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**Financial Liberalization, the
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Abstract

In this paper we investigate whether the relationship between financial liberalization and bank efficiency is conditional on the country-level institutional environment. We use a data set of 79,246 bank-year observations for 67 countries covering the period 1996-2005, and apply stochastic frontier analysis (SFA) to measure bank cost efficiency. We first find evidence for a positive association between financial liberalization and bank cost efficiency. Next, we find support for the fact that the institutional environment matters for this relationship. In particular, we show that market transparency, legal framework efficiency and the quality of the overall institutional environment positively affect this relationship. Perhaps most interestingly, our findings suggest that freedom of press, transparency of information exchange and media dependence are fundamental for financial liberalization to positively affect bank cost efficiency. Without these conditions financial liberalization may not affect bank cost efficiency. *(140 words)*

Key words: Financial liberalization, Institutions, Bank efficiency, Stochastic frontier analysis

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1. Introduction

Financial liberalization policies have been implemented for many years by many countries, as it is generally believed that these policies help building more efficient financial institutions by making them less state-directed and exposing them to increased market competition, which leads to more efficient ways of intermediating resources from savings to investments. Therefore, such policies are expected to positively contribute to economic growth (Bumann et al., 2013). At the same time, however, experiences with these policies have not always been positive. For example, in the early 1980s Latin American countries such as Chile and Argentina experienced huge macroeconomic crises after a period of strong financial liberalization (Diaz-Alejandro, 1985). Also, the Asian crisis of 1997-1998 was, at least partly, due to liberalization programs of financial markets these countries had been carried out since the late 1980s (Mishkin, 1999). These and other experiences suggest that we still do not exactly know under what conditions financial liberalization policies really work, i.e. the context in which these policies are carried out may have an impact on the outcomes of these policies.

In this paper we dig deeper into understanding what conditions may positively affect the impact of financial liberalization on the efficiency of financial institutions. In particular, we focus on the country-level institutional environment and investigate whether different institutional aspects affect the relationship between financial liberalization and the efficiency of financial institutions. In choosing this focus, we have been inspired by the existing empirical evidence on the determinants of bank efficiency. On the one hand, several studies have investigated the relationship between financial liberalization and bank efficiency (see, e.g., Bhattacharyya et al., 1997; Barajas et al., 2000; Kumbhakar and Sarkar, 2003; Patti and Hardy, 2005; Williams and Nguyen, 2005; Hermes and Vu, 2010; Hermes and Meesters, 2015). On the

other hand, empirical studies suggest that bank efficiency is affected by the underlying country-level institutional setting (see, e.g., La Porta et al., 1998; Demirguc-Kunt and Huizinga, 1999; and Levine et al., 2000; Lensink et al., 2008; Hasan et al., 2009). Yet, no study has investigated whether these institutional conditions have an impact on the relationship between financial liberalization and bank efficiency.

We use stochastic frontier analysis (SFA) to measure the cost efficiency of banks, using a dataset of 79,246 bank-year observations for 67 countries in the period 1996-2005. We first analyze the relationship between financial liberalization policies and bank cost efficiency conditional on institutional environment and show that indeed there is positive relationship, suggesting that financial liberalization improves bank efficiency. Next, we investigate whether institutional variables moderate the relationship between financial liberalization policies and bank efficiency. We look at various aspects of the institutional environment and find that they indeed help strengthening the positive association between financial liberalization policies and bank efficiency. More specifically, our findings suggest that freedom of press and transparency of information exchange and media independence are fundamental conditions that allow financial liberalization to positively affect bank cost efficiency. Without these conditions financial liberalization does not seem to affect bank cost efficiency. The results from this analysis are potentially important from a policy perspective. They may guide governments and policy makers to constitute policies that help improving the institutional environment, facilitating the effectiveness of financial liberalization policies on bank cost efficiency.

The remainder of the study is organized as follows. Section 2 provides a short literature review. Section 3 discusses how we measure financial liberalization and institutions. Section 4 describes the methodology of measuring bank cost efficiency and our econometric modelling

approach. Moreover, this section shortly discusses the descriptive statistics. Section 5 presents our main empirical findings and discusses the robustness checks. In section 6 we discuss the conclusions from the analysis, reflect on its strengths and weaknesses, and provide possible ways of extending our research.

2. Literature review

2.1 Financial liberalization and bank efficiency

Financial liberalization policies reduce or even eliminate government controls and interventions in the country's financial system. These policies aim at improving bank efficiency, which may be defined as the capacity of banks to transform inputs to outputs, i.e. facilitating the intermediation of funds from savings to investment. Improving the efficiency with which banks carry out their role as financial intermediaries should ultimately contribute to higher economic growth (Ataullah *et al.*, 2004). Yet, the consequences of these policies for the financial sector, as well as for the macro economy as a whole, remain controversial.

McKinnon (1973) and Shaw (1973) argue that government controls and interventions interfere with the market price mechanism and weaken or even eliminate market competition, thereby adversely affecting the capacity of banks to intermediate funds from depositors to investors. Eliminating these controls and interventions, they argue, restores and strengthens the market price mechanism and improves the conditions for market competition, which is expected to stimulate more efficient allocation of scarce financial resources. First, financial liberalization policies remove interest ceilings and credit controls set by the government, allowing banks to choose to finance investment projects based on sound economic and financial criteria, instead of politically motivated criteria. Second, these policies may also allow for more domestic and/or

foreign banks entering the market, resulting in increased bank competition. This in turn weeds out inefficient banks and forces other ones to become more efficient in resource allocation, bank management, risk management and financial innovation in order to survive (Denizer *et al.*, 2000; Claessens *et al.*, 2001). Third, policies may include opening the capital account, which allows banks, next to domestic and foreign investors, to engage in improved portfolio diversification. In all these cases, bank efficiency is expected to improve as they enhance the banks' intermediation role.

Yet, others stress the potential adverse effects of financial liberalization on bank efficiency. Stiglitz (2000) argues that financial liberalization does not necessarily solve asymmetric information problems. Even in a more liberalized financial market, banks suffering from asymmetric information problems may be unable to improve their efficiency in transforming savings into investments. A crucial component of liberalization should be increasing the disclosure and transparency of information so as to allow banks to make informed decisions when allocating financial resources. Boot (2000) argues that financial liberalization may even deteriorate asymmetric information problems. Following financial liberalization, borrowers may have more easy access to bank loans due to the increase of competition in the banking market. The easier access reduces the value of building up long-term relationships of banks with their customers. When relationship lending becomes less important, banks experience a loss of information on customer credibility, which may actually aggravate their asymmetric information problems.

The controversy regarding the consequences of financial liberalization for bank efficiency has not been fully solved by the empirical literature. Studies analyzing the relationship between financial liberalization include Bhattacharyya *et al.* (1997), Kumbhakar *et al.*, (2001),

Maudos et al. (2002), Isik and Hassan (2003), Kumbhakar and Sarkar (2003), Patti and Hardy (2005), Williams and Nguyen (2005), Ataullah et al. (2004), Ataullah and Le (2006), Denizer et al. (2007), Burki and Niazi (2010), and Bhattacharyya and Pal (2013). In most cases, these studies use data from a single country. Only a few studies use a multi-country setting (see, e.g. Hermes and Vu, 2010; Williams, 2012; Andries and Capraru, 2013; Chortareas et al., 2013; and Hermes and Meesters, 2015). Moreover, from these empirical studies it remains unclear under what conditions the relationship between financial liberalization and bank efficiency is positive or negative.

The theoretical (and empirical) controversy with respect to the consequences of financial liberalization policies on bank efficiency, and the mixed experiences countries have had with these policies in the past, leads us to consider the possibility that the nature of the relationship between financial liberalization policies and bank efficiency depends on the environment in which these policies are implemented. One potentially important contextual variable we focus on in our analysis is the institutional environment.

2.2 The institutional environment and bank efficiency

Several studies find that institutions matter for bank performance and financial development. In particular, several studies suggest that legal reforms that strengthen creditor rights, contract enforcement and accounting practices improve the efficiency of financial intermediaries (La Porta *et al.*, 1998; Demirguc-Kunt and Huizinga, 1999; and Levine *et. al.*, 2000; Hasan *et al.*, 2009; Gaganis and Pasiouras, 2013). Moreover, some studies focus on financial regulation and bank supervision and show that country-level differences in regulation and supervision may explain differences in bank performance between countries (Demirguc-Kunt *et al.*, 2004; Barth *et*

al., 2006). Mamatzakis et al. (2013) find that strict labor regulation is associated with lower bank efficiency while certain aspects of credit regulation are positively associated with improved efficiency. Kalyvas and Mamatzakis (2014) show that credit information sharing improves bank efficiency, especially during the financial crisis of 2008-2010. Lensink and Meesters (2014) take a broader view when analyzing the relationship between institutions and bank efficiency. In particular, they use the World Bank Worldwide Governance Indicators (WGI) as a measure of the country-level institutional quality and focus on explaining the efficiency of foreign banks. They find that higher quality of institutions improves the efficiency banks.

