to data restrictions we cannot go back any further than 1996, even though the financial reforms data start in 1973. The complete list of countries from which we have used bank information is provided in Table 1. This table also shows the number of bank-year observations per country. Bank data from the United States dominate our sample: 70% of the observations are from US-based banks. Germany, Japan and Italy are also important in terms of the number of bank-year

Table 1. List of countries and number of bank-year observations per country

Country	Country	Country
Algeria (9)	Hungary (34)	Pakistan (3)
Argentina (1)	India (469)	Paraguay (75)
Australia (30)	Indonesia (224)	Peru (89)
Austria (112)	Ireland (3)	Philippines (80)
Azerbaijan (6)	Israel (44)	Poland (126)
Bangladesh (115)	Italy (5716)	Portugal (56)
Belarus (16)	Jamaica (42)	Romania (106)
Belgium (205)	Japan (3561)	Singapore (33)
Brazil (64)	Jordan (3)	South Africa (38)
Bulgaria (32)	Kenya (101)	Spain (133)
Chile (4)	Latvia (136)	Sri Lanka (78)
Colombia (17)	Lithuania (57)	Sweden (426)
Costa Rica (35)	Madagascar (15)	Switzerland (1802)
Denmark (421)	Malaysia (110)	Tanzania (16)
Estonia (24)	Mexico (2)	Thailand (94)
Ethiopia (34)	Morocco (24)	Ukraine (98)
Finland (44)	Mozambique (23)	United States (61 698)
France (584)	Nepal (83)	Uruguay (1)
Georgia (15)	Netherlands (89)	Vietnam (44)
Germany (9144)	Nigeria (312)	
Greece (80)	Norway (276)	

Note: Numbers within parentheses are the number of bank-year observations per country.

observations. Data for the macroeconomic variables are from the World Development Indicators provided by the World Bank. As explained, data regarding financial reform measures are provided by Abiad *et al.* (2010).

Table 2 provides information about the average level of bank inefficiency per country. The inefficiency scores reported are averaged over banks and years within a particular country. The higher the scores, the higher the level of inefficiency of the average bank in a country. The table shows that bank efficiency varies substantially between countries. In general terms, the table suggests that banks in developed economies are more efficient than those coming from emerging economies. Whereas bank inefficiency scores for banks in the United States, Germany and Italy are between 1.15 and 1.20, they are above 4.00 for countries like Azerbaijan, Mozambique and Paraguay.

Tables 3 and 4 provide information on the financial liberalization and bank regulation and supervision measures we use in the analysis. Table 3 presents

¹² This is true, even if we incorporate the results of Greene (2005a) to exploit the sparse nature of the Hessian.

Table 2. Average efficiency scores per country

Country name	Mean	SD	Frequency	Country name	Mean	SD	Frequency
Algeria	2.96	1.14	9	Lithuania	3.25	1.06	57
Argentina	1.89	0.00	1	Madagascar	4.95	1.85	15
Australia	1.34	0.34	30	Malaysia	2.24	0.84	110
Austria	1.19	0.41	112	Mexico	3.23	0.01	2
Azerbaijan	4.63	5.93	6	Morocco	2.58	0.40	24
Bangladesh	2.81	0.86	115	Mozambique	4.37	2.14	23
Belarus	2.64	0.55	16	Nepal	2.24	1.62	83
Belgium	1.48	0.64	205	Netherlands	1.14	0.19	89
Brazil	2.77	1.11	64	Nigeria	3.39	1.78	312
Bulgaria	3.33	1.71	32	Norway	1.19	0.26	276
Chile	1.60	0.08	4	Pakistan	2.86	0.18	3
Colombia	2.85	0.94	17	Paraguay	4.16	2.90	75
Costa Rica	2.12	0.70	35	Peru	2.46	0.81	89
Denmark	1.21	0.32	419	Philippines	3.27	0.92	80
Estonia	2.73	0.76	24	Poland	2.19	0.95	126
Ethiopia	2.60	0.53	34	Portugal	2.15	0.58	56
Finland	1.95	0.84	44	Romania	3.39	1.81	106
France	1.56	0.46	584	Singapore	1.52	0.55	33
Georgia	7.70	9.78	15	South Africa	1.91	0.83	38
Germany	1.18	0.22	9144	Spain	1.78	0.61	133
Greece	2.11	0.53	80	Sri Lanka	2.76	0.72	78
Hungary	2.63	1.35	34	Sweden	1.14	0.44	426
India	3.59	0.71	469	Switzerland	1.14	0.36	1802
Indonesia	2.50	1.26	224	Tanzania	2.67	1.77	16
Ireland	1.04	0.05	3	Thailand	3.07	2.10	94
Israel	2.18	0.63	44	Ukraine	3.57	2.25	98
Italy	1.19	0.42	5716	United States	1.16	0.60	61 697
Jamaica	2.91	1.07	42	Uruguay	2.17	0.00	1
Japan	1.34	0.31	3561	Vietnam	2.42	0.67	44
Jordan	2.68	0.12	3	Total	1.24	0.70	87 312
Kenya	1.69	0.81	101				
Latvia	2.89	1.39	136				

