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Author: Yun Luo Sailesh Tanna Glauco De Vita

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Highlights

- We investigate the interrelationship between financial openness, bank risk and bank profit efficiency
- Estimation is based on data for 2,007 commercial banks in 140 countries over the period 1999-2011
- Financial openness reduces bank profit efficiency directly, and increases bank risk indirectly through decreased profit efficiency
- A battery of robustness tests corroborate the validity of the results

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Financial openness, risk and bank efficiency: Cross-country evidence☆

Yun Luo[a], Sailesh Tanna[b,*], Glauco De Vita[a]

[a] *Centre for Business in Society (CBiS), Faculty of Business and Law, Coventry University, Gosford Street, Coventry CV1 5DL, UK.*

[b] *Department of Economics, Finance and Accounting, Faculty of Business and Law, Coventry University, Priory Street, Coventry CV1 5FB, UK.*

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*Corresponding author. Tel.: +4424 7765 7414. Fax: +4424 7765 8400.

E-mail addresses: ab6716@coventry.ac.uk (Y. Luo), s.tanna@coventry.ac.uk (S. Tanna), glauco.devita@coventry.ac.uk (G. De Vita).

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ABSTRACT

This paper assesses the interrelationship between financial openness, bank risk and bank profit efficiency using a cross-country sample of 2,007 commercial banks covering 140 countries over the period 1999-2011. To establish whether the impact of financial openness on both bank risk and profit efficiency occurs directly or through each one of the two bank characteristics (efficiency and risk, respectively), we begin our analysis by investigating the potential reverse Granger causality between profit efficiency and risk using a dynamic simultaneous model via system GMM estimation. We then account explicitly for the role of bank risk in the estimation of bank profit efficiency using stochastic frontier analysis, allowing for the influence of different measures of financial openness and risk alongside other control variables. Our results indicate that financial openness reduces bank profit efficiency directly, not through changes in bank risk. We also find that financial openness increases bank risk indirectly, through the decreased bank profit efficiency channel.

JEL Classification: G21; F36; C23; C24

Keywords: Financial openness; Risk; Bank efficiency; Stochastic Frontier Analysis; Granger causality

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1. Introduction

Since the 1980s the global capital market has become increasingly interdependent owing to increased cross-border capital mobility among countries. Both developed and developing countries have thus embarked on the liberalization of their capital accounts, allowing foreign ownership of domestic resources, including equity (financial openness). This process gained further impetus in the 1990s as a result of the IMF and World Bank led reform programmes which embraced the Washington Consensus.

The initial stimulus behind the drive for financial liberalization was its postulated link with economic growth, stemming from the seminal contributions of McKinnon (1973) and Shaw (1973). In broad terms, the finance-growth nexus works through the efficiency of the financial intermediation process which makes for a better allocation of financial resources, in turn promoting investment and economic growth.

The prospect of benefits to be gained from financial development led to widespread deregulatory reforms with many countries allowing banks to be foreign-owned and inviting foreign entry of banks on a national treatment basis (Claessens et al., 2001). As part of this process of liberalization, deregulation and greater global financial integration, banks worldwide expanded their services abroad and engaged in greater risk taking while at the same time adapting to the changing social and economic environment in order improve their productive efficiency (Denizer et al., 2007). Heightened competition brought about by greater financial openness and freedom of markets also placed a strong emphasis on banks to improve their efficiency by adjusting their risk-return profiles.

In this paper, we revisit empirically the influence of financial openness on bank profit efficiency but we do so by accounting explicitly for the role played by bank risk in this relationship. Although various individual links among these three variables have already been

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analyzed in previous literature, few studies have considered the three variables jointly in an international sample of bank-level data.

At the theoretical level, several propositions exist in the literature with regard to both direct and indirect effects, positive as well as negative, of financial openness on bank profit efficiency, as well as the role that bank risk may play in relation to each of the above variables.

The first, positive and direct effect of financial openness on bank profit efficiency stems from the well-established, though arguably controversial, theoretical premise that opening up the economy to foreign capital provides banks with greater possibilities for enhanced capital allocation to productive investments, also as a result of a higher propensity to channel funds toward higher expected return projects (see, e.g., Obstfeld, 1994; Levine, 1997).[1]

The above premise (and related supporting evidence) forms the cornerstone of the free market view, a view that stands opposite to that purported by those who advocate more regulated markets because financial openness can also generate significant economic costs and have a direct negative impact on efficiency. For example, Agénor (2003) posited that entry by foreign banks may, as a result of their credit rationing strategies (on firms and, to a lesser extent, households), have a negative impact on the expected increase in efficiency in the financial sector. He also postulated that financial openness can create pressures on local banks (which tend to have lower operational costs) to merge in order to remain competitive. The resulting market concentration (which could also arise as foreign banks acquire local banks) could create monopoly power that would reduce the overall efficiency of the banking

[1] Furthermore, the availability of foreign capital and/or greater foreign bank presence may increase the profit efficiency of banks through better financial intermediation, economies of scale and scope, and reduced transaction-, overhead- and information-costs (see, e.g., Levine, 2001).

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system. Moreover, bank consolidation and restructuring driven by the freedom of markets could further undermine the efficacy of corporate control and management best practice, which may in turn adversely affect bank profits. Nevertheless, whether the direct effect of financial openness on bank profit efficiency is positive or negative remains an empirical question, which has yet to be satisfactorily squared by the applied literature.

Possible reasons why previous findings are mixed and hence ambiguous may be due to the failure to incorporate in the analysis of the above relationship the simultaneous role that bank risk may play as a conduit for an additional, indirect influence of financial openness on bank profit efficiency, and its potential reverse causality with the latter since it is equally possible that financial openness might affect bank risk via its impact on bank profit efficiency.[2]

The indirect effect of financial openness on bank profit efficiency that operates through bank risk could also be positive or negative. A portfolio management theory perspective would suggest a positive impact, particularly for larger banks, warranted by new opportunities for risk spreading and international portfolio diversification in terms of both income and asset diversity (see, e.g., Laeven and Levine, 2007). Conversely, the indirect effect through the risk channel could be negative given the new opportunities for banks to incur more risks under a more liberalized and deregulated financial regime as banks expand their operations into foreign markets or in non-traditional activities (see Cubillas and González, 2014). Higher bank risk and risk taking may, in turn, undermine efficiency gains from financial openness (see Dailami, 2009). These considerations should suffice in making it at least plausible to hypothesize the existence of an additional indirect – positive or

[2] Indeed, a number of studies have examined the trade-offs between bank efficiency and risk using Granger causality techniques (see, e.g., Berger and DeYoung, 1997; Williams, 2004; Fiordelisi et al., 2011).

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negative – effect running from financial openness to bank profit efficiency that may operate via bank risk; the determination of the prevailing net effect remaining a task for empirical estimation.

To the best of our knowledge, no single study has examined the importance of bank risk in investigating the effect of financial openness on bank profit efficiency, nor the impact of financial openness on both bank risk and profit efficiency by distinguishing between its direct influence and the effect that occurs through each one of the two bank characteristics (efficiency and risk, respectively). This paper makes a fresh contribution in these directions.

Accordingly, using a sample of 2,007 commercial banks operating in 140 countries over the period 1999-2011, the analysis will cater for these investigative routes as follows. Given that bank profit efficiency may be directly affected by financial openness, or indirectly through changes in bank risk levels, and since bank profit efficiency may also be a factor affecting bank risk, the analysis starts by using dynamic simultaneous models on both profit efficiency and bank risk with financial openness as an explanatory variable via system GMM estimations that also allow us to address the reverse causality between bank risk and profit efficiency. Then, to assess the sensitivity of our results, we estimate profit efficiency using stochastic frontier analysis (SFA) that allows estimates of efficiency to be influenced directly by a number of variables including different measures of risk and financial openness. Since country-specific differences in institutional factors and regulations may affect the role and relevance of bank risk in influencing bank profit efficiency under a more globally integrated financial environment, and given that this influence may vary with the state of economic development, we also control for country-specific differences in the regulatory environment and other factors, and conduct a battery of robustness tests.

The main results show that financial openness reduces bank profit efficiency directly, not through the channel of bank risk. Significantly, we also show that financial openness

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increases bank risk indirectly, through the decreased bank profit efficiency, a result that has not yet been reported in the literature.

The rest of the paper is organized as follows. Section 2 offers a brief theoretical background and discusses previous literature. Section 3 describes the methodology and data. Section 4 presents and discusses the empirical results. Section 5 concludes.

2. A review of related literature

As anticipated in our introduction, opening up the economy to foreign capital flows and relaxing entry barriers into the banking sector are expected to promote greater financial development and stimulate domestic competition. In this process banks too may accrue efficiency gains, directly or indirectly, as a result of more possibilities to allocate resources to productive investments, improved risk diversification and management best practice, reduced transaction, overhead and information costs, and new financial instruments and services (Claessens et al., 2001; Hermes and Lensink, 2008; Levine, 2001; Laeven and Levine, 2007; Herwartz and Walle, 2014). Yet, as noted earlier, the empirical evidence on the impact of financial liberalization/openness on bank efficiency is mixed, with many studies reporting a negative effect. Most of the applied studies relating to profit, cost or technical efficiency are conducted for individual countries with relatively few offering regional or cross-country level coverage.

Among country-specific studies, Williams and Intarachote (2003) investigate the impact of financial liberalization on the profit efficiency of Thai banks and find that bank profit efficiency decreases during the deregulation period. Bonaccorsi di Patti and Hardy (2005) investigate the effects of financial liberalization on bank cost and profit efficiency in Pakistan and find that while profit efficiency improved immediately after liberalization, the efficiency improvement did not continue in subsequent years. Using a dataset of Turkish

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banks, Denizer et al. (2007) too find that banking efficiency declined after financial liberalization owing to serious scale and macroeconomic problems.

Among region-specific studies, Hermes and Nhung (2010) investigate the impact of financial liberalization on Latin American and Asian banks over the period 1991-2000. Their results indicate a positive effect on bank efficiency. Other studies focus specifically on the impact of privatization or foreign ownership on bank efficiency. For example, Williams and Nguyen (2005) study the impact of commercial bank ownership resulting from liberalization on bank profit efficiency, technical change and productivity in Indonesia, Korea, Malaysia, the Philippines and Thailand, during the period 1990-2003. Their findings suggest that privatization policies encouraged improvements in bank efficiency and productivity over the deregulation period. Yildirim and Philippatos (2007) analyze the profit and cost efficiency in the transition economies following privatization and find that foreign-owned banks are more cost efficient, but less profit efficient, than domestic state-owned banks. Other related research on bank efficiency has considered the effects of banking and/or financial sector reforms as part of economic restructuring and liberalization in transition economies (e.g., Fries and Taci, 2005; Bonin et al., 2005; Brissimis et al., 2008) and, more recently, of the impact of greater economic and financial freedom in European Union member states (Chortareas et al., 2013, Mamatzakis et al., 2013). The main conclusion to be drawn from this strand of research is that greater freedom of banks in their operations has led to enhancements in overall efficiency levels particularly in environments where institutional reforms and governance requirements are strong.

At a broader cross-country level, Claessens et al. (2001) examined the extent and effect of foreign presence in domestic banking markets using 7,900 bank observations from 80 countries for the period 1988–1995. They found that the increased presence of foreign banks is associated with a reduction in profitability and margins for domestic banks. Lensink

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et al. (2008) examine whether the efficiency of foreign banks depends on the institutional quality of the host country and on institutional differences between the home and host country. Using SFA for a sample of 2,095 commercial banks in 105 countries over 1998-2003, they find that foreign ownership negatively affects bank efficiency. However, in countries with good governance this negative effect is less pronounced. Additionally, their results suggest that higher quality of home country institutions and higher similarity between home and host country institutional quality reduce foreign bank inefficiency. Hermes and Meesters (2015) examine the impact of financial liberalization on bank cost efficiency using a multi-country sample of banks covering 61 countries for the period 1996-2005. Employing a range of domestic and international liberalization measures, they report a positive association between financial liberalization and increased bank efficiency that hinges upon the quality of bank regulation and supervision. The impact of the regulatory and supervisory framework on bank efficiency is examined by Pasiouras et al. (2009) and Lozano-Vivas and Pasiouras (2010) who find that regulations and incentives that promote private monitoring and strengthen authorities' supervisory power affect both cost and profit efficiency positively, while restrictions on banks' activities improve profit efficiency but reduce cost efficiency.