2.3 Financial liberalization, institutions and bank efficiency

While previous research has focused on analyzing the relationship between financial liberalization and bank efficiency and between the institutional environment and bank efficiency separately, we conjecture that the way financial liberalization affects bank efficiency may be conditional on the institutional environment. To the best of our knowledge this has not been analyzed before in the empirical literature. A few studies are related to what we aim to do in our paper. Chinn and Ito (2006) show that the impact of capital account liberalization on economic growth depends on the quality of institutions. Demirguc-Kunt and Detragiache (1998) find that the likelihood of a banking crisis following financial liberalization policies is higher when the institutional framework is weak, i.e. when the rule of law and contract enforcement mechanisms are weak and corruption is high. Delis (2012) comes closest to what we do in our paper. He examines the relationship between financial reforms, institutions and bank competition and shows that institutions are essential for financial liberalization policies to increase competition in the banking industry.

When talking about the institutional environment, we take a broad perspective, i.e. we go beyond the narrow definition of institutions in terms of legal reforms and/or bank regulation and supervision most previous studies have focused on. Instead, we follow Lensink and Meesters (2014) and look at various dimensions of institutions as described by the World Bank Worldwide Governance Indicators (WGI). These indicators of the institutional environment have been widely used in economic research. In our research we are particularly interested in the following four institutional dimensions, i.e. voice and accountability, regulatory quality, rule of law and control of corruption.

So, how can the institutional environment affect the relationship between financial liberalization and bank efficiency? We start the discussion by focusing on the *voice and accountability* dimension of the institutional environment. This dimension focuses on the extent to which a country has established democratic rights, freedom of expression, freedom of association and media independence. Financial institutions play a crucial role in collecting information and reducing asymmetric information (Stiglitz, 2000). Democratic rights and freedom of expression and association positively contribute to increased transparency and freedom of information exchange in a country. This, in turn better enables banks to fulfill their intermediary role by reducing asymmetric information. In a related fashion, media independence may increase the flow of information available to banks to play their role in efficiently intermediating savings to investments. Moreover, the media also plays the role as watchdog (Miller, 2006) and may reduce the probability of misuse of information by banks, increasing their efficiency in allocating financial resources. Houston et al. (2011) show that private monitoring and the existence of independent and competitive media reduce the extent of corruption in bank lending. Thus, when financial liberalization policies are carried out in

countries scoring high on voice and accountability, we expect the positive impact of these policies on bank efficiency will be higher as well.

Regulatory quality refers to perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. We argue that banks will be more willing to invest in improving the efficiency of their operations if they positively perceive the government's ability to formulate and implement sound financial liberalization policies and if the government can be trusted and committed to pursuing them over the longer run. Thus, this dimension is important for the credibility of financial liberalization policies. Financial liberalization is therefore expected to be more effective in the presence of high levels of government effectiveness and regulatory quality.

The next institutional dimension, *rule of law*, represents perceptions of the extent to which agents have confidence in the quality of contract enforcement, property rights, the police, and the courts. The importance of this dimension for the development of financial markets has been discussed extensively in the literature. La Porta et al. (1997; 2000) argue that differences in legal rules and quality of enforcement can explain the differences in the level of development of financial systems around the world. Beck and Levine (2002) find that the quality of the legal framework can boost financial development by effectively protecting the interests of outsiders and strengthening contract enforcement. Demirguc-Kunt and Huizinga (1999) point out that in a country with poor contract enforcement, banks require higher interest margins and investors have to set higher expected returns to compensate for the additional risk of default. Qian and Strahan (2007) find that strong creditor rights enhance loan availability, because lenders are more willing to provide credit on favorable terms. An effective legal framework with effective contract enforcement and strong creditor rights reduces risk premiums banks require when lending.

Japelli et al. (2005) point out that judicial efficiency reduces credit constraints and increases incentives for banks to extend credit in a competitive market. These studies point out that regulatory quality boosts financial development by reducing the costs for banks to carry out their intermediary role. Moreover, it reduces the uncertainty and risk of defaults. In such an environment, i.e. one in which regulations are conducive to promoting financial development, financial liberalization policies are therefore expected to be more successful in enhancing bank efficiency.

The final institutional dimension refers to the extent to which *corruption* (i.e. public power is used for private gain) is prevalent in a country. The impact of corruption on the relationship between financial liberalization and bank efficiency is ambiguous. On the one hand, corruption may negatively impact efficient financial intermediation when government officials and/or firm representatives bribe banks to get access to loans for low-productivity projects (Barth et al., 2009). Furthermore, corruption may reduce the capacity of financial intermediaries to accurately forecast the financial position of firms, as corruption is associated with higher levels of asymmetric information between the bank and its customers (Chen et al., 2010). Finally, Goel and Hasan (2011) find that higher levels of corruption are associated with a larger number of bad loans and loan defaults. Thus, corruption and efficient financial intermediation are negatively associated.

On the other hand, however, research has also shown that corruption may stimulate economic and financial transactions. In the literature this has been termed the *greasing the wheels* hypothesis (Leff, 1964; Bardhan, 1997, Méon and Sekkat, 2005). Especially in an environment in which economic and financial transactions are inhibited by strong regulatory capture and administrative barriers, corruption may help overcoming the adverse effects of rules

and regulations on economic decision making. Corruption, for example in terms of paying a bribe to government officials may help in speeding up, or even circumventing, certain formal procedures and administrative barriers, which in turn may facilitate transactions. As the financial sector is generally seen as one of the economic sectors for which the regulatory burden is relatively high, the greasing the wheels hypothesis of corruption may be relevant. Several studies have found evidence for the greasing the wheel hypothesis (see, e.g., Méon and Weill, 2010; Dreher and Gassebner, 2013; Katoa and Satob, 2015). The hypothesis does not go uncontested in the literature, however (Campos et al., 2010). The context as well as the extent to which corruption takes place does seem to be important.

Taking into account the above arguments, this leads us to expect that, when financial liberalization policies are carried out, the positive impact of these policies on bank efficiency may be either lower or higher in the presence of higher levels of corruption. Financial liberalization policies create the potential for banks to raise their efficiency due to extended markets, more competition, and reduction of government controls on interest rates and credit allocation, and corruption may effectively reduce or increase the extent to which banks will allocate resources more efficiently as the process of resource allocation remains being captured, or, alternatively, stimulated by corruptive practices.

3. Data

We use three different data sets for our analysis. Bank level data is taken from BankScope. These data are used in the estimations of bank-level efficiency. Reliable data from this source covering a sufficient number of banks is only available from 1996. The measures of financial liberalization are provided by the financial reform dataset developed by Abiad et al. (2010).

These data are available for the period 1973-2005. Measures of institutions and other country-level data are from the World Development Indicators (WDI) and World Governance Indicators (WGI). BankScope is a comprehensive dataset covering most countries around the world and accounts for more than 90 per cent of all banking assets. Because BankScope data start in 1996 and the dataset of Abiad et al. (2010) ends in 2005, we have to restrict our analysis to the period 1996-2005.

3.1 Financial liberalization

Abiad et al. (2010) collect data on seven dimensions of financial liberalization in 91 countries. In our analysis, we only include four of the seven dimensions. That is, we use data on the presence of bank credit controls, interest rate controls, bank entry barriers, and state ownership of banks. The other three dimensions not included in our dataset are related to capital account restrictions, security market policies and prudential regulations. These dimensions have no direct link to banks and are therefore not relevant for the analysis in this paper.

For each dimension Abiad et al. (2010) provide an annual rating indicating to what extent government policies have been taken to liberalize financial markets on this dimension. The higher the rating, the more liberalized markets are on this dimension. *Credit controls* describe the extent to which government policies are in place requiring banks to allocate a minimum amount of bank lending into prioritized industrial sectors. The variable *credit controls* ranges from 0 (i.e. credit allocation fully controlled by the government) to 4 (fully liberalized). *Interest rate controls* refer to government policies aiming at setting lending and deposit rates of banks. This variable ranges from 0 (i.e. interest rates fully set by the government) to 4 (fully liberalized). *Entry barriers* refer to the fact that the government restricts market entry of domestic and/or foreign

banks, by restricting the degree of participation of these banks, the scope of their activities, the location of bank operations, and/or the licensing of their activities. This variable ranges from 0 (entrance entirely restricted by the government) to 4 (entrance fully liberalized). Finally, the variable *state ownership* refers to the extent to which the government controls the assets of the banking system and takes values from 0 (i.e. banking system is entirely state-owned) to 3 (entirely privatized).

4.2 Institutional environment

The data describing the institutional environment are taken from the World Governance Indicators (WGI) developed by Kaufmann et al. (2010) of the World Bank. Kaufmann et al. (2010) collect data on the institutional environment at the country-level. The data are based on a large number of country-level surveys carried out by survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms, measuring the views of firms, citizens and experts on various aspects of the institutional environment. The measures refer to perceptions instead of actual states of the institutional environment. As was discussed in section 2, we focus on four dimensions of institutions, i.e. voice and accountability (*Voice*), regulatory quality (*Regulation*), rule of law (*Law*), and control of corruption (*Corruption*), respectively. Values of these dimensions range from -2.5 to 2.5. A higher value corresponds to a better performance of a particular institutional dimension. This also holds for our corruption variable, as it is a measure of the extent to which corruption is controlled for.