Table 3. Average scores for the financial liberalization and bank regulation and supervision dimensions, total sample (1996–2005 annual data)

	(1)	(2)	(3)	(4)	(5)
Year	Credit controls	Interest rate controls	Entry barriers	Privatization	Bank regulation and supervision
1996	2.172	2.704	2.508	1.409	1.262
1997	2.258	2.704	2.491	1.524	1.409
1998	2.315	2.754	2.508	1.540	1.540
1999	2.303	2.770	2.590	1.590	1.704
2000	2.340	2.786	2.622	1.754	1.754
2001	2.360	2.819	2.639	1.770	1.819
2002	2.356	2.836	2.672	1.786	1.950
2003	2.368	2.836	2.688	1.852	1.983
2004	2.368	2.852	2.704	1.934	2.065
2005	2.340	2.852	2.721	1.983	2.065

Notes: Data are based on Abiad *et al.* (2010). The minimum score for each of the five dimensions in the table is 0; the maximum score is 3. See also the discussion in the main text of the article and the Appendix of Abiad *et al.* (2010) for a more elaborate discussion of the measurement of these financial reform dimensions.

Table 4. Summary statistics for the financial liberalization and bank regulation and supervision dimensions, total sample and subsamples of countries (1996–2005 averages)

	(1)	(2)	(3)	(4)	(5)
	Credit controls	Interest rate controls	Entry barriers	Privatization	Bank regulation and supervision
All countries ($N = 61$)					
Average	2.318	2.791	2.614	1.714	1.755
SD	(0.76)	(0.60)	(0.73)	(1.16)	(0.88)
Developed countries ($N = 19$)					
Average	2.730	3.000	2.942	2.168	2.447
SD	(0.51)	(0.00)	(0.23)	(0.95)	(0.66)
Asia ($N = 10$)					
Average	2.112	2.550	1.840	1.100	1.180
SD	(0.79)	(0.68)	(0.96)	(1.14)	(0.68)
Latin America ($N = 10$)					
Average	2.060	2.900	2.640	1.530	1.360
SD	(1.06)	(0.38)	(0.53)	(0.96)	(0.62)
Sub-Saharan Africa ($N = 10$)					
Average	2.321	2.642	2.714	2.000	1.428
SD	(0.56)	(0.79)	(0.70)	(1.16)	(0.52)
Transition economies ($N = 12$)					
Average	2.054	2.608	2.650	1.591	1.808
SD	(0.64)	(0.93)	(0.80)	(1.30)	(0.99)
Middle East and North Africa ($N = 3$)					
Average	2.308	3.000	2.666	1.166	1.333
SD	(0.54)	(0.00)	(0.47)	(0.59)	(1.26)

Notes: Data are based on Abiad *et al.* (2010). The minimum score for each of the five dimensions in the table is 0; the maximum score is 3. See also the discussion in the main text of the article and the Appendix of Abiad *et al.* (2010) for a more elaborate discussion of the measurement of these financial reform dimensions.

data on the changes of these measures during the period 1996–2005. Two observations stand out. First, financial reforms lag behind with respect to privatization and bank regulation and supervision policies. For these two financial reform dimensions the scores are significantly lower than those of the other three dimensions presented in the table. The data confirm the findings of earlier studies suggesting that regulatory and supervisory reforms in many cases only come after financial liberalization has been carried out in areas such as interest liberalization and bank entry (see, e.g. Williamson and Mahar, 1998; Abiad *et al.*, 2010). Second, bank regulation and supervision policies have changed most dramatically between 1996 and 2005 as the score for this dimension increases from 1.26 to 2.07.

Table 4 provides more detail on the difference in financial reform policies between subsamples of countries. This table shows that there is quite some variation between subsamples of countries in terms

of the scores for the different financial reform policies. In particular, this holds for bank regulation and supervision policies. Whereas for the developed countries the average score over the period 1996–2005 for this dimension is 2.45, it is only 1.18, 1.36 and 1.43 for Asia, Latin America and Africa, respectively.

