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How consistent are measures of financial liberalization in assessing its impact on bank cost efficiency? A cross–country empirical analysis

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Abstract

Using a sample of commercial bank–year observations covering 104 countries over the 1999–2017 period, we consider five contemporary *de jure* and *de facto* indicators of financial liberalization to provide a comparative assessment of their impact on bank cost efficiency. With the sole exception of one *de jure* index, all other financial liberalization measures consistently indicate an improvement in cost efficiency. We also compare the effects before and after the 2007 global financial crisis, which instigated a policy shift from deregulation to prudential re–regulation. We find that prudential re–regulation did not detrimentally affect bank cost efficiency. Our results for the main financial liberalization measures hold irrespective of countries' stage of economic development and prove robust to re–estimations based on a single-country efficiency frontier for the US, alternative model specifications and methodologies that account for endogeneity and cross section dependence. The key policy implication from our findings is that prudential policies aimed at fostering stability and less bank risk–taking, can be pursued without any risks of hindering financial intermediation and lowering bank cost efficiency.

Keywords Financial liberalization · Prudential re–regulation · Financial openness · Financial integration · Bank cost efficiency

JEL classification G21 · G28 · D24 · C49 · F36

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1 Introduction

How has the banking sector worldwide reacted to financial liberalization in terms of bank cost efficiency levels? Answering this question requires not only an understanding of the theoretical channels through which financial liberalization influences bank cost efficiency but also a comprehensive empirical assessment of its impact using reliable measures of financial liberalization or openness.[1]There is no consensus on how to best measure financial liberalization, and different indicators can be said to capture different dimensions of this multifaceted construct. Nevertheless, empirical studies on the liberalization–bank cost efficiency nexus tend to neglect the rather nebulous issue of measurement, often choosing a single measure of financial openness without a cogent rationale for the choice or an in–depth analysis of the consistency (or otherwise) of the results obtained *vis–à–vis* those that would be produced using alternative indicators. Quinn et al. (2011) too, highlight the problem. They conduct a comprehensive assessment of several indicators used in past research investigating the link between financial openness or integration and economic growth and find that *de jure vs. de facto* indicators yield systematically different growth results.

Research linking financial liberalization with bank cost efficiency has been conducted at both individual country and cross–country levels. While single–country studies have implicitly employed time–dependent measures of liberalization associating bank efficiency with episodes of economic or financial deregulation, multi–country studies have tended to rely on specific indices reflecting country–level differences in the liberalization reforms. A prominent feature among past studies has been to examine how the foreign ownership of banks in the domestic economy affects the efficiency of the host banking system (e.g., Levine 2001; Claessens and Van Horen 2013), or to compare the relative efficiency of domestic *vis–à–vis* foreign banks under liberalization (e.g., Havrylchyk 2006; Berger 2007). Recent research on bank efficiency has also used contemporary measures of financial freedom or openness as explanatory variables in regressions (e.g., Chortareas et al. 2013; Luo et al. 2016). However, comparatively limited research exists at cross–country level on the liberalization–bank cost efficiency nexus, and the existing results are mixed. Moreover, it is still unclear how dependent the results obtained to date are to the specificities of the measures employed to proxy financial liberalization, leaving a glaring gap on a systematic evaluation of the suitability of alternative measures (which include both domestic and international dimensions of liberalization along with *de jure* and *de facto* indicators of capital account openness) in application to the empirical assessment of the impact of financial liberalization on bank cost efficiency.

We contribute to this literature by shedding light on the implications of choosing one financial liberalization measure over others and showing whether and how results on bank cost efficiency vary when different measures are used. In our analysis based on a large sample of commercial banks covering 104 countries over the

[1] Like several studies in the efficiency literature, we focus on cost efficiency rather than more general metrics of profitability or profit efficiency since in the aftermath of the global financial crisis, cost optimization and achieving high cost efficiency, have become paramount for the ability of commercial banks and other financial institutions to compete and survive (see Chortareas et al. 2013, 2016).

1999–2017 period, we consider five contemporary indicators of financial liberalization, three policy based measures (the Heritage Foundation financial freedom index, and the *de jure* financial openness indices by Chinn and Ito 2008; and Fernández et al. 2016), and two outcome-based (*de facto*) measures (foreign bank presence, and Lane and Milesi–Ferretti's financial integration index). Alongside our focal analysis of the effects of different liberalization indicators on bank cost efficiency, we test whether such effects differ across countries' levels of economic development, and before and after the 2007 global financial crisis which instigated a policy shift from deregulation to prudential re–regulation associated with Basel II and III. Using stochastic frontier analysis (SFA) to estimate bank cost efficiency, we specify a translog cost function to represent a global frontier, and an inefficiency (one-step) model based on Battese and Coelli (1995) to simultaneously control for time–varying inefficiency, unobserved banks' heterogeneity and a range of bank– and country–level influences.

We show that with the sole exception of Fernández et al.'s (2016) index of financial integration, all other liberalization measures consistently indicate a significant improvement in bank cost efficiency. We also find that during the post–crisis period, prudential re–regulation did not detrimentally affect bank cost efficiency. Hence, contrary to the generally held view, this finding suggests that prudential re–regulation policies aimed at fostering financial stability may be pursued without any risks of lowering bank cost efficiency. Our comparative evaluation of alternative liberalization measures leads us to give less credence to the results obtained from Fernández et al.'s (2016) index, which is judged to perform sub-optimally in the context of banking sector liberalization, at least insofar as its effect on bank cost efficiency is concerned. We now make this point even more explicit in the paper. Significantly, the fact we find such consistent results across measures of financial liberalization (with the sole exception of the Fernández et al.'s 2016 index) adds, especially given Quinn et al.'s (2011) considerations, considerable weight to the validity and robustness of our findings on the impact of liberalization (and prudential re-regulation) on bank cost efficiency.