4. Methodology and econometric modelling approach

We measure bank efficiency by focusing on cost efficiency of banks. This approach has been widely used in the banking literature (Berger and Humphrey, 1997). 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 (Berger and Mester, 2003). 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.

In the literature two approaches towards using stochastic frontier analysis have been used. 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; and Meeusen and van den Broeck, 1977). Second, the cost frontier and 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. According to Wang and Schmidt (2002), the two-step approach yields biased coefficients. We apply the model proposed by Battese and Coelli (1995) to simultaneously estimate the cost frontier and the inefficiency equation.

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

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

where

$$u_{i,t} \sim N^+(m_{i,t}, \sigma_u^2) \quad (1a)$$

and

$$v_{i,t} \sim i. i. d. N(0, \sigma_v^2) \quad (1b).$$

$C_{i,t}$ is the total cost of bank i at time t ; $C(y_{i,t}, w_{i,t}, q_{i,t}; \beta)$ is the functional form of the cost frontier; $u_{i,t}$ measures the cost inefficiency of bank i at time t ; and $v_{i,t}$ captures measurement errors and random effects. Within the cost frontier $C(y_{i,t}, w_{i,t}, q_{i,t}; \beta)$, $y_{i,t}$ is a vector of the logarithm of outputs of bank i at time t , $w_{i,t}$ is a vector of the logarithm of input prices of bank i at time t , $q_{i,t}$ is a vector of the specific variables of bank i at time t , and β is a vector of all parameters to be estimated. Equation (1a) explains the properties of both error terms in model (1). The error term $v_{i,t}$ has the same properties as the error term in OLS. It has mean of zero and a normal distribution. The error term $u_{i,t}$ measures bank inefficiency. It is independently and identically distributed with a normal distribution, truncated at 0 with $m_{i,t}$. The specification of $m_{i,t}$ will be further developed in equation (3) below.

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 as proposed by Christensen et al. (1973). Using

such a specification leads to a better fit of the frontier than the standard Cobb-Douglas specification (Kumbhakar and Knox Lovell, 2000).

The full cost function can be specified as follows:

$$\begin{aligned}
\ln(TC_{i,j,t}) = & \beta_0 + \beta_1 \ln(P_Deposits_{i,j,t}) + \beta_2 \ln(P_Labour_{i,j,t}) + \beta_3 \ln(P_Capital_{i,j,t}) + \beta_4 \ln(Loan_{i,j,t}) + \\
& \beta_5 \ln(OthAssets_{i,j,t}) + \beta_6 \ln(Offbalance_{i,j,t}) + \beta_7 Time + \beta_8 Time^2 + \beta_9 (\ln(P_Deposits_{i,j,t}))^2 + \\
& \beta_{10} \ln(P_Deposits_{i,j,t}) * \ln(P_Labour_{i,j,t}) + \beta_{11} \ln(P_Deposits_{i,j,t}) * \ln(P_Capital_{i,j,t}) + \\
& \beta_{11} \ln(P_Deposits_{i,j,t}) * \ln(Loan_{i,j,t}) + \beta_{12} \ln(P_Deposits_{i,j,t}) * \ln(OthAssets_{i,j,t}) + \\
& \beta_{13} \ln(P_Deposits_{i,j,t}) * \ln(Offbalance_{i,j,t}) + \beta_{14} \ln(P_Deposits_{i,j,t}) * Time + \beta_{15} (\ln(P_Labour_{i,j,t}))^2 + \\
& \beta_{16} \ln(P_Labour_{i,j,t}) * \ln(P_Capital_{i,j,t}) + \beta_{17} \ln(P_Labour_{i,j,t}) * \ln(Loan_{i,j,t}) + \beta_{18} \ln(P_Labour_{i,j,t}) * \\
& \ln(OthAssets_{i,j,t}) + \beta_{19} \ln(P_Labour_{i,j,t}) * \ln(Offbalance_{i,j,t}) + \beta_{20} \ln(P_Labour_{i,j,t}) * Time + \\
& \beta_{21} (\ln(P_Capital_{i,j,t}))^2 + \beta_{22} \ln(P_Capital_{i,j,t}) * \ln(Loan_{i,j,t}) + \beta_{23} \ln(P_Capital_{i,j,t}) * \\
& \ln(OthAssets_{i,j,t}) + \beta_{24} \ln(P_Capital_{i,j,t}) * \ln(Offbalance_{i,j,t}) + \beta_{25} \ln(P_Capital_{i,j,t}) * Time + \\
& \beta_{26} (\ln(Loan_{i,j,t}))^2 + \beta_{27} \ln(Loan_{i,j,t}) * \ln(OthAssets_{i,j,t}) + \\
& \beta_{28} \ln(Loan_{i,j,t}) * \ln(Offbalance_{i,j,t}) + \beta_{29} \ln(Loan_{i,j,t}) * Time + \beta_{30} (\ln(OthAssets_{i,j,t}))^2 + \\
& \beta_{31} \ln(OthAssets_{i,j,t}) * \ln(Offbalance_{i,j,t}) + \beta_{32} \ln(OthAssets_{i,j,t}) * Time + \\
& \beta_{33} (\ln(Offbalance_{i,j,t}))^2 + \beta_{34} \ln(Offbalance_{i,j,t}) * Time + \beta_{35} EQUITY_{i,j,t} + \beta_{36} LLR_{GL_{i,j,t}} + \\
& u_{i,j,t} + v_{i,j,t} \tag{2}
\end{aligned}$$

The dependent variable is $\ln(TC_{i,j,t})$, the logarithm of total cost of bank i in country j at time t .

TC is specified as total interest expenses plus total non-interest expenses times 1,000. The model consists of three types of input costs: cost of deposits ($C_Deposits$), cost of labor (C_Labor), and cost of capital ($C_Capital$). $C_Deposits$ is the ratio of total interest expenses to total deposits; C_Labor is the ratio of personnel expenses to the number of employees times 1,000; $C_Capital$ is the ratio of total non-interest expenses minus total personnel expenses divided by

total non-earning assets. All these three input cost variables are taken in logarithm, i.e.

$$\ln(C_Deposits_{i,j,t}), \ln(C_Labor_{i,j,t}), \text{ and } \ln(C_Capital_{i,j,t}).$$

In addition, the model includes three categories of outputs: loans (*Loan*), other earning assets (*OthAssets*), and off-balance sheet activities (*Offbalance*). Also these three output variables are taken in logarithm, i.e. $\ln(Loan_{i,j,t})$, $\ln(OthAssets_{i,j,t})$, and $\ln(Offbalance_{i,j,t})$. Furthermore, we include two bank-specific variables $EQUITY_{i,j,t}$ and $LLR_{i,j,t}$. *EQUITY* is measured as the ratio of total equity over total asset of a bank and is used to control for the financial strategy of a bank. Different financial strategies may lead to different levels of bank cost efficiency. *LLR* is measured as the ratio of loan loss reserves to total gross loans. This variable is used to control for the difference in risk-taking strategy of banks. Since the translog specification is a second order approximation of the cost function, we add time trend variables *Time* and *Time*² to the model. Because we use a translog specification, we include the square of the input, output, bank-specific and time trend variables, as well as combinations of these variables, in the cost function. Furthermore, we control for time invariant, bank-specific characteristics by adding the constant term β_0 into the model. In other words, we use a fixed-effect estimator.

We specify the inefficiency equation as follows:

$$m_{i,j,t} = \delta_0 + \sum_n \delta' z_{i,j,t} \tag{3}$$

$z_{i,j,t}$ is a vector of variables determining the bank-specific distance to the cost frontier, i.e. our measure of bank inefficiency; δ' is a vector of coefficients to be estimated. This specification is used to analyze the relationship between financial liberalization and bank efficiency and the

impact institutions have on this relationship. Because the dependent variable in equation (3) is a measure of the extent of the inefficiency of a bank, a negative coefficient for the independent variables in the model is associated with lower levels of bank inefficiency, or higher bank efficiency.

Most importantly for our analysis, equation (3) includes a variable *Financial_liberalization*, which is an aggregate measure of financial liberalization measures taken by the government. This measure is obtained by applying principal component analysis using data for the four dimensions of financial liberalization on which we focus our analysis, i.e. the presence of bank credit controls, interest rate controls, bank entry barriers, and state ownership of banks.¹ Next to this aggregate measure of financial liberalization, we include several country-specific variables into the inefficiency equation as controls. These variables include the GDP growth rate (*GDP_Growth*) as a proxy for the level of economic growth, and the inflation rate (*Inflation*) and real interest rate (*Interest_rate*) to control for macro-economic and financial market conditions. We also include time trend variables *Time* and *Time*² to allow for differences in bank efficiency over time. Thus, we use the following specification for the inefficiency equation:

$$m_{i,j,t} = \delta_0 + \delta_1 GDP_Growth_{j,t} + \delta_2 Inflation_{j,t} + \delta_3 Interest_rate_{j,t} + \delta_4 Time_{j,t} + \delta_5 Time^2_{j,t} + \delta_6 Financial_liberalization + \varepsilon_{i,j,t} \quad (4)$$

¹ See appendix table A1, panel 1 for the outcomes of the principal component analysis. The results show that there is clearly one component that sufficiently incorporates the characteristics of the four underlying financial liberalization dimensions.