To conclude, Tables 3 and 4 suggest that during the period 1996–2005 financial reforms policies do seem to vary quite substantially between countries as well as over time. This conclusion particularly holds for bank regulation and supervision policies.

V. Empirical Results

Table 5 provides the estimation results with respect to the relationship between bank efficiency and financial

Table 5. Financial reform and bank efficiency: results of the estimations

Dependent variable = TC/PLABOR	(1)	(2)	(3)	(4)
Panel A: cost function				
<i>PFUND/PLABOR</i>	0.872*** (0.00715)	0.855*** (0.00723)	0.855*** (0.00740)	0.857*** (0.00744)
<i>(PFUND/PLABOR)²</i>	0.0410*** (0.000311)	0.0406*** (0.000308)	0.0406*** (0.000316)	0.0406*** (0.000317)
<i>PFUND/PLABOR × PCAP/PLABOR</i>	-0.0352*** (0.000653)	-0.0356*** (0.000660)	-0.0356*** (0.000660)	-0.0356*** (0.000660)
<i>PFUND/PLABOR × LOANS</i>	0.0326*** (0.000520)	0.0328*** (0.000523)	0.0328*** (0.000524)	0.0329*** (0.000525)
<i>PFUND/PLABOR × OTHER</i>	0.00303*** (0.000467)	0.00313*** (0.000465)	0.00314*** (0.000470)	0.00307*** (0.000470)
<i>PFUND/PLABOR × OBA</i>	-0.00504*** (0.000329)	-0.00510*** (0.000332)	-0.00509*** (0.000333)	-0.00516*** (0.000334)
<i>PFUND/PLABOR × Time trend</i>	-0.0111*** (0.000228)	-0.0112*** (0.000230)	-0.0112*** (0.000231)	-0.0113*** (0.000231)
<i>PCAP/PLABOR</i>	0.138*** (0.00911)	0.133*** (0.00927)	0.133*** (0.00927)	0.133*** (0.00926)
<i>(PCAP/PLABOR)²</i>	0.0235*** (0.000459)	0.0235*** (0.000462)	0.0235*** (0.000462)	0.0235*** (0.000462)
<i>PCAP/PLABOR × LOANS</i>	-0.00812*** (0.000561)	-0.00813*** (0.000564)	-0.00812*** (0.000564)	-0.00824*** (0.000565)
<i>PCAP/PLABOR × OTHER</i>	0.00394*** (0.000474)	0.00402*** (0.000475)	0.00402*** (0.000475)	0.00399*** (0.000475)
<i>PCAP/PLABOR × OBA</i>	0.00726*** (0.000360)	0.00734*** (0.000362)	0.00734*** (0.000362)	0.00742*** (0.000363)
<i>PCAP/PLABOR × Time trend</i>	0.00489*** (0.000252)	0.00458*** (0.000254)	0.00458*** (0.000254)	0.00458*** (0.000254)
<i>LOANS</i>	0.409*** (0.00859)	0.412*** (0.00868)	0.411*** (0.00868)	0.411*** (0.00869)
<i>(LOANS)²</i>	0.0459*** (0.000232)	0.0460*** (0.000232)	0.0460*** (0.000232)	0.0459*** (0.000232)
<i>LOANS × OTHER</i>	-0.0570*** (0.000349)	-0.0570*** (0.000348)	-0.0570*** (0.000348)	-0.0569*** (0.000349)
<i>LOANS × OBA</i>	-0.00451*** (0.000233)	-0.00449*** (0.000234)	-0.00449*** (0.000234)	-0.00447*** (0.000234)
<i>LOANS × Time trend</i>	0.00667*** (0.000216)	0.00650*** (0.000217)	0.00650*** (0.000217)	0.00650*** (0.000218)
<i>OTHER</i>	0.381*** (0.00726)	0.383*** (0.00728)	0.383*** (0.00732)	0.382*** (0.00733)
<i>(OTHER)²</i>	0.0287*** (0.000152)	0.0287*** (0.000152)	0.0288*** (0.000152)	0.0287*** (0.000152)
<i>OTHER × OBA</i>	0.00257*** (0.000225)	0.00253*** (0.000225)	0.00254*** (0.000225)	0.00250*** (0.000225)
<i>OTHER × Time trend</i>	-0.00749*** (0.000180)	-0.00746*** (0.000180)	-0.00746*** (0.000180)	-0.00748*** (0.000180)
<i>OBA</i>	0.0117** (0.00517)	0.0121** (0.00523)	0.0121** (0.00523)	0.0122** (0.00523)
<i>(OBA)²</i>	0.00168*** (0.000103)	0.00164*** (0.000103)	0.00164*** (0.000103)	0.00165*** (0.000103)
<i>OBA × Time trend</i>	0.000918*** (0.000138)	0.000963*** (0.000138)	0.000964*** (0.000138)	0.000971*** (0.000138)
<i>Time trend</i>	-0.0967*** (0.00336)	-0.100*** (0.00342)	-0.100*** (0.00342)	-0.100*** (0.00342)
<i>(Time trend)²</i>	-0.000227*** (6.76e-05)	-0.000288*** (6.77e-05)	-0.000288*** (6.78e-05)	-0.000313*** (6.82e-05)