Another strand of literature has concentrated on the link between financial liberalization and the likelihood of banking crises due to greater levels of risk taken by banks (Angkinand et al., 2010; Daniel and Jones, 2007; Demirgüç-Kunt and Detragiache, 1998; Kaminsky and Reinhart, 1999; Mehrez and Kaufmann, 2000). One potential channel through which liberalization affects bank risk-taking is via higher bank competition. Here, the effect can be positive or negative depending on whether the "competition-fragility" or the "competition-stability" force prevails. In the former case, higher competition erodes banks' charter value and undermines prudent behavior thus increasing banks' incentives for risk-taking (see, e.g., Keeley, 1990; and Hellmann et al., 2000). In the latter case ("competition-

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stability"), greater bank competition reduces bank risk as banks charge lower interest rates, which diminishes their incentives to move into riskier projects (see Boyd and De Nicolo, 2005; Uhde and Heimeshoff, 2009). Using an international sample of over 4,000 banks in 83 countries, Cubillas and González (2014) find that bank risk increases with financial liberalization via stronger bank competition in developed countries, whereas in developing countries higher risk results from expanding opportunities to undertake riskier investments.

Another channel through which financial liberalization affects risk-taking is via increased opportunities for banks to diversify into foreign markets or in non-traditional activities. In a recent paper, Berger et al. (2015) distinguish between a *diversification hypothesis* and a *market risk hypothesis* in their analysis of the relationship between bank internationalization and risk. The former hypothesis implies that banks sustain lower risk as they diversify their portfolios internationally, while the latter suggests that banks face higher risk when operating abroad owing to market specific factors which make their foreign assets relatively risky. Gulamhussen et al. (2014) emphasize the complexity of the relationship between bank internationalization and risk, with potential risk-reducing gains from portfolio diversification to be potentially offset by incentives leading banks to take on excessive risks. They study such a relationship on an international sample of 384 listed banks from 56 countries, for the period 2001-2007, and find robust evidence that international diversification increases bank risk. Their evidence is consistent with the market risk hypothesis that Berger et al. (2015) support in their empirical analysis of a large sample of US banks over the period 1989-2010.

Anginer and Demirgüç-Kunt (2014a) examine the evolution of credit risk co-dependence in the banking sectors of over 65 countries. They find that there has been a significant increase in default risk co-dependence over the 3-year period preceding the financial crisis. Significantly, they also show that countries that are more integrated with

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liberalized financial systems have experienced greater banking sector co-dependence. However, they highlight that this detrimental effect of financial openness is alleviated by a strong institutional environment that allows for efficient public and private monitoring of financial institutions.

The literature reviewed so far deals with the general link between financial liberalization and/or openness and bank efficiency, or bank risk and bank risk-taking, respectively. Given our interest, a third strand of the literature that has investigated the relationship between bank risk and bank efficiency also requires coverage.

Berger and DeYoung (1997) introduce four hypotheses to formalise the relationship between credit risk and bank efficiency: (i) the "bad management" hypothesis; (ii) the "skimping" hypothesis; (iii) the "bad luck" hypothesis; and (iv) the "moral hazard" hypothesis. Significantly, they also provide evidence that risk negatively influences cost efficiency among bankrupt banks. Kwan and Eisenbeis (1997) find a negative relationship between risk-taking behaviour and efficiency among financial institutions. However, Hughes and Mester (1993) suggest that risk-averse managers are more likely to lend higher quality loans, but the costs might be increased for monitoring of loan performance, hence lowering cost efficiency. Altunbas et al. (2007) investigate the efficiency of banks in European countries from 1992 to 2000 and fail to find a strong relationship between bank inefficiency and risk-taking behaviour. Hughes and Mester (2008) survey the literature on the relationship between efficiency, risk and asset quality in the banking sector. Their cogent synthesis concludes that the quality of equity capital influences the insolvency risk of banks. More recently, using DEA techniques and a Tobin regression approach, Chan et al. (2014) analyze the effects of off-balance sheet (OBS) activities and various types of risk on the cost and profit efficiency of banks in seven East Asian countries for the period 2001-2008. Their results show that a *Z*-score measure of bank insolvency risk is positively related to profit

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efficiency, while interest sensitivity, size, equity to total assets and OBS exposures all impact on cost efficiency. The analysis of the impact of input and output slacks reveals that in 20 percent of cases banks' cost efficiency can be improved by adjusting the former variables, whereas in only about one percent of cases a similar outcome is attainable for profit efficiency.

However, the literature has not been successful in establishing a conventional wisdom as to the precise patterns that may characterize a causal relationship between bank risk and efficiency in a setup which includes financial openness. In liberalized financial markets, international capital flows can amplify financial risks because of greater availability of capital which increases the funds intermediated by the financial sector thereby influencing the efficient operation of banks. Moreover, the potential for reverse causality adds to the complexity, consistent with a "*skimping*" hypothesis described by Berger and DeYoung (1997), in which there is a trade-off between short-term efficiency and future risk-taking due to moral hazard considerations. In their comprehensive assessment of the inter-temporal relationship between bank efficiency, capital and risk in a sample of European commercial banks, Fiordelisi et al. (2011) explain that banks might be tempted to increase revenues simply by taking on higher risk to compensate for lost returns. Using SFA and dynamic panel regressions with Granger causality tests, they conclude that lower bank efficiency with respect to costs and revenues Granger-causes higher bank risk (i.e., less efficient banks are more inclined to take on greater risk) and that increases in bank capital precede (in the temporal Granger-sense) cost efficiency improvements.

In conclusion, taking stock of various strands of previous literature at both the theoretical and empirical level, would suggest that financial openness may impact both bank risk and profit efficiency directly, or indirectly through the effect that occurs through each of the two bank characteristics (efficiency and risk, respectively). In the present study we add to

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what has gone before by analysing within a single study and using a large panel of countries the significance, directionality and Granger causality of these intricate relationships empirically, so as to establish the effectiveness of financial openness in affecting bank risk and profit efficiency, and the channel through which such effects may occur.

3. Methodology, variables and data

3.1. Dynamic GMM estimation and Granger causality

We begin by considering an autoregressive distributed lag (ARDL) system to test for Granger-causality among the variables of interest. Specifically, building upon the work of Berger and DeYoung (1997), Williams (2004), Casu and Girardone (2009) and Fiordelisi et al. (2011), we use the dynamic panel GMM estimation of the following ARDL model:

$$PE_{i,t} = f_1(PE_{i,lag}, RISK_{i,lag}, FINOPEN_{i,lag}) + \varepsilon_{i,t}$$

$$RISK_{i,t} = f_2(RISK_{i,lag}, PE_{i,lag}, FINOPEN_{i,lag}) + \varepsilon_{i,t}$$

where *i* denotes the cross-sectional dimension (the banks), *t* denotes time, *RISK* represents individual bank risk, *PE* denotes bank profit efficiency, *FINOPEN* denotes financial openness, and $\varepsilon_{i,t}$ is the random error term. The first equation tests whether changes in bank risk temporally precede variations in bank profit efficiency and the second equation tests whether changes in profit efficiency temporally precede variations in risk. The simultaneous estimation by GMM of the above equations allows us to account for potential endogeneity or simultaneity in the dynamics of bank risk and profit efficiency that may be jointly influenced by financial openness as well as the possibility of reserve causality between profit efficiency and risk.

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In the empirical estimation, as in Casu and Girardone (2009) and Fiordelisi et al. (2011), we include two lags for the variables of interest (risk, efficiency and financial openness) and so estimate an AR(2) process. Testing whether one variable *x* Granger causes another variable *y* can be determined by a Wald test of the null hypothesis that the two lags of the causal variable *x* are jointly equal to zero. The sum of the lagged coefficients of *x* represents the 'total effect' of the causal relationship, the statistical significance of which also provides a (Wald) test of Granger-causality.[3] Additionally, we assess the 'long run' effect of a change in *x* on *y*, determined from the estimated coefficients representing the dynamics of both *x* and *y*.[4]

Note that, since the dependent variable is a function of the error term, the lagged dependent variable is correlated with the error term, making the OLS estimator biased and inconsistent. Hence, we apply the system generalized method of moments (SYS-GMM) estimation for the dynamic panel data model, as suggested by Arellano and Bover (1995) and Blundell and Bond (1998), and employ the Windmeijer (2005) corrected standard errors.

3.2. Profit efficiency estimation

To determine bank profit efficiency scores and to investigate further the impact of financial openness and other control variables (including bank risk) on profit efficiency we follow the methodological approach of recent studies (Lozano-Vivas and Pasiouras, 2010; Gaganis and Pasiouras, 2013) by using SFA. Here we consider the Battese and Coelli (1995) model, which allows measurement of inefficiency from the best-practice frontier in a single-step estimation which incorporates other factors including country- and bank-specific

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[3] If the p-value of the Wald test is less than 5% in either case, we reject the null hypothesis that *x* does not Granger-cause *y* at the 5% significance level.

[4] The 'long-run' effect is the partial derivative $dy/dx = (\beta_1 + \beta_2)/(1 - \alpha_1 - \alpha_2)$, based on the assumption, *ceteris paribus*, that the dynamic adjustment of a unit change in *x* on *y* is complete, where β_1, β_2 and α_1, α_2 represent the lag coefficients of *x* and *y*, respectively.

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variables to influence directly the mean inefficiency of banks. This setup allows us to examine the impact of financial openness and risk on bank efficiency while controlling for other bank level and cross-country differences. In its general form, the profit model can be written as:

$$lnPBT_{i,t} = \pi(p_{i,t}, w_{i,t}, \beta) - u_{i,t} + v_{i,t}, \quad i = 1,2,\ldots,N; \quad t = 1,2,\ldots,T \qquad (1)$$

where $PBT_{i,t}$ is pre-tax profits of bank *i* at time *t*; $p_{i,t}$ refers to the vector of banks output prices; $w_{i,t,}$ is the vector of input prices; β is a vector of unknown scalar parameters that connect with output and input variables in the profit function; $v_{i,t}$ is the random error assumed to be independent and identically distributed $N(0, \sigma_v^2)$; $u_{i,t}$ is a non-negative random inefficiency term assumed to be independent but not identically distributed. The term $u_{i,t}$ follows a truncated-normal distribution, with truncation (at zero) of the $N(m_{i,t}, \sigma_u^2)$ distribution where the mean is defined as:

$$m_{i,t} = z_{i,t}\delta \qquad (2)$$

where $z_{i,t}$ is the vector of observable explanatory variables that might be considered as the inefficiency of bank *i* at time *t*, and δ is a vector of parameters to be estimated. Following Battese and Coelli (1995), the coefficients of (1) and (2) are generally estimated in a single-step using maximum likelihood. The specification of equation (1) follows the approach of Gaganis and Pasiouras (2013) to estimate a standard profit frontier that is specified in terms of input prices and output prices.

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Choice of Inputs and Outputs

The selection of input and output variables for the profit frontier is based on the typical intermediation approach (e.g., Gaganis and Pasiouras, 2013), which treats banks as financial intermediaries collecting funds (deposits) as inputs and transforming them into loans or other assets. We specify two output prices: (i) the ratio of interest revenue to loans (P_1); and (ii) the ratio of non-interest revenue to other earning assets (P_2). And three input prices: (i) the cost of 'loanable' funds (W_1), estimated by the ratio of interest expense/total deposits; (ii) the cost of physical capital (W_2), measured by overhead expenses net of personnel expenses/book value of fixed assets; and (iii) the cost of labour (W_3), defined as personnel expenses/total assets. Moreover, equity (*EQ*) is included as a quasi-fixed input in the profit function to control for different levels of banks' risk profile, as Berger and Mester (1997) suggest that failure to control for equity might lead to a scale bias in the estimation of inefficiency since equity is another source for loans. They explain that dividends paid do not take into account the overall cost, while the cost of raising equity is higher than raising deposits.[5] Among the inputs, the third input (W_3) is used to normalize the dependent variables and other input prices. In addition, a time trend (T=1 for 1999, T=2 for 2000, to T = 13 for 2011) with both linear and quadratic terms (T and T^2) is included to incorporate the effect of changes in technology over time. A dummy variable (*DEVEL*) is also included to distinguish between developed and developing countries, thus accounting for differences in their level of economic development.