Next, we investigate whether the institutional environment matters for the relationship between financial liberalization and bank efficiency. As explained in section 3, we use data for four dimensions to measure the institutional environment of a country based on Kaufmann et al. (2010), i.e. voice and accountability (*Voice*), regulatory quality (*Regulation*), rule of law (*Law*), and control of corruption (*Corruption*), respectively. As regulatory quality and rule of law are closely correlated, conceptually as well as statistically, we use principal component analysis to obtain a composite measure (labelled as *Legal*), capturing both institutional environment dimensions.²

We then estimate the following equation:

$$\begin{aligned}
 m_{i,j,t} = & \delta_0 + \delta_1 GDP_Growth_{j,t} + \delta_2 Inflation_{j,t} + \delta_3 Interest_rate_{j,t} + \delta_4 Time_{j,t} + \delta_5 Time^2_{j,t} + \\
 & \delta_6 Financial_liberalization_{j,t} + \delta_7 V_Institutions_{j,t} + \\
 & \delta_8 Financial_liberalization \times V_Institutions_{j,t} + \varepsilon_{i,j,t}
 \end{aligned} \tag{5}$$

In equation (5) *V_Institutions* is a vector of institutional variables including *Voice*, *Corruption* and *Legal*, our composite measure of the *Regulatory quality* and *Rule of law* of a country.

Moreover, equation (5) includes an interaction term *Financial_liberalization x V_Institutions*, i.e. we analyze the interaction effect of the aggregate financial liberalization measure with each of our three institutional variables separately (i.e. we present the results of three different versions of equation (5)). These interaction terms should capture the impact of the institutional environment on the relationship between financial liberalization and bank efficiency.

² See appendix table A1, panel 2 for the outcomes of the principal component analysis. The results show that there is clearly one component that sufficiently incorporates the characteristics of the two underlying legal environmental dimensions.

As a robustness check, we replace our individual institutional variables by a composite measure of the institutional environment of a country. We add this as a robustness check, since institutional factors may be highly correlated. The composite measure is based on a principal component analysis using data on (all) six institutional dimensions available in Kaufmann et al. (2010), i.e. we use data for *Political stability* and *Government effectiveness*, next to data for *Voice, Corruption* and our composite measure of the *Regulatory quality* and *Rule of law*. This composite measure is named *C_Institutions*. This measure is then interacted with our measure of financial liberalization (*Financial_liberalization*) to again investigate whether the relationship between financial liberalization and bank efficiency is influenced by the institutional environment in a country.³ Thus, we estimate equation (6):

$$\begin{aligned}
m_{i,j,t} = & \delta_0 + \delta_1 GDP_Growth_{j,t} + \delta_2 Inflation_{j,t} + \delta_3 Interest_rate_{j,t} + \delta_4 Time_{j,t} + \delta_5 Time^2_{j,t} + \\
& \delta_6 Financial_liberalization_{j,t} + \delta_7 C_Institutions_{j,t} + \\
& \delta_8 Financial_liberalization \times C_Institutions_{j,t} + \varepsilon_{i,j,t}
\end{aligned} \tag{6}$$

Table 1 shows the list of countries and the corresponding number of bank-year observations for each country in our data set. In our dataset, we have 79,246 bank-year observations covering 24,047 unique banks in 67 countries for the period 1996-2005. The large share of the observations is from banks in the United States, followed by observations from banks in Italy and Japan. Table 2 presents the summary statistics of the financial liberalization variables used in the analysis. The arithmetic means of the financial liberalization variables are relatively high because observations for the more liberalized and developed countries, such as the

³ See appendix table A1, panel 3 for the outcomes of the principal component analysis. The results show that there is clearly one component that sufficiently incorporates the characteristics of the six underlying institutional environmental dimensions.

United States, Japan and Italy account for a large part of the observations in our dataset. Next to using the financial liberalization variables separately, we also use a financial liberalization index, which is obtained by carrying out principal component analysis based on the data of the four variables.

<Insert table 1 here>

<Insert table 2 here>

Table 3 presents the summary statistics for the institutional and macroeconomic variables we use in the analysis. The first six variables are the six institutional dimensions, which are obtained from Kaufmann *et al.* (2010). The last two variables *Legal* and *C_Institutions* are obtained by using principal component analysis. Table 4 presents the correlation matrix of the institutional dimensions of Kaufmann *et al.* (2010) in our dataset. The table shows that most of these institutional factors are highly correlated, supporting our approach to also create a composite measure of the institutional environment to investigate whether institutional conditions do affect the relationship between financial liberalization and bank efficiency.

<Insert table 3 here>

<Insert table 4 here>

5. Results

Table 5 presents the of estimating the cost frontier as specified in equation (2). The table shows that from the list of inputs, the coefficients of the cost of deposits and the cost of capital are

positive and significant. This implies that if these costs increase, this leads to an outward shift of the cost function, which is what we would also expect. Instead, the cost of labor leads to lower total costs, which seems counterintuitive. Yet, since our cost function has a translog specification, meaning that different inputs enter the total cost equation in several different ways (i.e. as individual variables, squared variables and interacted with any of the other variables in the model) with different signs, one cannot determine the relationship between the cost of an input and total input by simply looking at the coefficient of the individual input variable. Overall, we conclude that our specification of the cost frontier fits theory reasonably well.

<Insert table 5 here>

The focus of our analysis is on the results with respect to the inefficiency equation as specified in equations (4) to (6). The results of this analysis are presented in table 6. Column [1] in this table refers to equation (4), columns [2] to [4] provide the results of three specifications of equation (5) – each specification referring to one of the three institutional variables we focus on in the analysis – and column [5] shows the results for the estimations of equation (6).

As discussed in section 2, in theory the relationship between financial liberalization and bank efficiency may be either positive or negative. The results of our analysis suggest that financial liberalization policies is associated with improvements of bank efficiency. The coefficient of *Financial_liberalization* – our composite measure financial liberalization, which includes policies related to relaxing credit and interest rate controls, bank entry barriers and government ownership of banks – is significant and negative in all but one of the specifications of the inefficiency equation presented in table 6.

Columns [2] to [4] in table 6 show the results when taking into the account the impact the institutional environment may have on the relationship between financial liberalization and bank efficiency. We start by focusing on the results for the bank inefficiency equation when using *Voice* as our measure of the institutional environment. As explained in section 2, this variable measures the extent to which a country has established democratic rights, freedom of expression, freedom of association and media independence. Under these institutional conditions, banks are expected to be better able to collecting information and reducing asymmetric information, thereby increasing bank efficiency. The results in column [2] show that the coefficient of *Voice* is negative but not significant. Yet, when we interact *Voice* with our measure of financial liberalization, the results show a significant negative coefficient for the interaction term. This suggests that without well-established democratic rights, transparency, freedom of expression, freedom of association and media independence, financial liberalization as such does not stimulate higher bank efficiency. Only in an environment with higher levels of *Voice*, financial liberalization policies are effective. This outcome recalls theories suggesting that asymmetric information is a major barrier adversely affecting the effectiveness of financial liberalization policies. As mentioned in section 2, banks play an important role in collecting information and reducing asymmetric information. Democratic rights and freedom of expression and association positively contribute to increased transparency and freedom of information exchange in a country. This, in turn better enables banks to fulfill their intermediary role by reducing asymmetric information. Moreover, media independence increases the flow of information available to banks and helps reducing the probability of misuse of information by banks, increasing their efficiency in allocating financial resources. Thus, when financial liberalization

policies are carried out in countries scoring high on voice and accountability, we expect the positive impact of these policies on bank efficiency will be higher as well.

Column [3] presents the results when using *Legal* as our measure of the institutional environment. As explained, this measure proxies the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development, as well as the confidence the public has in the quality of contract enforcement, property rights, the police, and the courts. Given an institutional environment in which the quality of government regulations, contract enforcement, property rights, etc. is high bank efficiency is expected to be higher as well. The results shown in the table support this view as the coefficient for *Legal* is negative and significant. The coefficient of the interaction term between *Legal* and our financial liberalization measure is negative and significant. This suggests that the positive association between financial liberalization and bank efficiency is strengthened when the legal environment is strong as well.

As is shown in column [4] the coefficient for the variable measuring the role of control of corruption (*Corruption*) is positive and significant, indicating that bank efficiency is negatively associated with control of corruption, i.e. it is higher at higher levels of corruption. The interaction effect of control of corruption and financial liberalization is also negative and significant, suggesting that the positive association between financial liberalization and bank efficiency is strengthened in the presence of higher levels of corruption. This outcome matches the greasing the wheels hypothesis as explained in section 2. According to this hypothesis, corruption may have a positive influence on banking activities as it helps smoothing procedures and business transactions. Thus, in the presence of strong regulatory capture and administrative barriers, corruption may help overcoming the adverse effects of rules and regulations on

economic and financial transactions. For banks – which are confronted with a relatively high regulatory burden – the greasing the wheels hypothesis of corruption seems to be relevant.