(continued)

Table 5. Continued

Dependent variable = TC/PLABOR	(1)	(2)	(3)	(4)
<i>CONSTANT</i>	7.756*** (0.0731)	7.586*** (0.0756)	7.587*** (0.0758)	7.616*** (0.0761)
<i>Bank fixed effects</i>	Yes	Yes	Yes	Yes
Panel B: inefficiency equation				
<i>FINLIB</i>	-0.908*** (0.140)		0.0288 (0.158)	1.292*** (0.341)
<i>GDPG</i>	0.119*** (0.00809)	0.133*** (0.00808)	0.133*** (0.00813)	0.135*** (0.00813)
<i>INFL</i>	0.0746*** (0.00406)	0.0579*** (0.00408)	0.0579*** (0.00408)	0.0588*** (0.00407)
<i>INTR</i>	0.00315 (0.00372)	-0.00353 (0.00369)	-0.00343 (0.00374)	-0.00483 (0.00379)
<i>REGULATION</i>		-4.461*** (0.283)	-4.487*** (0.316)	-4.530*** (0.314)
<i>FINLIB × REGULATION</i>				-6.813*** (1.610)
<i>CONSTANT</i>	-6.255*** (0.0352)	-4.996*** (0.0900)	-4.991*** (0.0941)	-4.933*** (0.0944)
<i>Sigma_v</i>	0.090	0.089	0.089	0.089
<i>Observations</i>	87 312	87 312	87 312	87 312

Notes: SDs are presented within parentheses. *, ** and *** indicate the significance levels at 10%, 5% and 1%, respectively.

Explanations of the abbreviations used in the table can be found in the main text as well as in Table A1, which provides an overview of all variables used in the analysis.

reforms. As explained earlier, the approach we follow to generate the estimation results is based on stochastic frontier analysis as proposed by Wang and Schmidt (2002). According to this approach, we simultaneously estimate the cost frontier (Equation 5) and the inefficiency equation (Equations 6 to 9). The main focus of the analysis is on the specification of the inefficiency equation, and in particular on whether bank efficiency is associated with financial liberalization policies in general, as well as with the quality of bank regulation and supervision.

Panel A of Table 5 refers to the estimation results of the cost frontier. A positive coefficient implies an outward shift of the cost function, and hence – *ceteris paribus* – higher costs. With respect to the inputs and outputs, the estimation results for the cost function shown in Column 1 appear to be as expected: the coefficients for *PFUND*, *PCAP*, *LOANS*, *OTHER* and *OBA* are significant and positive. Moreover, in many cases the interaction terms we include in the cost function are also positive and significant. This leads us to conclude that our specification of the cost frontier fits theory reasonably well.

Panel B of Table 5 shows the results of the estimation of the inefficiency equation as specified in Equation 6. We include the score of our financial liberalization variable resulting from the factor analysis (*FINLIB*) in the inefficiency equation, along with the control variables *GDPG*, *INFL* and *INT*. The results in Column 1 show that our measure of financial liberalization has a negative and significant sign. This indicates that financial liberalization is associated with improved bank efficiency. In other words, financial liberalization in terms of reducing credit controls, interest rate controls, entry controls and/or privatization of state banks does seem to contribute to making banks more efficient. As discussed in Section II of this article, several contributions to the literature on financial liberalization have stressed that this may be a possible outcome of financial reform policies (see, e.g. McKinnon, 1973; Shaw, 1973; Denizer, 2000; Claessens *et al.*, 2001). The results regarding the control variables show that for GDP growth and the inflation rate we find a positive and significant sign, whereas for the real interest rate the coefficient is not statistically significant. This indicates that

macroeconomic conditions may influence bank efficiency independent from the extent to which financial markets are liberalized.