3.2.1. Empirical SFA model

[5] According to Hughes and Mester (2008), who cite Berger and Mester (1997) and Mester (1996), it is necessary to incorporate equity as a quasi-fixed input in the empirical model so that the shadow price of equity is measured. Other studies (e.g., Pasiouras et al., 2009; and Lozano-Vivas and Pasiouras, 2010) also incorporate this variable as a quasi-fixed input in their cost and profit efficiency models.

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We employ a multi-product translog function to estimate the profit efficiency of banks. The function is represented by a second-order Taylor expansion that is commonly employed in previous studies, since the translog functional form allows for greater flexibility when evaluating the efficiency frontier. Using the above input and output prices, the empirical profit function is specified as:

$$\begin{aligned}\frac{\ln PBT}{W3} = {} & \beta_0 + \beta_1 \ln\left(\frac{P1}{W3}\right) + \beta_2 \ln\left(\frac{P2}{W3}\right) + \beta_3 \ln\left(\frac{W1}{W3}\right) + \beta_4 \ln\left(\frac{W2}{W3}\right) + \beta_5 \frac{1}{2}\left(\ln\left(\frac{P1}{W3}\right)\right)^2 \\ & + \beta_6 \ln\left(\frac{P1}{W3}\right)\ln\left(\frac{P2}{W3}\right) + \beta_7 \frac{1}{2}\left(\ln\left(\frac{P2}{W3}\right)\right)^2 + \beta_8 \frac{1}{2}\left(\ln\left(\frac{W1}{W3}\right)\right)^2 \\ & + \beta_9 \ln\left(\frac{P1}{W3}\right)\ln\left(\frac{W1}{W3}\right) + \beta_{10} \ln\left(\frac{P2}{W3}\right)\ln\left(\frac{W1}{W3}\right) + \beta_{11} \frac{1}{2}\left(\ln\left(\frac{W2}{W3}\right)\right)^2 \\ & + \beta_{12} \ln\left(\frac{P1}{W3}\right)\ln\left(\frac{W2}{W3}\right) + \beta_{13} \ln\left(\frac{P2}{W3}\right)\ln\left(\frac{W2}{W3}\right) + \beta_{14} \ln\left(\frac{W1}{W3}\right)\ln\left(\frac{W2}{W3}\right) \\ & + \beta_{15} \ln(EQ) + \beta_{16} \frac{1}{2}(\ln(EQ))^2 + \beta_{17} \ln(EQ)\ln\left(\frac{P1}{W3}\right) \\ & + \beta_{18} \ln(EQ)\ln\left(\frac{P2}{W3}\right) + \beta_{19} \ln(EQ)\ln\left(\frac{W1}{W3}\right) + \beta_{20} \ln(EQ)\ln\left(\frac{W2}{W3}\right) + \beta_{21} T \\ & + \beta_{22} T^2 + \beta_{23} T \ln\left(\frac{P1}{W3}\right) + \beta_{24} T \ln\left(\frac{P2}{W3}\right) + \beta_{25} T \ln\left(\frac{W1}{W3}\right) \\ & + \beta_{26} T \ln\left(\frac{W2}{W3}\right) + \beta_{27} T \ln(EQ) + \beta_{28} DEVEL - u_{i,t} + v_{i,t}\end{aligned}$$

It should be noted that to account for the negative minimum profit of banks, since the dependent variable requires the natural logarithmic transformation, we follow the approach suggested by Bos and Koetter (2011) by incorporating an additional independent variable, the negative profit indicator (*NPI*). In this way, the dependent variable is assigned a value of 1 when PBT ≤ 0; then, the additional independent variable (*NPI*) equals 1 when PBT ≥ 0 and equals the absolute value of PBT for banks with negative profits. A similar transformation is used by Tabak et al. (2011) and Gaganis and Pasiouras (2013) to estimate bank efficiency.[6]

[6] Some early studies (e.g., Berger and Mester, 1997; Pasiouras et al., 2009) add a constant value to convert the non-positive value of profit before tax, the absolute value of minimum profit before tax plus one and add to original value: PBT+ (| PBT^{min}|+1). However, Bos and Kotter (2011) indicate that

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3.2.2. Potential determinants of inefficiency

To investigate the determinants of inefficiency, in particular the impact of financial openness and risk on the mean inefficiency of banks, while at the same time controlling for other bank-level and country-level characteristics, m_{it} in equation (2) is given by:

$$m_{it} = \delta_0 + \delta_1 FINOPEN + \delta_2 RISK + \delta_3 CAPR + \delta_4 SUP + \delta_5 PRIM + \delta_6 ACTR + \delta_7 CONC + \delta_8 CLAIM + \delta_9 GDPGR + \delta_{10} INFA + \delta_{11} ASSETDIV + \delta_{12} SIZE + \delta_{13} INCMDIV + \delta_{14} CRISIS + \delta_{15} DEVEL + \delta_{16} D12 + \delta_{17} D11 + \delta_{18} D10 + \delta_{19} D09 + \delta_{20} D08 + \delta_{21} D07 + \delta_{22} D06 + \delta_{23} D05 + \delta_{24} D04 + \delta_{25} D03 + \delta_{26} D02 + \delta_{27} D01$$

where *FINOPEN* is a measure of financial openness, and *RISK* is the bank-level measure of risk. The other variables are included to control for country level differences in the regulatory environment (*CAPR*, *SUP*, *PRIM*, *ACTR*), market structure (*CONC*), financial development (*CLAIM*), macroeconomic conditions (*GDPGR, INFA*), banking crises (*CRISIS*), and the development dummy (*DEVEL*); as well as bank characteristics which include bank size (*SIZE*), business model asset diversification (*ASSETDIV*), and income diversification (*INCMDIV*). Additionally, we include year dummies (*D*01-*D*12) to control for time effects.

3.3. Measures of financial openness

In our empirical analysis, we include several measures to account for the degree of financial openness across countries. First, we employ the *de jure* financial openness index (*FINOPEN-Chinn-Ito*) as constructed by Chinn and Ito (2008) to capture the effect of capital account liberalization across countries. Chinn and Ito (2008) have extended their earlier work

such a transformation might affect the error term (a critical issue in SFA) and might also omit the information for the truncated part of the distribution of the dependent variable, leading to misleading results.

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(Chinn and Ito, 2006) and updated their dataset annually using the information published in the IMF *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER) with binary coding (restriction does not exist =1, otherwise = 0) of the information to calculate the openness index according to four categories: (1) the presence of multiple exchange rates; (2) restrictions on current account transactions; (3) restrictions on capital account transactions; (4) the requirement of the surrender of export proceeds. The index is given the score 0-4 after transforming the binary variables into a quantitative scale, with a higher value implying more openness of the capital account. This index covers a large number of countries (181 countries) from 1970 to 2011.

Our second measure of financial openness is the Financial Freedom Index (*FINFREE*), which represents one of the ten components of the Index of Economic Freedom published annually by the Heritage Foundation. *FINFREE* measures the extent of government regulation of financial services, the extent of state intervention in banks and other financial services, the difficulty of opening and operating financial services firms (for both domestic and foreign individuals), and the government influence on the allocation of credit. The index assigns an overall score on a scale of 0–100 where 0 means that private financial institutions are prohibited and 100 means that government influence is negligible. Therefore, higher values of the index indicate greater financial freedom.

As our third measure, we consider the percentage of foreign-owned banks operating in the domestic market (*FOREIGN*), which has commonly been applied in previous studies of bank performance (e.g., Pasiouras et al., 2009). This additional measure also allows us to control for the effect of foreign presence in the domestic banking sector while investigating the effect of financial openness using the above two measures.

In recognition of the fact that the results of efficiency studies are inevitably affected by the variables choice, it should be emphasized that using different measures of financial

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openness serves to ensure that our choice is representative, and that includes *de jure* as well as *de facto* indicators (Kose et al., 2009; Gehinger, 2013). The Chinn and Ito (2008) indicator is a *de jure* indicator, based on a principal components model. Similarly, *FINFREE*, being a policy-based measure, is also a *de jure* indicator. However, Kose et al. (2009) and Gehringer (2013) argue that a *de facto* measure of liberalization is more reliable. Although *FOREIGN* is a *de facto* measure of financial openness (by construction), as a further check for robustness, we also consider an alternative *de facto* measure (*FINOPEN-Kose*) as computed by Kose et al. (2009) using the ratio of the sum of the gross stocks of foreign assets and liabilities to GDP, which is based on the *External Wealth of Nations Database* constructed by Lane and Milesi-Ferretti (2007).

3.4. Bank risk

We consider three alternative measures of bank risk in our analysis. First, as our main measure, we use *Z*-score (*ZSCORE*), which reflects the probability of a bank's insolvency risk based on the amount of buffer the bank has, to guard against shocks to earnings. *ZSCORE* is calculated as $Z = [(ROA + E/A) / \sigma(ROA)]$, where *ROA* is the rate of return on assets, *E/A* is the equity to asset ratio, and $\sigma(ROA)$ is an estimate of the standard deviation of the rate of return on assets.[7] *Z*-score can thus be interpreted as the number of standard deviations by which returns would have to fall from the mean to deplete all equity in the bank (see, e.g., Fang et al., 2014). A high *ZSCORE* implies that the bank is more stable due to its inverse relationship with the bank's insolvency probability.

Second, as part of robustness, we account for bank credit risk by using the ratio of non-performing loans to total loans (*NPL/L*), with a higher proportion of non-performing

[7] As Laeven and Levine (2009) indicate, the above *Z*-score measure is highly skewed, so its natural logarithm (which is normally distributed) is commonly used. A higher value of *Z*-score implies a lower default risk.

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loans signifying a higher credit risk of banks. Although *NPL/L* may not be a reliable measure since it may be inconsistent across banks (which use special purpose vehicles to manage part of their loans outside their loan book) as well as across countries (as banks adopt different criteria depending on the jurisdiction and also might adopt differentiated write off policies), it complements the mix of different risk measures used by being an accounting measure that focuses on credit risk *subject to managerial discretion*, and can be considered a 'point-in-time' risk measure (see Fiordelisi et al., 2011).

Finally, in our SFA, we also consider marginal expected shortfall (*MES*) as described by Acharya et al. (2012). Thanks to its coverage of systemic risk – and unlike *ZSCORE* and *NPL/L* – *MES* can be considered a measure of firm-level risk linked to the risk of breakdown of the whole banking system. The *MES* of a firm is defined as the expected loss an equity investor in a financial firm would experience if the market declined substantially, and is constructed by Anginer and Demirgüç-Kunt (2014b) at the country level. This measure is commonly employed in the literature to capture a financial institution's exposure to systemic risk and we include it to complement our measures of bank risk as *MES* can be broadly rationalized in terms of standard balance sheet indicators of bank financial soundness as well as systemic importance. The logic underlying this choice is based on the notion that a shortage of capital is dangerous for the individual bank, but also for the whole economy if it occurs at a time when also the rest of the banking sector is undercapitalized.

3.5. Control variables

Regulation and supervision

Following previous studies that focus on bank regulations and efficiency (Barth et al., 2013b; Gaganis and Pasiouras, 2013; Lozano-Vivas and Pasiouras, 2010; Pasiouras et al., 2009), we employ a set of four index-based measures to control for country-specific

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differences in banking regulations. They represent capital requirements (*CAPR*), the degree of official supervisory power (*SUP*), the degree of private monitoring (*PRIM*), and restrictions on bank activities (*ACTR*). The data for these indicators are sourced from Barth et al. (2013a).

CAPR is an index that measures both initial and overall capital stringency. Overall capital stringency estimates whether capital requirements reflect certain risk elements and deduct certain market value losses from capital before minimum capital adequacy is determined. On the other hand, the initial capital stringency examines whether certain funds may be used to initially capitalize a bank and whether they are officially verified. The construction of the index is based on a set of eight questions with higher scores reflecting more capital stringency. The results of the previous empirical studies assessing the impact of capital stringency on bank performance are mixed. For example, Barth et al. (2006) indicate that there is no strong correlation between the capital stringency and bank performance, whereas Pasiouras et al. (2009) find a negative association with bank profit efficiency.