Finally, column [5] presents the results when using a composite measure of all six institutional dimensions available in the dataset developed by Kaufmann et al. (2010). The results are very similar to those of *Legal*. That is, the composite institutional variable positively influences bank efficiency (the coefficient is negative and significant). Moreover, the interaction effect with the financial liberalization variable is also negative and significant, suggesting that the positive association between financial liberalization and bank efficiency is strengthened when the institutional environment improves.

<Insert table 6 here>

We perform two robustness checks. First, we use one-year lagged variables for our measure of financial liberalization in all specifications presented in table 6. Using a one-year lag reflects the idea it may take some time before financial liberalization policies have an impact on bank efficiency. The results of this analysis are reported in tables 7 and 8 and are all very consistent with our main findings as reported in tables 5 and 6.

<Insert table 7 here>

<Insert table 8 here>

Second, we aim at adding bank-specific variables to the inefficiency equation. In particular, we use bank size, measured as the logarithm of total asset of a bank, as our bank-

specific variable. Bank size may either positively or negatively affect bank efficiency. On the one hand, larger banks may be more difficult to measure and govern, reflecting a negative association between bank size and bank efficiency. On the other hand, large banks may have access to cheaper funding due to scale economies and asymmetric information, which means that bank size and bank efficiency show a positive association. Adding this bank-specific measure to the inefficiency equation (not reported) does not change our main results. The coefficient of the bank size variable itself is positive and significant, i.e. the size of a bank has a negative association with bank efficiency. This suggests that larger bank are more difficult to manage, leading to higher levels of bank efficiency.

8. Conclusions and final remarks

To the best of our knowledge, this is the first paper that explicitly investigates the impact of the institutional environment on the relationship between financial liberalization and bank cost efficiency. Using a dataset consisting of 79,246 bank-year observations for 67 countries covering the period 1996-2005, and applying stochastic frontier analysis (SFA) to measure bank cost efficiency, we find supportive evidence for the fact that the institutional environment indeed matters for the relationship between financial liberalization and bank efficiency.

We first show that financial liberalization policies and bank cost efficiency are associated positively. Next, we find evidence that these policies only positively affect bank efficiency in the presence of better democratic rights, higher market transparency, and freedom of information exchange. We also show that the positive association between financial liberalization policies and bank efficiency is strengthened in the presence of higher levels of legal framework efficiency and at higher levels of the quality of the overall institutional environment. Finally, we

find that higher levels of corruption positively influence the relationship between financial liberalization and bank efficiency, a finding we interpret as supportive evidence for the greasing the wheel hypothesis.

The results of this paper alerts us to the notion that successful financial liberalization policies may depend on the context in which they are carried out. In particular, the paper stresses the fact that the institutional environment helps making such policies more effective in improving financial sector performance. Perhaps most interestingly, democratic rights and the related institutional features such as transparency and freedom of information exchange and media independence seem to be especially relevant in order to ensure that financial liberalization can make a positive contribution to improvements in bank efficiency. In our view, therefore, these outcomes contain potentially important lessons for governments that aim at improving the quality of the financial sector by pursuing a strategy of financial liberalization policies.

We acknowledge that the analysis in our paper can be extended and improved in various directions. We have focused on bank efficiency as a measure of bank performance. The analysis could be extended by looking at a wider range of measures of bank performance. Furthermore, the analysis uses data for the period 1996-2005. This is determined by the availability of data: BankScope data start in 1996 and the dataset of Abiad et al. (2010) ends in 2005. Our work could be extended to more recent years if an update of the financial liberalization data becomes available. This would allow us to analyze the impact of the recent financial crisis. Finally, although our sample covers a large number of bank observations in several countries, still some potentially important and interesting countries are currently not included. Adding more countries would also reduce the dominant position of the U.S. banks in our research. We leave these suggestions for improving and extending our analysis for future research.

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

| <i>Country Name</i> | <i>Freq.</i> | <i>Country Name</i> | <i>Freq.</i> | <i>Country Name</i> | <i>Freq.</i> |
|---------------------|--------------|---------------------|--------------|---------------------|--------------|
| Albania | 21 | India | 185 | Paraguay | 75 |
| Argentina | 1 | Indonesia | 228 | Peru | 108 |
| Australia | 61 | Ireland | 7 | Philippines | 93 |
| Azerbaijan | 6 | Israel | 41 | Poland | 83 |
| Bangladesh | 85 | Italy | 5,961 | Portugal | 72 |
| Belarus | 24 | Jamaica | 21 | Romania | 100 |
| Belgium | 7 | Japan | 3,568 | Russian Federation | 312 |
| Brazil | 68 | Jordan | 7 | Singapore | 55 |
| Bulgaria | 37 | Kenya | 138 | South Africa | 43 |
| China-People's Rep. | 47 | Korea Rep. of | 10 | Spain | 142 |
| Colombia | 23 | Kyrgyzstan | 20 | Sri Lanka | 85 |
| Costa Rica | 44 | Latvia | 126 | Sweden | 463 |
| Czech Republic | 148 | Lithuania | 57 | Switzerland | 2,194 |
| Denmark | 227 | Madagascar | 4 | Tanzania | 16 |
| Estonia | 26 | Malaysia | 204 | Thailand | 111 |
| Ethiopia | 37 | Mexico | 2 | Uganda | 4 |
| Finland | 27 | Morocco | 5 | Ukraine | 97 |
| France | 471 | Mozambique | 23 | United Kingdom | 381 |
| Georgia Rep. of | 15 | Nepal | 75 | Uruguay | 1 |
| Germany | 10 | Netherlands | 18 | USA | 61,905 |
| Greece | 89 | Nigeria | 372 | Vietnam | 36 |
| Hong Kong | 8 | Norway | 291 | | |
| Hungary | 21 | Pakistan | 4 | | |

Source: BankScope

Table 2 Summary statistics of the variables measuring different dimensions of financial liberalization

| <i>Variable</i> | <i>Observation</i> | <i>Mean</i> | <i>Standard Dev.</i> | <i>Min</i> | <i>Max</i> |
|---------------------------------|--------------------|-------------|----------------------|------------|------------|
| <i>Credit control</i> | 79,861 | 2.9120 | 0.3194 | 0 | 3 |
| <i>Interest rate control</i> | 79,861 | 2.9872 | 0.1350 | 0 | 3 |
| <i>Entry barrier</i> | 79,861 | 2.9574 | 0.2306 | 0 | 3 |
| <i>State ownership</i> | 79,861 | 2.7770 | 0.5346 | 0 | 3 |
| <i>Financial liberalization</i> | 79,861 | 0.6223 | 0.7126 | -8.4054 | 0.8675 |

Note: *Financial liberalization* is an index obtained by applying principal component analysis using the data for the four individual measures of financial liberalization; these measures are taken from Abiad et al. (2010).

Table 3: Summary statistics of the variables measuring different dimensions of the institutional environment and macroeconomic characteristics

| <i>Variables</i> | <i>Observations</i> | <i>Mean</i> | <i>Standard Dev.</i> | <i>Min</i> | <i>Max</i> |
|-----------------------|---------------------|-------------|----------------------|------------|------------|
| <i>Corruption</i> | 79,861 | 1.5429 | 0.5956 | -1.4884 | 2.5856 |
| <i>Stability</i> | 79,861 | 0.4311 | 0.5614 | -2.1213 | 1.6681 |
| <i>Voice</i> | 79,861 | 1.2302 | 0.3619 | -1.9476 | 1.8264 |
| <i>Regulation</i> | 79,861 | 1.4620 | 0.4474 | -1.7527 | 2.2261 |
| <i>Effectiveness</i> | 79,861 | 1.5599 | 0.4943 | -1.2822 | 2.3449 |
| <i>Law</i> | 79,861 | 1.3704 | 0.4699 | -1.5229 | 1.9875 |
| <i>Legal</i> | 79,861 | 0.5428 | 0.8001 | -4.7103 | 1.4848 |
| <i>C_Institutions</i> | 79,861 | 0.7488 | 1.2785 | -7.9317 | 2.8819 |
| <i>Interest_rate</i> | 79,261 | 4.0978 | 3.0899 | -41.2296 | 78.7900 |
| <i>Inflation</i> | 79,830 | 2.6869 | 2.9973 | -8.4842 | 168.6202 |
| <i>GDP_Growth</i> | 79,831 | 2.9262 | 1.5850 | -13.1267 | 26.4000 |

Note: *Legal* and *C_Institutions* are variables obtained by applying principal component analysis using the data for the six individual measures of the institutional environment; these measures are taken from Kaufmann et al. (2010). The data for the country-specific variables are taken from the World Bank Development Indicators.