In Column 2 of Table 5, we analyse the relationship between bank regulation and bank efficiency by including *REGULATION* instead of *FINLIB* in the regression model along with the set of control variables, i.e. we estimate Equation 7. The results in Column 2 show that *REGULATION* is statistically significant and that it has a negative sign. This result supports the hypothesis that the quality of bank regulation is positively associated with bank efficiency. In other words, bank regulation seems to be an important input for making banks more efficient. This outcome is in line with what has been suggested by several contributions to the literature on the effects of financial reform (see, e.g. McKinnon, 1991; Mishkin, 1999; Andersen and Tarp, 2003). The results for the control variables do not change from the results reported in Column 1.

In Column 3, we present the results of the analysis in which we include both our financial liberalization and regulation variables in the inefficiency equation at the same time, i.e. we estimate Equation 8. Whereas the coefficient for the variable *REGULATION* remains to be significant and negative, confirming the results found in Column 2, the coefficient of our measure of financial liberalization (*FINLIB*) becomes positive but is insignificant. Again, the results for the control variables are similar to those reported in Columns 1 and 2.

Column 4 presents the results of estimating Equation 9, where we analyse whether the relationship between financial liberalization and bank efficiency is conditional on the quality of bank regulation and supervision. In the inefficiency equation, we include our variable measuring the quality of bank regulation and supervision (*REGULATION*), the measure of financial liberalization policies (*FINLIB*) and the interaction term of both these variables, along with the set of control variables. The results in Column 4 show that the coefficient for *FINLIB* is positive and significant, suggesting that financial liberalization policies as such are associated with lower levels of bank efficiency. Moreover, *REGULATION* remains to have a significant negative coefficient, which is in line with the findings of the model specification presented in

Columns 2 and 3. Yet, the results also show a negative and significant result for the interactive term *FINLIB* × *REGULATION*. The outcomes for the control variables are again similar to those reported in Columns 1–3. The results for the interactive term *FINLIB* × *REGULATION* may be interpreted as supportive evidence for the hypothesis that a positive association between financial liberalization and bank efficiency is conditional on the quality of bank regulation and supervision of a country.

We further investigate the exact nature of the interactive effect we find and report in Column 4 by calculating the marginal effects of financial liberalization on efficiency conditional on bank regulation and supervision. We plot these marginal effects in Fig. 1. This figure shows that if bank regulation and supervision in a country has a value of 0 or 0.1,¹³ an increase in financial reform will lead to a significant increase in the inefficiency of banks. However, if the quality of bank regulation and supervision increases to the values 0.2 or 0.3, an increase in financial liberalization will significantly decrease the inefficiency of the banking sector in

Fig. 1. Effect of financial liberalization on bank efficiency conditional on bank regulation and supervision

Notes: The dashed lines indicate the 95% confidence interval. Please note that in the original Abiad *et al.* (2010) data-set the banking supervision variable can obtain the values 0, 1, 2 and 3. For optimization reasons related to the calculation of the cost function and the inefficiency equation, we have divided the observations for this variable by 10 so that they are in the same range as the other variables in our model.

¹³ In the original Abiad *et al.* (2010) data-set, the banking supervision variable can obtain the values 0, 1, 2 and 3. For optimization reasons regarding the calculation of the cost function and the inefficiency equation we have divided the observations for this variable by 10 so that they are in the same range as the other variables in our model.

that country. Moreover, Fig. 1 also shows that the negative effect of liberalization on bank efficiency is stronger the lower the quality of bank regulation and supervision.

Next, we perform a number of robustness tests. First, we redo the analysis using only data for

countries with more than 50 bank-year observations. This robustness test is performed to evaluate to what extent our results may be driven by observations from countries with a relatively low number of bank-year observations. The results of this robustness test are presented in Table 6, Panel A. These results are based