SUP measures the degree of official power of the supervisory authorities based on information relating to whether bank supervisors can take relevant actions against bank management, with higher value of *SUP* indicating greater powers of supervision. Barth et al. (2004) show that strict supervision can prevent banks from engaging in excessive risk taking and, in so doing, contribute to bank stability and development. On the other hand, Quintyn and Taylor (2003) warn that improper regulatory and supervisory policies can lead to financial instability and strong supervisory power might relate to corruption as supervisors use their power to benefit preferred organizations. Barth et al. (2006) conclude that if a 'public interest' view prevails then a powerful supervisory approach should directly improve bank efficiency through increased competition. However, the 'private interest' approach to supervisory power contends that effective supervision should encourage private monitoring through requirements of bank disclosure of information.

PRIM measures the degree of private monitoring in the regulatory approach, which requires banks to release accurate and comprehensive information to the public. *PRIM* takes a value from 0 to 8, with higher values indicating more stringent requirements on information disclosure and private monitoring. Pasiouras et al. (2009) and Lozano-Vivas and Pasiouras (2010) unveil a positive impact of enhanced monitoring on profit efficiency.

Finally, *ACTR* measures the degree of restrictions on bank activities in securities, insurance, real estate investment, and ownership of non-financial firms; the higher the value, the greater the restrictions. Barth et al. (2004) indicate that activity restrictions serve to limit risk-taking incentives of banks in gaining more profitability, and while it is hard to monitor complex and large banks, activity restrictions may contribute to lower competition and efficiency.

Bank specific controls

Following Fiordelisi et al. (2011) and Laeven and Levine (2007) among others, we also include bank-specific factors that may influence the mean inefficiency of banks, including: diversification across different asset types (*ASSETDIV*), calculated as 1- [(Net Loans – Other Earning Assets) / Total Earning Assets]; diversification across different sources of income (*INCMDIV*), calculated as 1- [(Net Interest Income – Other Operating Income) / Total Operating Income]; and bank size (*SIZE*), proxied by the natural logarithm of total bank assets. Both asset diversity and income diversity take values between 0 and 1, which increase with the degree of diversification.

Other country-specific controls

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In addition, we control for differences in market structure using a measure of bank concentration (*CONC*) defined as a ratio of the total assets of the three largest commercial banks to the total assets of all commercial banks of a country; and in financial development using the ratio of claims on the private sector to GDP (*CLAIM*) thus capturing the extent of financial intermediation. We also account for banking crises using a dummy variable which takes value 1 for three years, covering the year of inception of a crisis as reported by Laeven and Valencia (2012) and the two following years, and value 0 otherwise. Kroszner et al. (2007), Dell'Ariccia et al. (2008), Cubillas et al. (2012), and Fernández et al. (2013) have also used this definition to capture the effect of the crises. Finally, in addition to time dummies used to capture the effects of technological change, we introduce a development dummy (*DEVEL*) to represent the effect of unobserved environmental factors that are common within different levels of economic development (as in Lozano-Vivas and Pasiouras, 2010).

3.6. Data

We constructed our sample by first considering all the commercial banks in the Bankscope database (Bureau van Dijk Electronic Publishing), and then excluding: (i) banks operating in countries for which any of the above financial openness measures were not available; (ii) banks for which other country-specific variables were not available; (iii) bank-year observations for which at least one of the bank-specific variables was missing; and (iv) bank-year observations through the 'Winsorization' of all bank-level data at the top and bottom 1 percentiles to account for extreme values and unobservable input errors. This process led to a final sample of 9,999 bank-year observations, covering 140 countries and 2,007 commercial banks of unbalanced panel data for the period 1999-2011. All bank-specific data were obtained from the balance sheets and income statements of commercial banks in the Bankscope database, and all input and output variables were adjusted using GDP

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deflators (1995 = 100). Data for each individual bank is expressed in US million dollars for a given year. The sample covers only commercial banks in order to make efficiency estimates comparable for cross-country analysis. Besides, restricting the sample to commercial banks makes the similarity of production technology assumption that is implicit in our model more realistic. Table 1 presents descriptive statistics for bank-specific and country-specific variables. All the figures seem plausible and are generally in line with those typically reported in previous studies. Table 2 presents the correlation coefficients of the variables, and their respective statistical significance, showing reassuring values.

4. Results

4.1. Profit efficiency scores

Prior to presenting the SYS-GMM causality test results, it appears opportune to provide a brief discussion of the average estimated efficiency scores, which are presented in Table 3 using a global frontier, where the results are distinguished by year and between developed and developing economies. These can be briefly summarized as follows.

First, the overall average profit efficiency for the entire sample is 0.5155, implying that an average bank could improve its profits by a considerable amount (around 48 per cent) relative to the best practice bank in the sample. These estimates are broadly comparable to those reported in some US and European studies (e.g., Berger and Mester, 1997; DeYoung and Hasan, 1998; Maudos et al., 2002) although they are generally lower than those found in some recent cross-country studies (e.g., Gaganis and Pasiouras, 2013). Part of the reason may be due to the inclusion of financial openness and risk indicators in our analysis.

Second, the trend in profit efficiency over time has been cyclical, declining during 1999-2000 before increasing steadily over the period 2000-2006, and then declining sharply

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again during the financial crisis of 2007-2009 before picking up slightly in 2010. The variability in profit efficiency is also lower when profit efficiency is generally high.

Third, the cyclical trend observed in profit efficiency is similar for both developed and developing countries, although the overall mean scores suggest that banks in developed countries are marginally less profit efficient than in developing countries, as has been observed in previous studies (e.g., Pasiouras et al., 2009).

4.2. Dynamic GMM estimation and Granger causality

The results of the estimation of the dynamic models and Granger causality tests are reported in Tables 4 and 5, where Panel A shows the estimates of profit efficiency and Panel B the estimates of risk regressions. For this analysis we capture the influence of financial openness using *FINOPEN* (*Chinn-Ito*) and *FINFREE* as proxies (with the corresponding results shown in columns 1 and 2, respectively). The influence of bank risk is captured using two measures, namely *Z*-score (Table 4), and the ratio of non-performing loans to total loans, *NPL/L* (Table 5). Both tables provide SYS-GMM estimates to account for potential endogeneity of the explanatory variables and the possibility of reverse causality between profit efficiency and risk. The regressions are conducted with two lags for both the dependent and independent variables, and the results display the total (sum of lags) effect, as well as the long-run effect of the causal variables on the dependent variable. The Sargan/Hansen and Arellano-Bond tests reported in the tables confirm the validity of the instruments underlying SYS-GMM estimation and the absence of serial correction in the first-differenced residuals, respectively.

In Table 4, where bank risk is measured by *ZSCORE*, the results (in Panel A) show that financial openness (whether *FINOPEN* or *FINFREE*) negatively Granger-causes bank profit efficiency (*PE*). Although the initial effect of *FINOPEN* on *PE* is positive (at first lag),

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this is offset by a negative impact at second lag, yielding the total effect, and consequently the long run effect, negative. In the case of *FINFREE*, the effect on *PE* is statistically significant (and negative) only at second lag. The results also show that an increase in bank soundness (implied by the positive and statistically significant total lag effect of *ZSCORE*) temporally precedes an increase in *PE*. Conversely, therefore, higher bank risk measured by the inverse of *Z*-score negatively Ganger-causes lower *PE*. The results (in Panel B) confirm that *PE* positively Granger-causes *ZSCORE*, implying that lower (higher) bank profit efficiency temporally precedes higher (lower) bank risk. Here, additionally, the results show that neither of the two measures of financial openness (*FINOPEN/FINFREE*) has a statistically significant impact on *ZSCORE*.

Table 5 reports the results using the *NPL/L* measure of bank risk, and these are broadly similar to those of Table 4, with financial openness found to negatively Granger-cause *PE*. While the effect of *FINOPEN / FINFREE* on *PE* is more pronounced in the second lag, and that of *NPL/L* on *PE* is more significant in the first lag, the total effect of these causal variables on *PE* is statistically significant, confirming a negative association of profit efficiency with both financial openness and risk. In addition, the results (in Panel B) show that *PE* negatively Granger-causes *NPL/L,* with the effect being significant (and much stronger in terms of magnitude) in both first and second lags. This result supports the above finding (using *ZSCORE*) that lower bank profit efficiency temporally precedes higher bank risk, a finding consistent with the *"skimping"* hypothesis, implying that a bank may be tempted to increase revenues simply by taking on higher risks to compensate for lost returns that may be associated with increased competition (Berger and DeYoung, 1997; Fiordelisi et al., 2011). Additionally, we find that *FINFREE* negatively Granger-causes the *NPL/L* risk

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measure although its total effect is only statistically significant at the 10% level, while the effect of *FINOPEN* is not significant at all.[8]

In both Tables 4 and 5, the results confirm the persistence of own (lagged) effects on profit efficiency and risk. In particular, the dynamic effects of *PE* (Panel A) are statistically significant at both lags while those of risk (Panel B) persist mainly in the first period. In terms of the magnitude of the estimates of the causal variables, the results also confirm that the total effect of *PE* on risk (whether *NPL/L* or *ZSCORE*) is greater than that of financial openness (whether *FINOPEN* or *FINFREE*) on *PE*. More significantly, the causality that runs from *PE* to risk is much stronger than that which runs from risk to *PE*, given that the long-run effects are much higher in the former case than in the latter, under both measures of financial openness.[9]

Taken together, the results indicate that both higher financial openness and higher bank risk Granger-cause lower profit efficiency. Our findings also reveal bidirectional causality between bank risk and efficiency as found in previous studies (e.g., Fiordelisi et al., 2011), though the profit efficiency channel influencing risk is much stronger than *vice versa*. This implies that, since financial openness does not Granger-cause bank risk (directly), its effect on higher bank risk operates (and persists) indirectly through lower profit efficiency.

4.3. SFA base results

To ascertain the sensitivity of our SYS-GMM results, in this section we report the base results of SFA. Table 6 shows the results highlighting the impact of financial openness,

[8] Hence this effect is not robust across both measures of financial openness and to the extent that it does Granger-cause lower bank risk - albeit at 10% significance level - it may be seen as supporting the *diversification hypothesis* (Berger et al., 2015).

[9] For instance, with *FINOPEN* as the conditioning variable, the long-run effect of the unit change in *PE* on *ZSCORE* is 0.6340 while that of a unit change in *ZSCORE* on *PE* is 0.1103. The corresponding figures under the *NPL/L* measure of risk are -21.6605 and -0.0132. Similarly, conditional on *FINFREE*, the results confirm the dominance of the *PE* to risk channel.

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risk and other control variables on bank profit inefficiency, estimated using the Battese and Coelli (1995) model. Here we use three different measures of financial openness and the results using each of these measures are reported individually and jointly in columns 1-8, in turn for each measure of bank risk (*NPL/L* and Z*SCORE*).

The results in columns (1), (4), (5) and (8) show that *FINOPEN* (*Chinn-Ito*), which captures the effect of capital account openness, has a statistically significant and positive impact on profit *inefficiency*. This implies that financial openness has, therefore, a negative association with profit efficiency, suggesting that banks in countries with a higher degree of financial openness are likely to be less profit efficient. In terms of the economic magnitude of this effect, the estimated *FINOPEN* coefficients (all statistically significant at the 1% level) range from 0.1063 (column 4) to 0.1419 (column 8).

Next, we consider the effect of financial freedom (*FINFREE*) and foreign presence represented by the percentage of foreign owned banks in the domestic banking sector (*FOREIGN*). The results pertaining to financial freedom (*FINFREE*) in columns (2) and (6), and those related to foreign ownership (*FOREIGN*) in columns (3) and (7), confirm a negative association with profit efficiency, though the magnitude of the effects is lower than that of capital account openness (*FINOPEN-Chinn-Ito)*. In columns (4) and (8) we simultaneously include all financial openness variables, added individually in columns (1) - (3) and (5) – (7), and the main results hold with minor differences.

The negative impact of financial openness on profit efficiency is consistent with most previous studies assessing the impact, directly or indirectly, of financial liberalization on profit efficiency (e.g., Denizer et al., 2007; Williams and Intarachote, 2003) and can be explained by the fact that while financial openness may stimulate banks to engage in restructuring and diversification of their portfolios, some of the bankers may lack specific technological skills and knowledge, for instance in risk management, which may reduce their

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profitability. Additionally, greater competition associated with the presence of foreign banks in the domestic market creates pressures on local banks (typically operating at less than optimal capacity) to consolidate their operations, and the resulting scale problem is likely to adversely affect their profit efficiency.