Table 4: Correlation matrix of institutional variables

| | <i>Voice</i> | <i>Stability</i> | <i>Effectiveness</i> | <i>Regulation</i> | <i>Law</i> | <i>Corruption</i> |
|----------------------|--------------|------------------|----------------------|-------------------|------------|-------------------|
| <i>Voice</i> | 1 | | | | | |
| <i>Stability</i> | 0.406* | 1 | | | | |
| <i>Effectiveness</i> | 0.8796** | 0.358* | 1 | | | |
| <i>Regulation</i> | 0.8811** | 0.2767 | 0.9432*** | 1 | | |
| <i>Law</i> | 0.9104*** | 0.3864* | 0.9569*** | 0.9131*** | 1 | |
| <i>Corruption</i> | 0.8473** | 0.2068 | 0.9463*** | 0.8974** | 0.9312*** | 1 |

Note: *** p>0.9 ** p>0.8 *p>0.35 where p is correlation

Table 5: Estimation results for the cost frontier

| <i>Dependent variable: ln(TC)</i> | [1] | [2] | [3] | [4] | [5] |
|---------------------------------------|--------------------------|---------------------------|---------------------------|--------------------------|---------------------------|
| <i>ln(C_Deposits)</i> | 0.891*** (0.0262) | 0.815*** (0.0271) | 0.866*** (0.0267) | 0.892*** (0.0264) | 0.868*** (0.0266) |
| <i>ln(C_Labour)</i> | -0.0741*** (0.0283) | -0.0600** (0.0292) | -0.0925*** (0.0286) | -0.0922*** (0.0282) | -0.0896*** (0.0287) |
| <i>ln(C_Capital)</i> | 0.767*** (0.0274) | 0.721*** (0.0283) | 0.728*** (0.0280) | 0.740*** (0.0277) | 0.726*** (0.0280) |
| <i>ln(C_Deposit) * ln(C_Deposit)</i> | -0.0263*** (0.000677) | -0.0284*** (0.000713) | -0.0275*** (0.000704) | -0.0270*** (0.000702) | -0.0275*** (0.000703) |
| <i>ln(C_Deposit) * ln(C_Labor)</i> | -0.0801*** (0.00252) | -0.0762*** (0.00257) | -0.0799*** (0.00255) | -0.0815*** (0.00254) | -0.0800*** (0.00255) |
| <i>ln(C_Deposit) * ln(C_Capital)</i> | -0.0127*** (0.00174) | -0.0144*** (0.00178) | -0.0139*** (0.00176) | -0.0135*** (0.00175) | -0.0140*** (0.00176) |
| <i>ln(C_Deposit) * ln(Loan)</i> | 0.0132*** (0.00162) | 0.0184*** (0.00172) | 0.0162*** (0.00169) | 0.0147*** (0.00167) | 0.0161*** (0.00169) |
| <i>ln(C_Deposit) * ln(OthAssets)</i> | 0.00448*** (0.00141) | 0.00224 (0.00145) | 0.00334** (0.00144) | 0.00421*** (0.00143) | 0.00337** (0.00144) |
| <i>ln(C_Deposit) * ln(Offbalance)</i> | -0.00106 (0.000793) | -0.00290*** (0.000828) | -0.00220*** (0.000819) | -0.00170** (0.000814) | -0.00214*** (0.000817) |
| <i>ln(C_Deposit) * Time</i> | -0.0342*** (0.000642) | -0.0344*** (0.000654) | -0.0341*** (0.000651) | -0.0341*** (0.000649) | -0.0342*** (0.000651) |
| <i>ln(C_Labor) * ln(C_Labour)</i> | -0.00341*** (0.00123) | -0.00270** (0.00126) | -0.00219* (0.00124) | -0.00262** (0.00123) | -0.00218* (0.00124) |
| <i>ln(C_Labor) * ln(C_Capital)</i> | -0.0585*** (0.00232) | -0.0549*** (0.00237) | -0.0549*** (0.00236) | -0.0558*** (0.00235) | -0.0548*** (0.00237) |
| <i>ln(C_Labor) * ln(Loan)</i> | -0.0363*** (0.00206) | -0.0392*** (0.00211) | -0.0369*** (0.00209) | -0.0359*** (0.00207) | -0.0372*** (0.00209) |
| <i>ln(C_Labor) * ln(OthAssets)</i> | 0.0107*** (0.00161) | 0.0125*** (0.00163) | 0.0115*** (0.00161) | 0.0106*** (0.00160) | 0.0116*** (0.00161) |
| <i>ln(C_Labor) * ln(Offbalance)</i> | 0.0141*** (0.00125) | 0.0144*** (0.00126) | 0.0139*** (0.00125) | 0.0139*** (0.00124) | 0.0140*** (0.00125) |
| <i>ln(C_Labor) * Time</i> | -0.0163*** (0.000936) | -0.0151*** (0.000944) | -0.0161*** (0.000933) | -0.0168*** (0.000930) | -0.0163*** (0.000934) |
| <i>ln(C_Capital) * ln(C_Capital)</i> | -0.0306*** (0.00134) | -0.0323*** (0.00136) | -0.0318*** (0.00135) | -0.0311*** (0.00134) | -0.0316*** (0.00135) |
| <i>ln(C_Capital) * ln(Loan)</i> | -0.0293*** (0.00149) | -0.0290*** (0.00151) | -0.0295*** (0.00150) | -0.0295*** (0.00150) | -0.0293*** (0.00150) |
| <i>ln(C_Capital) * ln(OthAssets)</i> | -0.00564*** (0.00128) | -0.00645*** (0.00129) | -0.00615*** (0.00129) | -0.00596*** (0.00128) | -0.00624*** (0.00129) |
| <i>ln(C_Capital) * ln(Offbalance)</i> | 0.0271*** (0.000965) | 0.0273*** (0.000974) | 0.0273*** (0.000973) | 0.0273*** (0.000970) | 0.0273*** (0.000972) |
| <i>ln(C_Capital) * Time</i> | -0.0109*** (0.000717) | -0.0111*** (0.000720) | -0.0112*** (0.000719) | -0.0111*** (0.000718) | -0.0112*** (0.000719) |
| <i>Loan</i> | 0.872*** (0.0231) | 0.920*** (0.0239) | 0.888*** (0.0236) | 0.874*** (0.0233) | 0.892*** (0.0236) |
| <i>OthAssets</i> | 0.341*** (0.0182) | 0.310*** (0.0186) | 0.326*** (0.0183) | 0.339*** (0.0182) | 0.325*** (0.0184) |
| <i>Offbalance</i> | -0.152*** | -0.161*** | -0.153*** | -0.152*** | -0.154*** |

| | | | | | |
|--|---------------|---------------|---------------|---------------|---------------|
| | (0.0136) | (0.0138) | (0.0136) | (0.0136) | (0.0136) |
| <i>ln (Loan) * ln (Loan)</i> | 0.0469*** | 0.0462*** | 0.0463*** | 0.0465*** | 0.0464*** |
| | (0.000673) | (0.000700) | (0.000697) | (0.000690) | (0.000696) |
| <i>ln (Loan) * ln (OthAssets)</i> | -0.0876*** | -0.0865*** | -0.0868*** | -0.0872*** | -0.0869*** |
| | (0.000870) | (0.000891) | (0.000889) | (0.000883) | (0.000888) |
| <i>ln (Loan) * ln (Offbalance)</i> | -0.00427*** | -0.00367*** | -0.00384*** | -0.00402*** | -0.00387*** |
| | (0.000597) | (0.000614) | (0.000612) | (0.000607) | (0.000611) |
| <i>ln (Loan) * Time</i> | 0.00412*** | 0.00472*** | 0.00453*** | 0.00436*** | 0.00452*** |
| | (0.000535) | (0.000542) | (0.000541) | (0.000540) | (0.000541) |
| <i>ln (OthAssets) * ln (OthAssets)</i> | 0.0393*** | 0.0390*** | 0.0391*** | 0.0393*** | 0.0392*** |
| | (0.000342) | (0.000344) | (0.000344) | (0.000343) | (0.000344) |
| <i>ln (OthAssets) * ln (Offbalance)</i> | 0.00544*** | 0.00501*** | 0.00511*** | 0.00525*** | 0.00516*** |
| | (0.000511) | (0.000517) | (0.000517) | (0.000515) | (0.000517) |
| <i>ln (OthAssets) * Time</i> | -0.00670*** | -0.00691*** | -0.00682*** | -0.00675*** | -0.00677*** |
| | (0.000470) | (0.000472) | (0.000471) | (0.000471) | (0.000471) |
| <i>ln (Offbalance) * ln (Offbalance)</i> | 0.00322*** | 0.00313*** | 0.00317*** | 0.00321*** | 0.00316*** |
| | (0.000238) | (0.000239) | (0.000239) | (0.000239) | (0.000239) |
| <i>ln (Offbalance) * Time</i> | 0.00188*** | 0.00163*** | 0.00173*** | 0.00181*** | 0.00173*** |
| | (0.000318) | (0.000319) | (0.000320) | (0.000319) | (0.000320) |
| <i>Time</i> | 0.0639*** | 0.0472*** | 0.0598*** | 0.0674*** | 0.0608*** |
| | (0.0102) | (0.0103) | (0.0102) | (0.0102) | (0.0102) |
| <i>Time^2</i> | -0.00571*** | -0.00573*** | -0.00568*** | -0.00570*** | -0.00571*** |
| | (0.000230) | (0.000230) | (0.000230) | (0.000231) | (0.000230) |
| <i>Equity</i> | -0.306*** | -0.314*** | -0.311*** | -0.311*** | -0.310*** |
| | (0.0172) | (0.0174) | (0.0173) | (0.0172) | (0.0173) |
| <i>LLR</i> | 0.00453*** | 0.00372*** | 0.00413*** | 0.00444*** | 0.00413*** |
| | (0.000308) | (0.000321) | (0.000316) | (0.000312) | (0.000316) |
| <i>Constant</i> | 7.604*** | 7.316*** | 7.630*** | 7.684*** | 7.600*** |
| | (0.199) | (0.206) | (0.202) | (0.199) | (0.202) |
| Observations | 79,246 | 79,246 | 79,246 | 79,246 | 79,246 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimation results for bank cost inefficiency