Table 6. Financial reform and bank efficiency: robustness tests

Dependent variable = Bank inefficiency	(1)	(2)	(3)	(4)
<i>Panel A: estimations using data from countries with more than 50 bank-year observations</i>				
<i>FINLIB</i>	−0.890*** (0.150)		0.236 (0.170)	0.751** (0.374)
<i>GDPG</i>	0.129*** (0.00834)	0.148*** (0.00843)	0.149*** (0.00848)	0.150*** (0.00849)
<i>INFL</i>	0.0816*** (0.00442)	0.0624*** (0.00440)	0.0623*** (0.00440)	0.0626*** (0.00440)
<i>INTR</i>	−0.0138*** (0.00414)	−0.0218*** (0.00410)	−0.0208*** (0.00416)	−0.0212*** (0.00419)
<i>REGULATION</i>		−5.047*** (0.292)	−5.249*** (0.326)	−5.266*** (0.325)
<i>FINLIB × REGULATION</i>				−2.646 (1.704)
<i>CONSTANT</i>	−6.216*** (0.0362)	−4.785*** (0.0921)	−4.747*** (0.0963)	−4.725*** (0.0970)
<i>Sigma_v</i>	0.00672	0.00673	0.00673	0.00673
<i>Observations</i>	86 720	86 720	86 720	86 720
<i>Panel B: estimations using data from countries with more than 100 bank-year observations</i>				
<i>FINLIB</i>	−1.270*** (0.161)		−0.309* (0.181)	1.461*** (0.489)
<i>GDPG</i>	0.146*** (0.00890)	0.161*** (0.00900)	0.160*** (0.00899)	0.164*** (0.00902)
<i>INFL</i>	0.0630*** (0.00479)	0.0501*** (0.00474)	0.0497*** (0.00475)	0.0510*** (0.00474)
<i>INTR</i>	−0.0386*** (0.00588)	−0.0371*** (0.00561)	−0.0394** (0.00577)	−0.0417*** (0.00580)
<i>REGULATION</i>		−4.703*** (0.317)	−4.434*** (0.354)	−4.401*** (0.352)
<i>FINLIB × REGULATION</i>				−8.556*** (2.169)
<i>CONSTANT</i>	7.603*** (0.0833)	7.430*** (0.0859)	7.423*** (0.0863)	7.460*** (0.0866)
<i>Sigma_v</i>	0.00678	0.00678	0.00680	0.00679
<i>Observations</i>	85 913	85 913	85 913	85 913
<i>Panel C: estimations using data from G10 countries</i>				
<i>FINLIB</i>	−7.422*** (0.421)		−6.345*** (0.485)	4.073 (2.528)
<i>GDPG</i>	0.249*** (0.0116)	0.215*** (0.0112)	0.252*** (0.0116)	0.259*** (0.0117)
<i>INFL</i>	0.283*** (0.0163)	0.168*** (0.0151)	0.269*** (0.0164)	0.264*** (0.0167)
<i>INTR</i>	−0.169*** (0.00743)	−0.126*** (0.00735)	−0.161*** (0.00759)	−0.0170*** (0.00796)

(continued)

Table 6. Continued

Dependent variable = Bank inefficiency	(1)	(2)	(3)	(4)
<i>REGULATION</i>		-4.879*** (0.387)	-1.981*** (0.446)	-1.071** (0.494)
<i>FINLIB</i> × <i>REGULATION</i>				-38.19*** (9.093)
<i>CONSTANT</i>	-5.784*** (0.0551)	-4.709*** (0.117)	-5.283*** (0.125)	-5.446*** (0.131)
<i>Sigma_v</i>	0.00716	0.00718	0.00715	0.00715
<i>Observations</i>	83 225	83 225	83 225	83 225

Notes: SDs are presented within parentheses. *, ** and *** indicate the significance levels at 10%, 5% and 1%, respectively.

Explanations of the abbreviations used in the table can be found in the main text as well as in Table A1, which provides an overview of all variables used in the analysis.

The results presented in Panel A of this table are based on the data from the following 33 countries: Austria, Bangladesh, Belgium, Brazil, Denmark, France, Germany, Greece, India, Indonesia, Italy, Japan, Kenya, Latvia, Lithuania, Malaysia, Nepal, Netherlands, Nigeria, Norway, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Ukraine, and the United States.

The results presented in Panel B of this table are based on the data from the following 21 countries: Austria, Bangladesh, Belgium, Denmark, France, Germany, India, Indonesia, Italy, Japan, Kenya, Latvia, Malaysia, Nigeria, Norway, Poland, Romania, Spain, Sweden, Switzerland, and the United States.

on data from 33 countries from different country regions. Since the results in Table 5 indicated that our specification of the cost frontier fits theory reasonably well, we do not report the results for the cost frontier in Table 6, but focus on the results for the inefficiency equation.¹⁴ The results for the inefficiency equation are qualitatively similar to those of the baseline regressions shown in Table 5. In particular, we still find that financial liberalization without taking into account bank regulation and supervision has a significantly negative impact on bank efficiency (Column 1). Yet, when interacted with the measure for the quality of bank regulation and supervision, it becomes positively associated with bank efficiency, whereas the measure of the quality of regulation and supervision as well as the interaction between financial liberalization and bank regulation and supervision are significantly negative (Column 4).