The results in Table 6 also confirm a statistically significant and positive association of credit risk (*NPL/L*) with profit inefficiency (columns 1-4), implying that higher credit risk associated with increased provisions for bad performing loans contributes to lowering profit efficiency. Similarly, with the effect of *ZSCORE* on profit inefficiency being negative (columns 5-8), profit efficiency is negatively associated with insolvency risk (inverse of Z-score). Hence, the results confirm that higher bank risk lowers profit efficiency.

With regard to the regulatory and supervisory control measures (*CAPR*, *PRIM, ACTR* and *SUP*), they are all statistically significant, thereby confirming that the effects of financial openness and risk on profit efficiency are significant after controlling for the regulatory and supervisory environment. It is also worth noting that three of these measures (*CAPR*, *PRIM* and *ACTR*) are negatively related to profit inefficiency, implying that they improve profit efficiency while the one reflecting official supervisory power (*SUP*) is positively related to profit inefficiency. The overwhelming evidence in support of a positive influence on profit efficiency is consistent with the findings of most previous studies (e.g., Lozano-Vivas and Pasiouras, 2010; Pasiouras et al., 2009) and could be seen to provide empirical content to the 'public interest' view, which suggests that the government acts in the interests of the public and regulates banks to promote efficient banking and ameliorate market failures (Barth et al., 2006, 2013b). Nevertheless, we would call for caution in extrapolating too much inference from the signs of these estimated coefficients since without the estimation of interaction effects (see, for example, Cubillas and González, 2014) the significance of these regulatory and supervisory measures in counteracting the effects of

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financial openness remains one to be interpreted within their function as control variables in this model.

With regard to the bank-specific controls, we find negative and statistically significant effects between asset diversification (*ASSETDIV*), income diversification (*INCMDIV*), size (*SIZE*) and bank profit inefficiency. The results imply that more diversified bank business and larger banks enjoy greater profit efficiency gains.

Among the other country-specific controls, the effect of the banking crises dummy (*CRISIS*) has a proportionately much larger impact on lowering profit efficiency than the financial openness variables, a result consistent with the downward trend in profit efficiency observed over the 2007-2009 crisis period in Table 3.

The statistically significant effect of the dummy *(DEVEL)* indicates that banks in developed countries are prone to higher profit inefficiency than those operating in developing countries. This result does not lend itself to a straightforward interpretation but it seems plausible to rationalize it by arguing that bank behaviour particularly in terms of excessive risk-taking may exacerbate the propensity of banks in developed countries to incur higher profit inefficiency. Moreover, banks in developed countries and in more developed financial systems may share a higher degree of co-dependence in default risk with other commercial banks around the world (for more on co-dependence see Anginer and Demirgüç-Kunt, 2014a), thus making them more susceptible to common exposure to economic, liquidity and information shocks that increase both the likelihood and hence the profit-(in)efficiency incidence of a crisis than banks operating in developing countries.

Other results show that financial development (*CLAIM*), market concentration (*CONC*) and *GDP* growth (*GDPGR*) contribute to improving profit efficiency, while higher inflation (*INFA*) reduces profit efficiency. These results are consistent with those of aforementioned previous studies.

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4.4. SFA robustness

In this section we investigate six additional issues that could influence our SFA results. First, whilst retaining *ZSCORE* as our main measure of bank risk, we also include *NPL/L* in the regression, thereby controlling for both measures of bank risk simultaneously. These new results are shown in column (1) of Table 7 (to be compared with those reported in Table 6). Second, we run regressions over the pre-crisis years (from 1999 to 2006) and post-crisis years (from 2007 to 2011). The results of this exercise are reported in columns (2) and (3). Third, in column (4), we use a Fourier Flexible (FF) profit function specification as an alternative to a standard profit function, implying the use of an alternative measure of (mean) profit inefficiency. Fourth, in column (5), we add to the baseline financial openness variables the *de facto FINOPEN* measure based on Kose et al. (2009) (*FINOPEN-Kose*). Fifth, in column (6), we replace *ZSCORE* with the *MES* measure of risk and also retain the *FINOPEN-Kose* variable. The sample size of this estimation is curtailed by the availability of *MES* data. Finally, in columns (7) and (8), the empirical results of the standard profit frontier model are replicated after splitting the sample into two groups of countries, developed and developing.[10] We performed the latter exercise also in order to interrogate the assumption that estimating a global (common) frontier with environmental factors and regulatory conditions can adequately cater for differences in technology (despite the inclusion of country group dummies). Thus, by estimating separate frontiers for the two groups of countries, we account explicitly for potential differences in technology across the developed and developing nations. To validate this distinction, we run a Chow-type likelihood-ratio test that demonstrated at the 1% significance level that the null hypothesis of no structural change can

[10] The division of the sample shows 591 banks from (31) developed countries and 1,207 banks from (102) developing countries, hence proportionally the sample reflects more banks from developed countries than from developing countries.

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be rejected and that it is, therefore, reasonable to split the sample into two sub-groups. The results unveil lower estimated coefficients in column (8) compared to those in column (7), implying that financial openness (as well as other variables) has a less pronounced effect on bank inefficiency in developing countries than in developed countries. This result is consistent with the earlier inference that banks in developed countries are more prone to higher profit inefficiency than in developing countries, although it should be noted that the earlier inference is based on the common frontier estimated for the entire sample while, by splitting the sample, we are now estimating two different frontiers.

So, what main conclusions can we draw from these robustness tests? With respect to the effect of financial openness and risk variables, the results can be said to hold when compared with the base results under a common frontier (Table 6), thus not altering the overall orientation of our conclusions. Significantly, the effects of financial openness and risk are consistent in the pre- and post-crises periods as well as in developed and developing countries, being positively associated with profit inefficiency. However, as the frontier changes with the change in sample size or specification, then inevitably some of the results are affected**.** In particular, the results of the *de facto FINOPEN-Kose* are only consistent in a reduced sample size and/or with the added effect of the base financial openness variables. Furthermore, the magnitude of this effect changes significantly with the inclusion of *MES* (column 6), becoming considerably larger compared to other financial openness variables, albeit in a reduced sample owing to data availability. One explanation for the significant change in the effects of *FINOPEN* (*de facto* as well as *de jure*) on profit inefficiency with the inclusion of *MES* is that when a predictor of a "tail event" in the market (i.e., of a firm loss if the overall market declines) is accounted for in the model, then the positive (negative) effect of *FINOPEN* on bank inefficiency (efficiency) changes considerably, with an increase in the case of the *de facto* measure (*FINOPEN-Kose*) from 0.0056 to 0.0980 and a decrease in the

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case of the *de jure* measure (*FINOPEN-Chinn-Ito*) from 0.1505 to 0.0439. This suggests that a *de facto FINOPEN* measure influences bank profit efficiency more significantly especially when the risk of a firm loss is linked to the risk of an overall market decline or systemic banking crisis, not bank risk *per se.* In general, however, the causal effect of the *de facto FINOPEN* on profit efficiency is less clear than that of the *de jure FINOPEN*. Kose et al. (2009) report some divergence across the findings of *de jure* and *de facto* measures of financial openness in their impact on total factor productivity (TFP) growth, and Quinn et al. (2011) too report systematic variations in output growth effects using these two types of measures.

Furthermore, though the earlier inference drawn for the effect of the dummy *(DEVEL)*, probably still applies under a common frontier using SFA, it no longer applies when the frontier changes with the change in sample size or specification. Specifically, the negative and statistically significant effect of *DEVEL* occurs in the following two cases: (i) under the reduced, pre-crisis sample 1999-2006 estimated using SFA; and (ii) under the full sample 1999-2011 estimated using the FF specification. The change in sign of *DEVEL* from negative to positive in pre- and post-crises periods, respectively, may be associated with the restructuring of the banking systems that developed countries have endured as a result of the crisis. In short, the only consequence of changing the sample size (under SFA) or the specification is the impact on *de facto* versus *de jure FINOPEN* and *DEVEL*, the rest of the results remain mostly consistent.

5. Conclusion

This paper investigates the impact of financial openness on bank profit efficiency by accounting for the endogenous role of bank risk. To the best of our knowledge, this is the first study that explicitly estimates the impact of financial openness on both, bank risk and profit

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efficiency in a cross-country setting by distinguishing between its direct influence and the effect that occurs through each of the two bank characteristics, efficiency and risk respectively. The study contributes to both, a better understanding of how financial openness affects the efficient operation of banks as well as bank risk and, given our investigation of the directional causality between the latter and bank profit efficiency, our knowledge of the channels through which the direct or indirect effects of financial openness are transmitted.

Using data for a large sample of 9,999 bank-year observations covering up to 140 countries over the period 1999-2011, we employ dynamic panel regressions to conduct Granger causality tests using system GMM estimation, complementing the analysis with SFA to estimate profit efficiency of banks while controlling for other variables and various country-specific and bank characteristics. The results can be summarized as follows: (a) Financial openness reduces bank profit efficiency directly, not through changes in bank risk; (b) Bank risk reduces bank profit efficiency regardless of financial openness; (c) Financial openness increases bank risk indirectly through the decreased bank profit efficiency.

Given our results, we can conclude that financial openness has a negative effect both in terms of bank risk and profit efficiency. Yet, caution should be exercised in taking this evidence to signify that the overall net effect of financial openness on the banking sector is harmful since there are potential benefits associated with financial openness owing to greater financial development that may counterbalance the negative effects we unveiled. These benefits, the analysis of which was beyond the scope of our study, include improvements in the quality and availability of financial services, opportunities to draw upon an international pool of resources, the spreading of new technologies leading to bank productivity improvements, enhanced risk management techniques, in addition to wider spillover effects expected to have a beneficial impact on the domestic economy. We attribute the negative effect of financial openness on profit efficiency to implicit costs, such as consolidation of

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banking operations, restructuring of bank portfolios, lack of risk management skills, and poor lending decisions, all of which may undermine bank profits and, in turn, induce banks to take on greater risk. In an increasingly globalized world, the policy implications that naturally flow from our findings call for greater prudential regulation and supervision with the aim of addressing the trade-off between financial liberalization and risk. Stricter capital requirements and monitoring could help constrain bankers' tendency to engage in higher risk-taking, while institutional reforms might foster better incentives for profitable investment opportunities to emerge from financial openness.

Two final caveats relating to our acknowledgement of limitations are in order. First, although as a test for robustness we account for the effect of banking crises using a dummy variable (which captures the year of inception of a crisis and the two following years), a more sophisticated investigation of how both temporary and/or permanent shocks to the variables in question may affect the intricate relationships among them is called for in order to gain a deeper understanding of the extent to which such breaks may be short-lived or bring permanent nonlinearities into play.

Second, studies wishing to extend our investigation may consider a deeper analytical treatment of the variables used as controls for the regulatory and supervisory environment so as to gauge the extent to which they counteract or exacerbate the impact of financial openness (and risk) on profit efficiency. Controlling for these measures allowed us to check whether the effects are, in fact, due to changes in financial openness or risk irrespective of the regulatory and supervisory environment. However, it could be of interest to examine further whether these regulatory characteristics make the effects more or less intense by including a number of interaction terms in the model.