| Dependent variable: bank cost inefficiency ($m_{i,t}$) | | | | | |
|--|-------------------------|-------------------------|------------------------|-------------------------|-------------------------|
| | [1] | [2] | [3] | [4] | [5] |
| <i>Time</i> | -0.114*** (0.0224) | -0.104*** (0.0228) | -0.0719*** (0.0232) | -0.0627*** (0.0233) | -0.0745*** (0.0232) |
| <i>Time</i> ² | 0.0193*** (0.00203) | 0.0183*** (0.00206) | 0.0161*** (0.00208) | 0.0154*** (0.00209) | 0.0156*** (0.00208) |
| <i>Financial_liberalization</i> | -0.156*** (0.0154) | 0.0257 (0.0171) | -0.267*** (0.0247) | -0.135*** (0.0168) | -0.256*** (0.0242) |
| <i>GDP_Growth</i> | -0.0190*** (0.00585) | -0.0191*** (0.00595) | -0.0120** (0.00591) | -0.0161*** (0.00588) | -0.0129** (0.00591) |
| <i>Inflation</i> | 0.149*** (0.00419) | 0.0995*** (0.00466) | 0.135*** (0.00516) | 0.153*** (0.00522) | 0.131*** (0.00521) |
| <i>Interest_rate</i> | 0.0551*** (0.00281) | 0.0501*** (0.00288) | 0.0573*** (0.00290) | 0.0587*** (0.00296) | 0.0562*** (0.00290) |
| <i>Voice</i> | | -0.542*** (0.0341) | | | |
| <i>Financial_liberalization x Voice</i> | | -0.218*** (0.0158) | | | |
| <i>Legal</i> | | | -0.0558*** (0.0162) | | |
| <i>Financial_liberalization x Legal</i> | | | -0.101*** (0.00999) | | |
| <i>Corruption</i> | | | | 0.0531** (0.0229) | |
| <i>Financial_liberalization x Corruption</i> | | | | -0.137*** (0.0172) | |
| <i>C_Institutions</i> | | | | | -0.0448*** (0.00989) |
| <i>Financial_liberalization x C_Institutions</i> | | | | | -0.0570*** (0.00615) |
| <i>Constant</i> | -3.837*** (0.0663) | -3.949*** (0.0792) | -2.963*** (0.0850) | -3.784*** (0.0689) | -3.750*** (0.0694) |
| Observations | 79,246 | 79,246 | 79,246 | 79,246 | 79,246 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Estimation results for the cost frontier (with one-year lagged Financial liberalization)

| Dependent variable: ln (TC) | [1] | [2] | [3] | [4] | [5] |
|---|--------------------------|---------------------------|---------------------------|--------------------------|---------------------------|
| <i>ln (C_Deposits)</i> | 0.891*** (0.0262) | 0.814*** (0.0271) | 0.866*** (0.0267) | 0.892*** (0.0264) | 0.868*** (0.0266) |
| <i>ln (C_Labour)</i> | -0.0738*** (0.0283) | -0.0596** (0.0292) | -0.0923*** (0.0286) | -0.0919*** (0.0282) | -0.0893*** (0.0287) |
| <i>ln (C_Capital)</i> | 0.767*** (0.0274) | 0.722*** (0.0283) | 0.728*** (0.0279) | 0.740*** (0.0277) | 0.727*** (0.0280) |
| <i>ln (C_Deposit) * ln (C_Deposit)</i> | -0.0263*** (0.000677) | -0.0284*** (0.000713) | -0.0275*** (0.000704) | -0.0270*** (0.000702) | -0.0275*** (0.000703) |
| <i>ln (C_Deposit) * ln (C_Labor)</i> | -0.0800*** (0.00252) | -0.0762*** (0.00257) | -0.0799*** (0.00255) | -0.0815*** (0.00254) | -0.0800*** (0.00255) |
| <i>ln (C_Deposit) * ln (C_Capital)</i> | -0.0127*** (0.00174) | -0.0144*** (0.00178) | -0.0139*** (0.00176) | -0.0135*** (0.00175) | -0.0140*** (0.00176) |
| <i>ln (C_Deposit) * ln (Loan)</i> | 0.0133*** (0.00162) | 0.0184*** (0.00172) | 0.0162*** (0.00169) | 0.0147*** (0.00167) | 0.0161*** (0.00169) |
| <i>ln (C_Deposit) * ln (OthAssets)</i> | 0.00447*** (0.00141) | 0.00225 (0.00145) | 0.00334** (0.00144) | 0.00421*** (0.00143) | 0.00337** (0.00144) |
| <i>ln (C_Deposit) * ln (Offbalance)</i> | -0.00106 (0.000793) | -0.00290*** (0.000828) | -0.00220*** (0.000819) | -0.00170** (0.000814) | -0.00214*** (0.000817) |
| <i>ln (C_Deposit) * Time</i> | -0.0342*** (0.000642) | -0.0344*** (0.000654) | -0.0341*** (0.000651) | -0.0341*** (0.000649) | -0.0342*** (0.000651) |
| <i>ln (C_Labor) * ln (C_Labour)</i> | -0.00342*** (0.00123) | -0.00272** (0.00126) | -0.00221* (0.00124) | -0.00263** (0.00123) | -0.00219* (0.00124) |
| <i>ln (C_Labor) * ln (C_Capital)</i> | -0.0585*** (0.00232) | -0.0550*** (0.00237) | -0.0550*** (0.00236) | -0.0559*** (0.00235) | -0.0549*** (0.00237) |
| <i>ln (C_Labor) * ln (Loan)</i> | -0.0364*** (0.00206) | -0.0392*** (0.00211) | -0.0369*** (0.00209) | -0.0359*** (0.00207) | -0.0372*** (0.00209) |
| <i>ln (C_Labor) * ln (OthAssets)</i> | 0.0108*** (0.00161) | 0.0125*** (0.00163) | 0.0115*** (0.00161) | 0.0107*** (0.00160) | 0.0116*** (0.00161) |
| <i>ln (C_Labor) * ln (Offbalance)</i> | 0.0141*** (0.00125) | 0.0144*** (0.00126) | 0.0139*** (0.00125) | 0.0139*** (0.00124) | 0.0140*** (0.00125) |
| <i>ln (C_Labor) * Time</i> | -0.0163*** (0.000936) | -0.0150*** (0.000945) | -0.0161*** (0.000933) | -0.0168*** (0.000930) | -0.0163*** (0.000934) |
| <i>ln (C_Capital) * ln (C_Capital)</i> | -0.0306*** (0.00134) | -0.0324*** (0.00136) | -0.0318*** (0.00135) | -0.0311*** (0.00134) | -0.0316*** (0.00135) |
| <i>ln (C_Capital) * ln (Loan)</i> | -0.0293*** (0.00149) | -0.0290*** (0.00151) | -0.0295*** (0.00150) | -0.0295*** (0.00150) | -0.0293*** (0.00150) |
| <i>ln (C_Capital) * ln (OthAssets)</i> | -0.00564*** (0.00128) | -0.00645*** (0.00129) | -0.00615*** (0.00129) | -0.00595*** (0.00128) | -0.00623*** (0.00129) |
| <i>ln (C_Capital) * ln (Offbalance)</i> | 0.0271*** (0.000965) | 0.0273*** (0.000974) | 0.0274*** (0.000973) | 0.0273*** (0.000970) | 0.0273*** (0.000972) |
| <i>ln (C_Capital) * Time</i> | -0.0109*** (0.000717) | -0.0111*** (0.000720) | -0.0112*** (0.000719) | -0.0111*** (0.000718) | -0.0112*** (0.000719) |
| <i>Loan</i> | 0.872*** (0.0232) | 0.920*** (0.0239) | 0.888*** (0.0236) | 0.874*** (0.0233) | 0.892*** (0.0236) |
| <i>OthAssets</i> | 0.341*** (0.0182) | 0.310*** (0.0186) | 0.326*** (0.0183) | 0.339*** (0.0182) | 0.325*** (0.0184) |
| <i>Offbalance</i> | -0.152*** | -0.161*** | -0.153*** | -0.152*** | -0.154*** |