Second, we further evaluate the impact of dropping countries with a relatively low number of bank-year observations by using only data from countries with more than 100 bank-year observations, which leaves 21 countries in the data-set. This subsample of countries includes developed countries such as the United States, Germany and Italy, but also less developed countries such as Bangladesh, Malaysia, Kenya

and Nigeria. The results of the estimations are shown in Table 6, Panel B. Again, the outcomes are qualitatively similar to those of the baseline regressions shown in Table 5.

Third, we redo the baseline regressions as reported in Table 5, using only data for the G10 countries. With this robustness test we aim at testing whether the relationship between financial liberalization, bank regulation and supervision, and bank efficiency holds even for countries that have the most liberalized financial systems and the strongest bank regulatory and supervisory frameworks. In general terms, the results reported in Table 6, Panel C, confirm the baseline regression results presented in Table 5.

Fourth, we carry out a robustness test by adding bank-specific variables to the cost frontier specification. In particular, we add two variables, one measuring the ratio of equity to total assets and the other measuring the bank's loan loss reserves divided by its assets. In the literature on bank efficiency, both variables are frequently used to differentiate between different financing and risk-taking strategies of banks, respectively (see, e.g. Berger and De Young, 1997; Fries and Taci, 2005). Our results do not change when we add these bank-specific variables.¹⁵

¹⁴ The results for the cost frontier are available on request from the authors.

¹⁵ The results for this robustness test are not presented to save space, but are available on request from the authors.

Fifth, we run the specifications as presented in Table 5, but use different financial liberalization measures individually (not tabulated). Again, this does not change our results. Credit controls, entry barriers and bank privatization without taking into account bank regulation and supervision have a significantly negative impact on bank efficiency. Yet, when interacted with the measure for the quality of bank regulation and supervision, these dimensions of financial liberalization are positively associated with bank efficiency, whereas the measure of the quality of regulation and supervision as well as the interaction between financial liberalization and bank regulation and supervision become significantly negative. This confirms the results shown in Table 5.

Finally, we use one-period lagged variables for financial liberalization and financial regulation, and analyse their joint impact on bank efficiency. Again, we get results similar to those presented in Table 5.

Our empirical results seem to be in line with experiences of governments that have liberalized financial markets in the past. In the 1970s, countries such as Argentina and Chile strongly liberalized their financial markets, but at the same time they did not develop strong bank regulation and supervision. This combination turned out to be disastrous: after some years both countries experienced large losses with respect to the macroeconomy in general and the efficiency of the financial system in particular (Diaz-Alejandro, 1985; Edwards and Cox-Edwards, 1991). Similar experiences were observed in Asia during the late 1990s. Countries that were struck most strongly by the financial crisis of 1997/98 were the ones that had liberalized financial markets in combination with weak regulatory and supervisory frameworks (Mishkin, 1999).

Also the recent financial crisis of 2008 fits into this picture. The waves of financial reforms that have been consistently carried out during the last few decades have led to the development of strongly integrated global financial markets and the creation of a large amount of new and complex financial derivatives. At the same time, however, bank regulation and supervision does seem not to have been developed at the same pace. The lack of strong financial regulation and supervision has been at least one of the causes of the current financial crisis.

Our empirical results lend support to the view expressed by those observers who stress the importance of the right order of steps to be taken when

liberalizing financial markets. These observers argue that financial liberalization should be preceded by strengthening the regulatory and supervisory frameworks (McKinnon, 1991). Otherwise, moral hazard behaviour of banks may be stimulated, which may destroy rather than increase bank efficiency.

VI. Summary and Conclusions

Using data for a sample of 87 312 bank-year observations covering 61 developed and emerging economies for the period 1996–2005, we have investigated the impact of financial liberalization on bank efficiency. Most importantly, we have focused on analysing whether the relationship between financial liberalization and efficiency is conditional on the quality of bank regulation and supervision. To the best of our knowledge, this is the first study that explicitly investigates the interrelationships between financial liberalization, bank regulation and supervision, and bank efficiency in a multi-country setting. We have used stochastic frontier analysis to calculate bank efficiency measures at the individual bank level.

Overall, our results show that financial liberalization programmes are positively associated with increased bank efficiency. Yet, we also show that this positive association is conditional on the quality of bank regulation and supervision. In other words, if countries liberalize their financial markets without putting in place strong bank regulation, liberalization policies may actually decrease, instead of increase bank efficiency. These are important lessons to be learned for governments that are in the process of liberalizing their financial market policies.