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Appendix A. Description of variables

Variable	Description	Source
Financial Openness (*FINOPEN-Chinn-Ito*)	The Chinn-Ito index measures the degree of capital account openness. Construction is based on transactions from the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER). The index is scored 0-4 using dummy variables based on four major categories: (i) the presence of multiple exchange rates; (ii) restrictions on current account transactions; (iii) restrictions on capital account transactions; (iv) the requirement of the surrender of export proceeds. For each category, the index equals 1 when the restriction does not exist, otherwise 0. For the third category of the controls on capital transactions, the authors use the share of a five-year window and incorporate three transactions variables. Overall, the higher value of this index implies more openness of the countries' capital account transactions.	Chinn and Ito (2008). This paper uses the 2010 version of the database, available from: http://web.pdx.edu/~ito/Chinn-Ito_website.htm
Financial Freedom (*FINFREE*)	Financial freedom component of the Heritage index of Economic Freedom. This is a composite index representing: (i) the extent of government regulation of financial services; (ii) the degree of state intervention in banks and other financial services; (iii) the extent of financial and capital market development; (iv) the difficulty of opening and operating financial services firms (for both domestic and foreign individuals); and (v) government influence on the allocation of credit. On a scale of 0-100, a higher value of the index implies greater freedom.	The Heritage Foundation. Available from: http://www.heritage.org/index/
Foreign Ownership (*FOREIGN*)	The percentage share of foreign-owned banks among total number of banks in a country.	Barth et al. (2013a)

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Financial Openness (*FINOPEN-Kose*)	Gross stocks of foreign assets and liabilities over GDP, as defined by Kose et al. (2009) using the *External Wealth of Nations Database* constructed by Lane and Milesi-Ferretti (2007).	Updated and extended dataset available from: http://www.philiplane.org/EWN.html
Z-score (*ZSCORE*)	Indicator of bank soundness calculated as the natural logarithm of Z-score = $(ROA + E/A) / \sigma(ROA)$.	Authors' calculation using data from Bankscope
Non-performing Loans (*NPL/L*)	Ratio of non-performing loans over total loans as a proxy for credit risk.	Authors' calculation using data from Bankscope
Marginal Expected Shortfall (*MES*)	A measure of a financial institution's exposure to systemic risk as defined by Acharya et al. (2012).	Anginer and Demirgüç-Kunt (2014b)
Capital Requirements (*CAPR*)	Index of capital requirements, composed on the basis of answers to following questions: (1) Is the capital-asset ratio risk weighted in line with the Basel I guidelines? (2) Does the minimum capital-asset ratio vary as a function of an individual bank's credit risk? (3) Does the minimum capital-asset ratio vary as a function of market risk? (4) Before minimum capital adequacy is determined, which of the following are deducted from the book value of capital? Market value of loan losses not realized in accounting books? Unrealized losses in securities portfolios? Or unrealized foreign exchange losses? (5) What fraction of revaluation gains is allowed as part of capital? (6) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (7) Can the initial disbursement or subsequent injections of capital be done with assets	Barth et al. (2013a)

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	other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds? On a scale of 0-10, larger values of this index indicate more stringent capital regulation.	
Official Supervisory Power (*SUP*)	Index of official supervisory power, determined by adding 1 if answer is yes or 0 otherwise to each of these questions: (1) Does the supervisory agency have the right to meet with external auditors about banks? (2) Are auditors required to communicate directly to the supervisory agency about elicit activities, fraud, or insider abuse? (3) Can supervisors take legal action against external auditors for negligence? (4) Can the supervisory authority force a bank to change its internal organizational structure? (5) Are off-balance sheet items disclosed to supervisors? (6) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? (7) Can the supervisory agency suspend the directors' decision to distribute (a) dividends, (b) bonuses, and (c) management fees? (8) Can the supervisory agency supersede the rights of bank shareholders and declare a bank insolvent? (9) Can the supervisory agency suspend some or all ownership rights? (10) Can the supervisory agency (a) supersede shareholder rights, (b) remove and replace management, and (c) remove and replace director? The range of this index 0-14, with larger values indicating greater supervisory power.	Barth et al. (2013a)
Private Monitoring (*PRIM*)	Index of private monitoring, composed on the basis of: (1) whether bank directors and officials are legally liable for the accuracy of information disclosed to the public, (2) whether banks must publish consolidated accounts, (3) whether banks must be audited by certified international auditors, (4) whether 100 percent of the largest 10 banks are rated by international rating agencies, (5) whether off-balance sheet items are disclosed to the public, (6) whether banks must disclose their risk management procedures to	Barth et al. (2013a)

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	the public, (7) whether accrued, though unpaid interest/principal, enter the income statement while the loan is still non-performing, (8) whether subordinated debt is allowable as part of capital, and (9) whether there is no explicit deposit insurance system and no insurance was paid the last time a bank failed. On a scale of 0-12, higher values of this index indicate greater regulatory empowerment of the monitoring of banks by private investors.	
Activity Restrictions (*ACTR*)	Index of activity restrictions. The score for this variable is determined by the extent to which banks may engage in: (a) underwriting, brokering and dealing in securities, and all aspects of the mutual fund industry, (b) insurance underwriting and selling, and (c) real estate investment, development, and management. These activities can be unrestricted, permitted, restricted or prohibited, that are assigned the values 1-4 respectively. Higher values indicate greater restrictiveness.	Barth et al (2013a)
Concentration (*CONC*)	Concentration in the banking sector, calculated as the share of assets attributed to three largest banks from the total commercial banking assets in the country.	Beck, T., Demirgüç-Kunt, A (2006). 2010 version of database available from: http://econ.worldbank.org/
Asset Diversity (*ASSETDIV*)	A measure of diversification across different types of assets, computed by the formula: 1 - | (Net loans – Other Earning Assets) / Total Earning Assets |.	Authors' calculations using data from Bankscope
Income diversity (*INCMDIV*)	A measure of diversification across different sources of income, computed by the formula: 1- | (Net Interest Income – Other Operating Income) / Total Operating Income |.	Authors' calculations using data from Bankscope

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Size (*SIZE*)	Natural logarithm of total assets (in US dollars).	Authors' calculations using data from Bankscope
Financial Development (*CLAIM*)	The ratio of private credit by deposit money banks to GDP.	World Bank Global Financial Development Database
GDP Growth (*GDPGR*)	Real annual GDP growth rate.	Global Market Information Database
Inflation (*INFA*)	Inflation rate (annual % change of Average consumer price index).	Global Market Information Database
Banking Crises (*CRISIS*)	Systemic banking crises dummy, which takes the value 1 in the year that the crisis occurs in a country and for 2 years after, 0 otherwise.	Laeven and Valencia (2012)
Development *(DEVEL)*	Country dummy taking value 1 for developed, and 0 for developing.	IMF

Table 1
Summary statistics.

Variable	Number of Observations	Mean	Standard Deviation	Coefficient of Variation	Min	Max	P1	P99
Profit frontier variables								
ln(*PBT/W3*)	9,999	3.1046	2.3113	5.3423	-5.1299	11.2382	-1.0986	8.5524
ln(*P1/W3*)	9,999	-3.0421	1.1193	1.2529	-9.5131	1.5249	-6.3946	-0.6416

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ln(*P2/W3*)	9,999	-3.1157	1.4935	2.2304	-12.2518	3.0445	-7.4336	0.3112
ln(*W1/W3*)	9,999	-3.5221	1.2216	1.4922	-11.5626	1.8157	-7.0476	-0.9324
ln(*W2/W3*)	9,999	-4.5278	1.1826	1.3986	-12.6873	0.5431	-8.3998	-2.0279
ln(*EQ)*	9,999	5.4353	1.8539	3.4368	0.6931	11.9343	2.0787	10.1900
Inefficiency terms								
FINOPEN-Chinn-Ito	9,999	1.4774	2.1827	-1.8750	2.4218	-1.8750	2.4218	1.4774
FINFREE	9,961	56.9836	18.9968	360.9040	10.0000	90.0000	30.0000	90.0000
FOREIGN	9,999	41.7457	34.1186	1164.0791	0.0000	100.0000	0.0000	100.0000
NPL/L	9,999	5.4858	6.4828	42.0268	0.0300	45.1900	0.0700	32.5500
ZSCORE	9,712	2.9116	1.0649	1.1341	-4.1746	8.5048	0.1077	5.4058
CAPR	9,999	6.8564	1.6605	2.7573	1.0000	10.0000	3.0000	10.0000
SUP	9,999	11.0741	2.3249	5.4051	4.0000	16.0000	6.0000	16.0000
PRIM	9,999	8.1637	1.4386	2.0695	4.0000	11.0000	5.0000	11.0000
ACT	9,999	7.4948	2.1346	4.5566	3.0000	12.0000	3.0000	12.0000
CONC	9,999	58.8842	19.6965	387.9535	21.3973	100.0000	22.1537	100.0000
CLAIM	9,999	77.2850	54.3326	2952.0325	2.2071	315.4939	5.1712	225.8926
GDPG	9,999	2.6599	4.2560	18.1131	-16.5892	33.0305	-8.8356	12.5898
INFA	9,999	6.1562	7.2307	52.2836	-27.6317	142.4782	-3.6634	28.1119
DEVEL	9,999	0.3382	0.4731	0.2238	0.0000	1.0000	0.0000	1.0000
ASSETDIV	9,999	0.5842	0.2490	0.0620	0.0500	0.9927	0.0759	0.9855
SIZE	9,999	7.7960	2.0116	4.0465	3.9512	13.8945	4.2047	13.2589
INCMDIV	9,999	0.6138	0.2762	0.0763	0.0144	1.0000	0.0377	1.0000
CRISIS	9,999	0.0357	0.1856	0.0344	0.0000	1.0000	0.0000	1.0000
FINOPEN-Kose	9,999	3.2443	5.2603	27.6711	0.3374	75.7574	0.4621	22.1160
MES	6,373	0.0215	0.0169	0.0003	-0.1087	0.0927	-0.0113	0.0629

Note: Variables are defined in Appendix A. P1 and P99 refer to the 1% and 99% percentiles. We exclude all bank-level data that are below 1st and above 99th percentiles.

Table 2
Correlation coefficients of determinants of efficiency.

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Notes: Variables are defined in Appendix A. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. The sample period is 1999–2011. All

	FINOPEN -Chinn-Ito	*FINFREE*	*FOREIGN*	*FINOPEN - Kose*	*NPL/L*	*ZSCORE*	*MES*	*CAPR*	*SUP*	*PRIM*
FINOPEN - Chinn-Ito	1.0000									
FINFREE	0.6471***	1.0000								
FOREIGN	-0.0200**	-0.0207**	1.0000							
FINOPEN - Kose	0.3525***	0.4259***	-0.0609***	1.0000						
NPL/L	-0.1002***	-0.1255***	0.0393***	-0.0729***	1.0000					
ZSCORE	0.0676***	0.0895***	-0.0848***	0.1131***	-0.2368***	1.0000				
MES	-0.3261***	-0.2753***	0.0165	-0.1311***	0.0130	-0.1009***	1.0000			
CAPR	-0.1296***	-0.1811***	-0.1343***	-0.9998***	0.0702***	0.0443***	0.0989***	1.0000		
SUP	0.0457***	0.0178*	0.0015	-0.0262***	-0.0031	-0.0078	-0.2152***	0.1793***	1.0000	
PRIM	0.1609***	0.1715***	0.0715***	0.1063***	-0.0806***	-0.0388***	0.0494***	0.0443***	0.0793***	1.0000
ACTR	-0.2503***	-0.3979***	-0.0085	-0.3296***	-0.0329***	0.0128	0.0555***	0.1180***	0.1346***	0.0256**
CONC	0.2934***	0.3143***	0.0328***	0.2614***	0.0023	0.1144***	-0.3288***	-0.1474***	-0.0120	-0.0804***
CLAIM	0.3944***	0.4412***	-0.0216**	0.4871***	-0.1364***	0.2078***	-0.0813***	-0.0911***	-0.1144***	0.1848***
GDPGR	-0.3067***	-0.2811***	-0.0398***	-0.1231***	-0.1336***	0.0308***	0.0812***	0.0140	0.0510***	-0.0855***
INFA	-0.3617***	-0.4159***	0.0169*	-0.2125***	0.0327***	-0.1136***	0.1339***	0.0303***	0.0604***	-0.1240***
DEVEL	0.6214***	0.6245***	-0.0521***	0.3883***	-0.1701***	0.1477***	-0.1448***	-0.1583***	-0.1273***	0.1923***
ASSETDIV	-0.1269***	-0.1368***	-0.0183*	-0.0314***	0.0038	-0.0327***	0.0112	0.0412***	-0.0100	0.0423***
SIZE	0.0002***	0.1155***	0.0395***	0.1408***	-0.1503***	0.0293***	0.1136***	0.0630***	-0.1276***	0.2255***
INCMDIV	0.0514***	0.0288***	0.0036	-0.0303***	-0.0114	0.1211***	-0.0933***	-0.0441***	0.0538***	-0.0079
CRISIS	0.1343***	0.1579***	-0.0174*	0.0691***	-0.0148	-0.0022	0.0771***	0.0094	-0.0319***	0.0425***

	ACTR	*CONC*	*CLAIM*	*GDPGR*	*INFA*	*DEVEL*	*ASSETDIV*	*SIZE*	*INCMDIV*	*CRISIS*
ACTR	1									
CONC	-0.1681***	1.0000								
CLAIM	-0.3258***	0.2701***	1.0000							
GDPGR	0.1456***	-0.1058***	-0.1618***	1.0000						
INFA	0.1553***	-0.1480***	-0.3675***	0.2357***	1.0000					
DEVEL	-0.3355***	0.2287***	0.6774***	-0.2776***	-0.4252***	1.0000				
ASSETDIV	0.0903***	-0.0587***	-0.0767***	0.0910***	0.0518***	-0.1604***	1.0000			
SIZE	-0.0721***	0.0000	0.3381***	-0.0376***	-0.1583***	0.2832***	0.0979***	1.0000		
INCMDIV	0.0169*	0.0589***	-0.0912***	0.0204**	-0.0272***	-0.0409***	-0.0895***	-0.1344***	1.0000	
CRISIS	-0.0813***	0.0358***	0.1619***	-0.1384***	-0.0636***	0.1969***	-0.0748***	0.0423***	-0.0588***	1.0000

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pairwise correlations are calculated using the maximum number of observations available in the sample.