| | | | | | |
|--|---------------|---------------|---------------|---------------|---------------|
| | (0.0136) | (0.0138) | (0.0136) | (0.0136) | (0.0136) |
| <i>ln (Loan) * ln (Loan)</i> | 0.0469*** | 0.0462*** | 0.0463*** | 0.0465*** | 0.0464*** |
| | (0.000673) | (0.000700) | (0.000697) | (0.000690) | (0.000696) |
| <i>ln (Loan) * ln (OthAssets)</i> | -0.0876*** | -0.0865*** | -0.0868*** | -0.0872*** | -0.0869*** |
| | (0.000870) | (0.000891) | (0.000889) | (0.000883) | (0.000888) |
| <i>ln (Loan) * ln (Offbalance)</i> | -0.00426*** | -0.00367*** | -0.00384*** | -0.00402*** | -0.00387*** |
| | (0.000597) | (0.000614) | (0.000612) | (0.000607) | (0.000611) |
| <i>ln (Loan) * Time</i> | 0.00412*** | 0.00473*** | 0.00453*** | 0.00437*** | 0.00452*** |
| | (0.000535) | (0.000542) | (0.000541) | (0.000540) | (0.000541) |
| <i>ln (OthAssets) * ln (OthAssets)</i> | 0.0393*** | 0.0390*** | 0.0391*** | 0.0393*** | 0.0392*** |
| | (0.000342) | (0.000344) | (0.000344) | (0.000343) | (0.000344) |
| <i>ln (OthAssets) * ln (Offbalance)</i> | 0.00544*** | 0.00501*** | 0.00511*** | 0.00525*** | 0.00516*** |
| | (0.000511) | (0.000517) | (0.000517) | (0.000515) | (0.000517) |
| <i>ln (OthAssets) * Time</i> | -0.00670*** | -0.00691*** | -0.00682*** | -0.00675*** | -0.00677*** |
| | (0.000470) | (0.000472) | (0.000471) | (0.000471) | (0.000471) |
| <i>ln (Offbalance) * ln (Offbalance)</i> | 0.00322*** | 0.00313*** | 0.00317*** | 0.00321*** | 0.00316*** |
| | (0.000238) | (0.000239) | (0.000239) | (0.000239) | (0.000239) |
| <i>ln (Offbalance) * Time</i> | 0.00188*** | 0.00163*** | 0.00173*** | 0.00181*** | 0.00173*** |
| | (0.000318) | (0.000319) | (0.000319) | (0.000319) | (0.000320) |
| <i>Time</i> | 0.0638*** | 0.0471*** | 0.0597*** | 0.0672*** | 0.0607*** |
| | (0.0102) | (0.0103) | (0.0102) | (0.0102) | (0.0102) |
| <i>Time^2</i> | -0.00571*** | -0.00573*** | -0.00568*** | -0.00570*** | -0.00571*** |
| | (0.000230) | (0.000230) | (0.000230) | (0.000231) | (0.000230) |
| <i>Equity</i> | -0.306*** | -0.314*** | -0.311*** | -0.311*** | -0.310*** |
| | (0.0172) | (0.0174) | (0.0173) | (0.0172) | (0.0173) |
| <i>LLR</i> | 0.00452*** | 0.00372*** | 0.00413*** | 0.00444*** | 0.00413*** |
| | (0.000308) | (0.000321) | (0.000316) | (0.000312) | (0.000316) |
| <i>Constant</i> | 7.601*** | 7.314*** | 7.629*** | 7.683*** | 7.599*** |
| | (0.199) | (0.206) | (0.202) | (0.199) | (0.202) |
| Observations | 79,246 | 79,246 | 79,246 | 79,246 | 79,246 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Estimation results for bank cost inefficiency (with one-year lagged Financial Liberalization)

| Dependent variable: bank cost inefficiency ($m_{i,t}$) | | | | | |
|--|-------------------------|-------------------------|------------------------|-------------------------|-------------------------|
| | [1] | [2] | [3] | [4] | [5] |
| <i>Time</i> | -0.114*** (0.0224) | -0.104*** (0.0228) | -0.0719*** (0.0232) | -0.0628*** (0.0233) | -0.0745*** (0.0231) |
| <i>Time^2</i> | 0.0193*** (0.00203) | 0.0183*** (0.00206) | 0.0161*** (0.00208) | 0.0154*** (0.00209) | 0.0156*** (0.00208) |
| <i>L_Financial_liberalization</i> | -0.157*** (0.0154) | 0.0247 (0.0171) | -0.267*** (0.0247) | -0.136*** (0.0168) | -0.257*** (0.0242) |
| <i>GDP_Growth</i> | -0.0191*** (0.00585) | -0.0191*** (0.00595) | -0.0120** (0.00591) | -0.0161*** (0.00589) | -0.0130** (0.00591) |
| <i>Inflation</i> | 0.149*** (0.00419) | 0.0996*** (0.00467) | 0.135*** (0.00517) | 0.153*** (0.00522) | 0.131*** (0.00521) |
| <i>Interest_rate</i> | 0.0551*** (0.00281) | 0.0501*** (0.00287) | 0.0573*** (0.00289) | 0.0587*** (0.00296) | 0.0562*** (0.00290) |
| <i>Voice</i> | | -0.541*** (0.0342) | | | |
| <i>L_Financial_liberalization</i> <i>x Voice</i> | | -0.218*** (0.0157) | | | |
| <i>Legal</i> | | | -0.0555*** (0.0162) | | |
| <i>L_Financial_liberalization</i> <i>x Legal</i> | | | -0.101*** (0.00998) | | |
| <i>Corruption</i> | | | | 0.0536** (0.0229) | |
| <i>L_Financial_liberalization</i> <i>x Corruption</i> | | | | -0.137*** (0.0172) | |
| <i>C_Institutions</i> | | | | | -0.0445*** (0.00989) |
| <i>L_Financial_liberalization</i> <i>x C_Institutions</i> | | | | | -0.0569*** (0.00614) |
| <i>Constant</i> | -3.836*** (0.0663) | -3.949*** (0.0791) | -2.963*** (0.0850) | -3.783*** (0.0689) | -3.750*** (0.0694) |
| Observations | 79,246 | 79,246 | 79,246 | 79,246 | 79,246 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix table A1: Composite measures for financial liberalization, legal environment and the overall institutional environment: Outcomes of the Principal Component Analysis

Panel 1

Results of *Financial_liberalization* based on Principal Component Analysis

| <i>Component</i> | <i>Eigenvalue</i> | <i>Difference</i> | <i>Proportion</i> | <i>Cumulative</i> |
|--------------------|-------------------|-------------------|-------------------|-------------------|
| <i>Component 1</i> | 1.8434 | 0.8935 | 0.4609 | 0.4609 |
| <i>Component 2</i> | 0.9499 | 0.2262 | 0.2375 | 0.6983 |
| <i>Component 3</i> | 0.7237 | 0.2406 | 0.1809 | 0.8792 |
| <i>Component 4</i> | 0.4831 | . | 0.1208 | 1.0000 |

Financial_liberalization is an aggregate measure of financial liberalization measures taken by the government. This measure is obtained by applying principal component analysis using data for four dimensions of financial liberalization, i.e. the presence of bank credit controls, interest rate controls, bank entry barriers, and state ownership of banks (Abiad et al., 2010). The results show that there is clearly one component that sufficiently incorporates the characteristics of the four underlying financial liberalization dimensions.

Panel 2

Results of *Legal* based on Principal Component Analysis

| <i>Component</i> | <i>Eigenvalue</i> | <i>Difference</i> | <i>Proportion</i> | <i>Cumulative</i> |
|--------------------|-------------------|-------------------|-------------------|-------------------|
| <i>Component 1</i> | 1.9332 | 1.8664 | 0.9666 | 0.9666 |
| <i>Component 2</i> | 0.0668 | . | 0.0334 | 1.0000 |

Legal is an aggregate measure of the legal environment of a country. This measure is obtained by applying principal component analysis using data for two legal environmental dimensions, i.e. regulatory quality and rule of law (Kaufmann et al., 2010). The results show that there is clearly one component that sufficiently incorporates the characteristics of the two underlying legal environmental dimensions.

Panel 3

Results of *Institutions* based on Principal Component Analysis

| <i>Component</i> | <i>Eigenvalue</i> | <i>Difference</i> | <i>Proportion</i> | <i>Cumulative</i> |
|--------------------|-------------------|-------------------|-------------------|-------------------|
| <i>Component 1</i> | 3.7584 | 3.6230 | 0.9396 | 0.9396 |
| <i>Component 2</i> | 0.1354 | 0.0576 | 0.0339 | 0.9734 |
| <i>Component 3</i> | 0.0779 | 0.0495 | 0.0195 | 0.9929 |
| <i>Component 4</i> | 0.0284 | . | 0.0071 | 1.0000 |

Institutions is an aggregate measure of the overall institutional environment of a country. This measure is obtained by applying principal component analysis using data for six legal environmental dimensions, i.e. next to data for voice, corruption, regulatory quality, rule of law, political stability and government effectiveness (Kaufmann et al., 2010). The results show that there is clearly one component that sufficiently incorporates the characteristics of the two underlying legal environmental dimensions.



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