At the same time, however, we acknowledge that our measure of bank regulation and supervision may be limited, i.e. it does not include policies that in hindsight could have helped reducing the probability of a financial crisis like the one we experienced in recent years. This crisis particularly hit the more developed countries. The high levels of financial liberalization of countries in the past decade may also have led to the need for new types of regulatory and supervisory practices. Examples of these practices may be increased transparency and accountability of risk management systems applied by banks, improved corporate governance practices regarding the composition and expertise of bank boards, the use of incentive-based compensation schemes, and so

on. Some of these practices have been included in the Basel III accords. Basel III, which has been implemented from 2013, focuses on increasing bank capital adequacy standards, improving transparency and disclosure by banks, and strengthening bank market liquidity risk. These practices should reduce the risk of financial crises in the future. Moreover, several countries have also introduced practices regarding bank governance and remuneration policies as part of codes of best practices for banks.¹⁶ Future research may focus on these new regulatory and supervisory policies and evaluate how they influence bank efficiency.

Future research could also focus on extending the data-set in terms of countries. This requires more information on financial liberalization programmes for a larger set of countries. Moreover, extending the time period for which we have data would enhance our understanding of the mechanisms at work explaining the interrelations between financial liberalization, bank regulation and supervision, and bank efficiency. The period for which we have data in this study is relatively short, which makes it more difficult to predict the long-term consequences of regulatory and supervisory policies on the relationship between financial liberalization and bank efficiency.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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¹⁶ Examples are the Banking Code of the Financial Service Authority in the United Kingdom, the Banking Code of the Committee Maas in the Netherlands and the Code of Banking Practice of the Australian Bankers' Association.

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Appendix

Table A1. Explaining the variables used in the analysis

Variable name	Explanation (data source)
<i>PLABOR</i>	Price of labour, measured as the ratio of total personnel costs to total number of employees (<i>source: BankScope</i>).
<i>PFUND</i>	Price of deposits, measured as the ratio of total interest costs paid by the bank to the value of total deposits and other interest-bearing funds (<i>source: BankScope</i>).
<i>PCAP</i>	Price of capital, measured as the ratio of total noninterest expenses minus total personnel costs to the value of nonearning assets (<i>source: BankScope</i>).
<i>LOANS</i>	Value of total loan portfolio (<i>source: BankScope</i>).
<i>OTHER</i>	Value of other income earning assets (<i>source: BankScope</i>).
<i>OBA</i>	Value of off-balance sheet activities (<i>source: BankScope</i>).
<i>Time trend</i>	Measure capturing the specific year for which data have been used. <i>Time trend</i> has the value 1 for data from the year 1996; it has the value 10 for data from 2005.
<i>FINLIB</i>	Measure of financial liberalization policies based on the scores for four dimensions of financial market policies (i.e. credit controls and reserve requirements, interest rate controls, entry barriers and state ownership in the banking sector). The scores run from 0 (meaning that with respect to a particular policy the government of a country is fully repressing/controlling the banking sector) to 3 (i.e. for this policy the government has fully liberalized the banking sector) and carrying out a principal component analysis to create one component capturing the extent to which a country has carried out financial liberalization policies (<i>source: Abiad et al., 2010</i>).
<i>REGULATION</i>	Measure of the quality of bank regulation based on the scores of three dimensions of bank regulation measures, that is (1) the adoption of risk-based capital adequacy ratios based on the Basel standard; (2) the independency of banking supervisory agency; and (3) the coverage of supervisory oversight; note that for this dimension more government intervention is interpreted as a positive reform policy (i.e. contributing to improving the efficiency of the banking system). The measure can take values between 0 and 3. The value 0 means that a country has put in place none of three dimensions of regulation and supervision; 1 means that the country has put in place one of the three dimensions of regulation and supervision; 2 means that the country has put in place two of the three dimensions of regulation and supervision; and 3 means that the country has put in place all three dimensions of regulation and supervision (<i>source: Abiad et al., 2010</i>).
<i>INFL</i>	Annual inflation rate (<i>source: World Bank, World Development Indicators</i>).
<i>INTR</i>	Annual real interest rate (<i>source: World Bank, World Development Indicators</i>).
<i>GDPG</i>	Annual growth rate of GDP (<i>source: World Bank, World Development Indicators</i>).

Table A2. Results of the principal component analysis using the values of four financial liberalization measures (i.e. credit controls, interest rate controls, entry barriers and privatization of state banks)

Component	Eigenvalue	Difference	Proportion	Cumulative
Component 1	1.63	0.58	0.41	0.41
Component 2	1.04	0.28	0.26	0.67
Component 3	0.76	0.19	0.19	0.86
Component 4	0.57	.	0.14	1.00