Table 3

Profit efficiency estimates.

All Sample				Developed				Developing			
Year	Obs.	Mean	Std. Dev	Year	Obs.	Mean	Std. Dev	Year	Obs.	Mean	Std. Dev
1999	234	0.5788	0.1999	1999	74	0.5658	0.1854	1999	160	0.5849	0.2066

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2000	330	0.4983	0.2247	2000	102	0.4892	0.2166	2000	228	0.5024	0.2286
2001	349	0.4705	0.2244	2001	108	0.4320	0.1929	2001	241	0.4878	0.2355
2002	354	0.5025	0.2249	2002	101	0.4617	0.2107	2002	253	0.5187	0.2288
2003	459	0.5239	0.2219	2003	135	0.5037	0.1872	2003	324	0.5324	0.2346
2004	596	0.5302	0.2159	2004	207	0.5318	0.2000	2004	389	0.5294	0.2241
2005	738	0.5788	0.2039	2005	297	0.5898	0.1958	2005	441	0.5713	0.2092
2006	865	0.5886	0.2040	2006	331	0.5979	0.1971	2006	534	0.5827	0.2081
2007	1,006	0.5778	0.1995	2007	357	0.5759	0.2015	2007	649	0.5789	0.1985
2008	1,116	0.4847	0.2214	2008	374	0.4297	0.2246	2008	742	0.5125	0.2147
2009	1,209	0.4423	0.2283	2009	414	0.4170	0.2218	2009	795	0.4555	0.2306
2010	1,255	0.4908	0.2301	2010	408	0.4745	0.2300	2010	847	0.4987	0.2299
2011	1,450	0.5017	0.2256	2011	474	0.4735	0.2224	2011	976	0.5153	0.2260
Total	9,961	0.5155	0.2236	Total	3,382	0.5006	0.2212	Total	6,579	0.5232	0.2245

Note: The table presents profit efficiency scores averaged by group and year. Estimation is based on main analysis in Table 4 using the Battese and Coelli (1995) model.

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Table 4

Granger causality for the relationship between financial openness, risk and profit efficiency.

	(1)		(2)
Panel A: Dependent Variable is Profit Efficiency (PE)			
	PE		*PE*
L.PE	0.4980***	*L.PE*	0.5120***
	(10.3728)		(11.0382)
L2.PE	0.0824*	*L2.PE*	0.0910**
	(1.9345)		(2.1960)
L.FINOPEN	0.1565*	*L.FINFREE*	-0.0000
	(1.7627)		(-0.1441)
L2.FINOPEN	-0.1607*	*L2.FINFREE*	-0.0007**
	(-1.8748)		(-2.2995)
Σ(FINOPEN)	-0.0042***	*Σ(FINFREE)*	-0.0007***
Prob > χ^2	0.0002	Prob > χ^2	0.0000
LR (FINOPEN→PE)	-0.0100	*LR (FINFREE→PE)*	-0.0012
L.ZSCORE	0.0571***	*L.ZSCORE*	0.0505***
	(3.3520)		(3.1098)
L2.ZSCORE	-0.0054	*L2.ZSCORE*	-0.0015
	(-0.3264)		(-0.0895)
Σ(ZSCORE)	0.0463***	*Σ(ZSCORE)*	0.0520***
Prob > χ^2	0.0031	Prob > χ^2	0.0072
LR (ZSCORE→PE)	0.1103	*LR (ZSCORE→PE)*	0.1310
Year dummies	Yes	Year dummies	Yes
AR(1) p-value	0.0000	AR(1) p-value	0.0000
AR(2) p-value	0.9640	AR(2) p-value	0.3320
Hansen p-value	0.4550	Hansen p-value	0.3080
Banks	1,811	Banks	1,798
Countries	138	Countries	133
N	5,748	*N*	5,743
Panel B: Dependent Variable is Risk (Z-score)			
	ZSCORE		*ZSCORE*
L.ZSCORE	0.7801***	*L.ZSCORE*	0.9087***
	(27.5443)		(6.6703)
L2.ZSCORE	0.1218***	*L2.ZSCORE*	-0.0080
	(4.2394)		(-0.0745)
L.PE	0.1278**	*L.PE*	0.1256**
	(2.3975)		(2.3648)
L2.PE	-0.0656	*L2.PE*	-0.1045*
	(-1.2830)		(-1.8626)
Σ(PE)	0.0622*	*Σ(PE)*	0.0211***
Prob > χ^2	0.0973	Prob > χ^2	0.0028
LR (PE→ZSCORE)	0.6340	*LR (PE→ZSCORE)*	0.2125

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L.FINOPEN	0.0138	*L.FINFREE*	0.0007
	(1.2560)		(1.2949)
L2.FINOPEN	-0.0116	*L2.FINFREE*	-0.0003
	(-1.0800)		(-0.6031)
Σ(FINOPEN)	0.0022	*Σ(FINFREE)*	0.0004
Prob > χ^2	0.4372	Prob > χ^2	0.1924
LR (FINOPEN→ZSCORE)	0.0224	*LR* (*FINFREE→ZSCORE*)	0.0040
Year dummies	Yes	Year dummies	Yes
AR(1) p-value	0.0000	AR(1) p-value	0.0510
AR(2) p-value	0.8120	AR(2) p-value	0.4900
Hansen p-value	0.4220	Hansen p-value	0.3470
Banks	1,811	Banks	1,798
Countries	138	Countries	133
N	5,723	*N*	5,728

Note: The dependent variable in Panel A is profit efficiency (*PE*). The dependent variable in Panel B is Z-score (*ZSCORE*) as a proxy of insolvency risk. *ZSCORE* is the natural logarithm of Z-score. *FINOPEN* measures the degree of capital account openness (Chinn and Ito, 2008). *FINFREE* is the financial freedom index of Heritage Foundation. The variables are defined in Appendix A. All models are estimated using the ARDL dynamic panel system with two lags. *L* and *L2* are abbreviations to denote the first and second lags of the respective variables. *Σ* denotes the sum of these lag effects. *LR* denotes the long-run effect of a unit change in the causal variable on the dependent variable. *N* denotes the number of bank-year observations. GMM estimates with t-statistics (in parenthesis) using robust standard errors are reported. Year dummies are included in all models. Country dummies are accounted for in the GMM estimation. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. AR(1) and AR(2) are Arellano-Bond autocorrelation tests with a null of no serial correlation. All equations include GMM-type instruments (lags). Hansen is a test of over-identifying restrictions in the two-equation system, which requires a value lower than 0.05 to reject the null hypothesis (of valid instruments) at the 5% level.

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Table 5

Granger causality for the relationship between financial openness, risk and profit efficiency.

	(1)		(2)
Panel A: Dependent Variable is Profit Efficiency (PE)			
	PE		*PE*
L.PE	0.5086***	*L.PE*	0.5115***
	(10.9869)		(12.2695)
L2.PE	0.1137**	*L2.PE*	0.1046***
	(2.5625)		(2.7305)
L.FINOPEN	0.0002	*L.FINFREE*	-0.0001
	(0.0266)		(-0.2964)
L2.FINOPEN	-0.0109	*L2.FINFREE*	-0.0006**
	(-1.4482)		(-2.0197)
Σ(FINOPEN)	-0.0107***	*Σ(FINFREE)*	-0.0007***
Prob > χ^2	0.0000	Prob > χ^2	0.0001
LR (FINOPEN→PE)	-0.0283	*LR (FINFREE→PE)*	-0.0018
L.NPL/L	-0.0045***	*L.NPL/L*	-0.0035***
	(-3.7632)		(-2.9845)
L2.NPL/L	-0.0005	*L2.NPL/L*	0.0001
	(-0.5151)		(0.1377)
Σ(NPL/L)	-0.0050***	*Σ(NPL/L)*	-0.0036**
Prob > χ^2	0.0008	Prob > χ^2	0.0111
LR (NPL/L→PE)	-0.0132	*LR (NPL/L→PE)*	-0.0094
Year dummies	Yes	Year dummies	Yes
AR(1) p-value	0.0000	AR(1) p-value	0.0000
AR(2) p-value	0.2580	AR(2) p-value	0.3190
Hansen p-value	0.1170	Hansen p-value	0.4230
Banks	2,007	Banks	1,994
Countries	140	Countries	135
N	5,978	*N*	5,972
Panel B: Dependent Variable is Risk (NPL/L)			
	NPL/L		*NPL/L*
L.NPL/L	0.7367***	*L.NPL/L*	0.7398***
	(2.5792)		(2.6481)
L2.NPL/L	-0.0619	*L2.NPL/L*	-0.0723
	(-0.3251)		(-0.3887)
L.PE	-4.7859***	*L.PE*	-4.8993***
	(-2.9325)		(-3.0364)
L2.PE	-2.2581***	*L2.PE*	-2.2880***
	(-2.7393)		(-2.7318)
Σ(PE)	-7.0440***	*Σ(PE)*	-7.1873**
Prob > χ^2	0.0075	Prob > χ2	0.0062

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LR (PE→NPL/L)	-21.6605	*LR (PE→NPL/L)*	-21.6159
L.FINOPEN	0.0397	*L.FINFREE*	-0.0187**
	(0.2140)		(-2.2143)
L2.FINOPEN	-0.1266	*L2.FINFREE*	0.0084
	(-0.6128)		(1.0588)
Σ(FINOPEN)	-0.0869	*Σ(FINFREE)*	-0.0103*
Prob > χ^2	0.4772	Prob > χ2	0.0599
LR (FINOPEN→NPL/L)	-0.2672	*LR (FINFREE→NPL/L)*	-0.0310
Year dummies	Yes	Year dummies	Yes
AR(1) p-value	0.0090	AR(1) p-value	0.0960
AR(2) p-value	0.7610	AR(2) p-value	0.7510
Hansen p-value	0.2340	Hansen p-value	0.2840
Banks	2,007	Banks	1,994
Countries	140	Countries	135
N	5,978	*N*	5,972

Note: The dependent variable in Panel A is profit efficiency (*PE*). The dependent variable in Panel B is the ratio of non-performing loans over total loans (*NPL/L*) as a proxy of credit risk. *FINOPEN* measures the degree of capital account openness (Chinn and Ito, 2008). *FINFREE* is the financial freedom index of Heritage Foundation. The variables are defined in Appendix A. All models are estimated using the ARDL dynamic panel system with two lags. *L* and *L2* are abbreviations to denote the first and second lags of the respective variables. *Σ* denotes the sum of these lag effects. *LR* denotes the long-run effect of a unit change in the causal variable on the dependent variable. *N* denotes the number of bank-year observations. GMM estimates with t-statistics (in parenthesis) using robust standard errors are reported. Year dummies are included in all models. Country dummies are accounted for in the GMM estimation. *, **, *** denote significance at the 10%, 5% and 1% level, respectively. AR(1) and AR(2) are Arellano-Bond autocorrelation tests with a null of no serial correlation. All equations include GMM-type instruments (lags). Hansen is a test of over-identifying restrictions in the two-equation system, which requires a value lower than 0.05 to reject the null hypothesis (of valid instruments) at the 5% level.

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Table 6

Determinants of bank mean profit inefficiency: SFA base results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FINOPEN	0.1193***			0.1063***	0.1417***			0.1419***
- Chinn-Ito	(4.9630)			(3.9356)	(5.2821)			(4.8896)
FINFREE		0.0034***		0.0046***		0.0058***		0.0022***
		(4.0825)		(2.2069)		(2.8985)		(1.0549)
FOREIGN			0.0072***	0.0036***			0.0041***	0.0044***
			(3.5881)	(4.3049)			(4.6255)	(4.8061)
NPL/L	0.0420***	0.0436***	0.0442***	0.0431***				
	(12.2097)	(9.4129)	(9.4426)	(9.4049)				
ZSCORE					-0.0976***	-0.1029***	-0.0978***	-0.0891***
					-(3.7060)	-(3.8170)	-(3.6034)	-(3.3607)
CAPR	-0.0875***	-0.0860***	-0.0867***	-0.0751***	-0.0710***	-0.0709***	-0.0644***	-0.0566***
	-(5.4108)	-(4.6775)	-(4.6973)	-(4.2604)	-(4.0527)	-(3.9726)	-(3.6302)	-(3.1601)
SUP	0.0723***	0.0815***	0.0753***	0.0718***	0.0808***	0.0860***	0.0909***	0.0821***
	(6.1316)	(6.3835)	(5.7998)	(5.7045)	(6.0505)	(6.2607)	(6.8015)	(6.1173)
PRIM	-0.0225***	-0.0240***	-0.0255***	-0.0358***	-0.0374***	-0.0368***	-0.0388***	-0.0479***
	-(1.1443)	-(1.1991)	-(1.2898)	-(1.8261)	-(1.8327)	-(1.8098)	-(1.9265)	-(2.3455)
ACTR	-0.1647***	-0.1738***	-0.1617***	-0.1615***	-0.1975***	-0.1978***	-0.2062***	-0.1984***
	-(11.2587)	-(8.6127)	-(8.0800)	-(8.1237)	-(8.7042)	-(8.4676)	-(8.9537)	-(8.6297)
CONC	-0.0140***	-0.0134***	-0.0139***	-0.0144***	-0.0154***	-0.0149***	-0.0144***	-0.0155***
	-(9.7245)	-(7.4815)	-(7.6159)	-(7.8233)	-(7.4786)	-(7.4840)	-(7.2497)	-(7.6897)
CLAIM	-0.0017***	-0.0019***	-0.0020***	-0.0017***	-0.0014***	-0.0018***	-0.0017***	-0.0014***
	-(2.4954)	-(2.6388)	-(2.9265)	-(2.5387)	-(1.8827)	-(2.4613)	-(2.2344)	-(2.0078)
GDPGR	-0.0624***	-0.0703***	-0.0675***	-0.0615***	-0.0850***	-0.0934***	-0.0947***	-0.0858***
	-(8.2215)	-(7.7840)	-(7.4764)	-(7.0861)	-(8.5503)	-(8.6237)	-(8.9906)	-(8.3049)
INFA	0.0097***	0.0067***	0.0100***	0.0122***	0.0122***	0.0112***	0.0081***	0.0141***
	(2.7101)	(1.8585)	(2.5686)	(3.0568)	(3.0008)	(2.5552)	(1.9663)	(3.1432)
ASSETDIV	-1.1700***	-1.2166***	-1.2091***	-1.1704***	-1.3716***	-1.4200***	-1.4162***	-1.3598***

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	-(10.6821)	-(8.4875)	-(8.4196)	-(8.3406)	-(8.5578)	-(8.6147)	-(8.6747)	-(8.4895)
SIZE	-0.2978***	-0.3000***	-0.2903***	-0.2978***	-0.3607***	-0.3567***	-0.3662***	-0.3658***
	-(13.0052)	-(12.6093)	-(12.2787)	-(12.6362)	-(13.6238)	-(12.7590)	-(13.4824)	-(13.4573)
INCMDIV	-0.5319***	-0.5314***	-0.5427***	-0.5444***	-0.6239***	-0.6302***	-0.6203***	-0.6417***
	-(5.6467)	-(5.3142)	-(5.2773)	-(5.4379)	-(5.7055)	-(5.7186)	-(5.8349)	-(5.8567)
DEVEL	0.2593***	0.5159***	0.3209***	0.2657***	0.0301***	0.1448***	0.3288***	0.0695***
	(2.5418)	(5.2765)	(3.1536)	(2.6094)	(0.3007)	(1.4191)	(3.4433)	(0.6788)
CRISIS	0.2817***	0.2732***	0.2496***	0.2659***	0.4473***	0.4117***	0.4236***	0.4319***
	(2.2739)	(2.1958)	(1.9970)	(2.1485)	(3.4983)	(3.2104)	(3.3013)	(3.3715)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-Likelihood	-11,512	-11,477	-11,516	-11,459	-11,074	-11,042	-11,078	-11,021
LR-tests	2,360.3***	2,333.2***	2,352.2***	2,369.8***	2,246.4***	2,212.7***	2,238.5***	2,254***
Banks	2,007	1,994	2,007	1,994	1,811	1,798	1,811	1,798
Countries	140	135	140	135	138	133	138	133
N	9,999	9,961	9,999	9,961	9,751	9,712	9,751	9,712

Note: Variables are defined in Appendix A. In the first four columns, (1), (2), (3) and (4), we use the ratio of non-performing loans over total loans (*NPL/L*) as a proxy for credit risk. In columns (5), (6), (7) and (8), we use the logarithm of Z-score (*ZSCORE*) as (inverse) proxy for insolvency risk. All equations include year dummies. Z-statistics are reported in parentheses. *N* denotes the number of bank-year observations. The estimated coefficients reported in this Table were obtained simultaneously with the parameter estimates of the stochastic frontier using the Battese and Coelli (1995) model. The estimates give the effect of the ‘‘z-environmental’’ variables on mean profit inefficiency. The LR-tests indicate that the overall mean (in)efficiency term has a statistically significant impact on the model. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

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Table 7
Determinants of bank mean profit inefficiency: SFA robustness.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FINOPEN	0.1235***	0.2208***	0.0752***	0.1425***	0.1505***	0.0439***	0.2936***	0.0456***
- Chinn-Ito	(4.5559)	(4.8148)	(2.0469)	(4.9114)	(5.1648)	(0.0481)	(0.8409)	(1.9673)
FINFREE	0.0043***	0.0010***	0.0037***	0.0057***	0.0047***	0.0129***	0.0664***	0.0075***
	(2.0903)	(0.3911)	(1.1506)	(5.7834)	(2.1368)	(0.0035)	(2.8718)	(3.5014)
FOREIGN	0.0036***	0.0037***	0.0057***	0.0047***	0.0038***	0.0054***	0.0154***	0.0013***
	(4.3371)	(2.8185)	(4.0100)	(2.0108)	(4.3217)	(0.0014)	(2.7975)	(1.6156)
FINOPEN					0.0056***	0.0980***		
- Kose					(4.8483)	(0.0193)		
ZSCORE	-0.0048***	-0.0746***	-0.1039***	-0.1707***	-0.0855***		-0.1062***	-0.0685***
	-(0.1910)	-(1.8818)	-(2.7837)	-(5.8743)	-(2.4189)		-(1.6244)	-(2.6280)
NPL/L	0.0456***							
	(9.8819)							
MES						0.1625***		
						(4.8911)		
CAPR	-0.0701***	-0.1452***	0.0106	-0.0476***	-0.0576***	-0.1318***	-0.0955	-0.0134
	-(4.0389)	-(4.3846)	(0.4547)	-(2.5167)	-(3.2513)	-(4.4118)	-(1.4565)	-(0.8269)
SUP	0.0726***	0.0242***	0.0996***	0.1076	0.0781***	0.1076	0.2679***	0.0472***
	(5.8192)	(1.2840)	(4.9226)	(7.3245)	(5.8732)	(5.7316)	(2.8443)	(4.0255)
PRIM	-0.0358***	-0.0754***	-0.0250	-0.0096	-0.0390***	0.0426	0.4203	-0.0343
	-(1.8093)	-(2.1736)	-(0.9452)	-(0.4629)	-(1.9551)	(1.3603)	(2.6606)	-(1.7473)
ACTR	-0.1619***	-0.1767***	-0.2495***	-0.2380***	-0.2094***	-0.3041***	-0.7526***	-0.1003***
	-(8.4123)	-(5.3323)	-(5.9359)	-(8.6845)	-(8.7207)	-(6.6472)	-(2.8276)	-(5.8433)
CONC	-0.0149***	-0.0203***	-0.0117***	-0.0174***	-0.0144***	-0.0019	-0.0679***	-0.0064***
	-(8.1573)	-(5.8915)	-(4.2142)	-(8.0223)	-(7.5097)	-(0.8351)	-(2.6944)	-(4.5132)
CLAIM	-0.0015***	0.0009	-0.0035***	-0.0039	0.0003	-0.0050	-0.0031	-0.0027***
	-(2.1941)	(0.6814)	-(3.4367)	-(4.9931)	(0.3921)	-(4.0313)	-(1.2951)	-(2.7305)
GDPGR	-0.0623***	-0.0906***	-0.0682***	-0.0903***	-0.0829***	-0.0944***	-0.8513***	-0.0364***
	-(7.2965)	-(5.1403)	-(5.2029)	-(8.2853)	-(8.0056)	-(6.2415)	-(2.9706)	-(5.0406)

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INFA	0.0142***	0.0236***	0.0108***	0.0174***	0.0153***	0.0116***	-0.2819***	0.0100***
	(3.5122)	(3.6489)	(1.9005)	(3.8814)	(3.3522)	(1.7179)	-(2.3183)	(2.8108)
ASSETDIV	-1.1863***	-1.4536***	-1.3655***	-1.4196***	-1.2761***	-1.2674***	-3.1746***	-0.6842***
	-(8.5522)	-(5.7590)	-(5.8726)	-(8.2971)	-(8.3300)	-(6.1300)	-(2.7701)	-(5.2920)
SIZE	-0.3062***	-0.3759	-0.3709***	-0.3378***	-0.3631***	-0.3193	-0.4740***	-0.3561
	-(12.6235)	-(8.5171)	-(10.6488)	-(12.1902)	-(13.2636)	-(10.5894)	-(2.6263)	-(14.2232)
INCMDIV	-0.5592***	-1.0198***	-0.3663***	-0.3437***	-0.6439***	-0.5432***	-3.9097***	-0.2121***
	-(5.4732)	-(5.4458)	-(2.6271)	-(3.1987)	-(5.9355)	-(4.0210)	-(2.8491)	-(2.0301)
DEVEL	0.1962***	-0.7568***	0.4577***	-0.1888***	0.0498***	0.1723***		
	(1.9424)	-(3.5068)	(3.1130)	-(2.2057)	(0.4793)	1.0193		
CRISIS	0.3392***	0.7884***	0.2996***	0.5186***	0.4065***	0.3129***	1.4577***	0.2542***
	(2.7394)	(2.5385)	(1.9551)	(3.5604)	(3.1982)	(2.0262)	(2.5402)	(1.2428)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log-	-10,945	-4,055.6	-6,729.3	-10,930	-11,006	-7,562.2	-3,771.3	-6,941.5
LR-tests	2,406***	802.2***	1,388***	2,157.9***	2,283.9***	1,645.5***	805.98***	1,650.9***
Banks	1,798	1,089	1,676	1,798	1,798	1,374	591	1,207
Countries	133	112	130	133	133	58	31	102
N	9,712	3,879	5,833	9,712	9,712	6,373	3,313	6,399
LR-type							LR chi2(56) = 530.54	LR chi2(56) = 578.42
Prob > chi2							0.0000	0.0000

Note: Variables are defined in Appendix A. Column (1) reports the estimation results while controlling for both *NPL/L* and *ZSCORE*; Column (2) reports the estimation results for pre-crisis sub-period 1999 to 2006, and column (3) for the post-crisis sub-period 2007 to 2011. Column (4) reports the results using Fourier Flexible (FF) functional form specification to derive profit inefficiency scores. Column (5) adds the *de facto* financial openness variable calculated by Kose et al. (2009), which is based on the External Wealth of Nations Database constructed by Lane and Milesi-Ferretti (2007). Column (6) replaces *ZSCORE* with the country-level marginal expected shortfall, *MES* (Acharya et al., 2012) as a proxy for systemic risk – this variable is scaled by a factor of 100. Columns (7) and (8) report results for the sample of banks in 31 developed and 102 developing countries respectively. *N* denotes the number of bank-year observations. All equations include year dummies. Z-statistics are reported in parentheses. The estimated coefficients reported in this Table were obtained simultaneously with the parameter estimates of the stochastic frontier using the Battese and Coelli (1995) model. The estimates give the effect of the ‘‘z-environmental’’ variables on mean profit inefficiency. The LR-tests indicate that the overall mean (in)efficiency term has a statistically significant impact on the model. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.