The next section provides a critical synthesis of related literature. Section 3 discusses the methodology. Section 4 presents the data and discusses the results. Section 5 concludes.

2 A critical review

2.1 Defining and measuring financial liberalization

Financial liberalization – broadly defined as a multifaceted process involving the opening up of domestic financial markets to competition and foreign capital that allows market forces rather than governments to determine financial outcomes – can be seen as a phenomenon gaining impetus in the early 1980s in response to the abysmal performance of the financial repression that prevailed in the 1970s and 1980s, pervasively so in developing countries.

Under financial repression, the explicit or indirect capping of interest rates on government debt and private deposits alike, along with government restrictions on the

transfer of assets abroad via capital controls, discouraged the mobilization of finance. As emphasized by McKinnon (1973) and Shaw (1973), the limited mobilization and inefficient allocation of financial resources (also due to the government control of domestic banks and barriers limiting entry by foreign institutions), slowed economic growth. The repressed systems carried high costs, with state and development banks frequently requiring recapitalization and bailouts by governments. Financial liberalization was also a reaction to wider pressures exerted on repressed financial systems by the advent of globalization, fueled by the growth of international trade, greater international travel and migration flows, and better communications.

The process of financial reforms that began in the 1980s went well beyond the elimination of interest rate controls and other government restrictions called for by the Washington Consensus. To different extents, governments in many countries also allowed the use of foreign currency instruments and opened capital accounts. Following the approach employed by Beim and Calomiris (2001) in defining financial liberalization, other characteristics of liberalization based on the progressive "constraint relaxation" (2001, p. 119) of the measures that epitomized financial repression, include: the lowering of bank reserve requirements; the reduction of government interference in banks' lending decisions; the facilitation and encouragement of capital inflows; the privatization of nationalized banks and the removal of restrictions on bank ownership; allowing banks to pursue profits unhindered by government directives; and the freedom of finance/capital to move across borders, which also entails the full convertibility of the currency.

Historically, these operational reforms and policy measures (which include a domestic component, the banking sector and capital markets, and an international component, pertaining primarily to the capital account) were not necessarily implemented simultaneously. In some countries, governments opted for an opening of the capital account to attract foreign capital whilst maintaining the domestic banking sector and equity markets closed off to foreign participation while in other countries a unique mixture of liberalization measures were implemented over time, following different sequences and strategies.

The multifaceted make up of financial liberalization, is reflected in a multitude of measures used in applied work on the effects on various economic variables (such as growth, growth volatility, productivity and crisis incidence). Each of these measures draws on different liberalization dimensions. To elucidate on the arduous task of measuring financial liberalization, we classify such measures into three broad categories: (a) Measures focusing on banking sector liberalization including foreign bank presence and financial freedom (largely domestic); (b) Financial openness (or capital account liberalization) measures, comprising *de jure* and *de facto* indices; and (c) Measures of equity market liberalization.

Starting with banking sector liberalization, it has typically been proxied by foreign bank presence, commonly measured by the percentage of foreign–owned banks operating in the domestic market (Barth et al. 2013), with a bank defined as 'foreign' if it has at least 50% foreign ownership. This is not a holistic measure, but one that precisely because of its bank specificity may better reflect the liberalization dimension affecting the banking sector.

Financial Freedom is a broader indicator of financial liberalization albeit only one component of the Economic Freedom Index of the Heritage Foundation (http://www.heritage.org/index/). This measure is regularly updated and covers most of the domestic dimensions of Abiad et al.'s (2010) dataset of financial reforms. Although it is regarded by many as adequately representing domestic financial integration, some authors have criticised the index for the lack of transparency with respect to data sources and aggregation methods (Quinn et al. 2011).

While financial freedom is associated with mainly domestic aspects of financial liberalization, financial openness (often used interchangeably with the term financial liberalization), implies greater interdependence of the economy with respect to international capital flows and foreign ownership of domestic resources, including equity. Financial openness indices tend to be categorized into *de jure* measures, which reflect the degree of legislated capital–account openness (the extent of regulations and restrictions imposed on cross–border capital transactions), and *de facto* measures, which are based on observed outcomes to represent a country's realized financial openness. The former indices are mostly based on reports submitted to the IMF by individual countries and research conducted by IMF staff, as per the methodology developed after the IMF Annual Report on Exchange Arrangements and Exchange Restrictions (*AREAER*). On the other hand, *de facto* measures, assess a country's actual degree of integration into the world economy, typically based on the quantification of stocks or flows of international capital relative to GDP.

The most popular *de jure* measure of financial openness is the Chinn and Ito (2008) capital account openness index. The index is based on binary dummy variables that codify the tabulation of restrictions on cross–border financial transactions reported in the IMF's *AREAER.* Despite its widespread adoption in cross–country empirical studies thanks to its large time and country coverage, the Chinn and Ito's index has been criticized for measuring more the *extensity* than *intensity* of capital controls. This is because the index only captures the degree of capital restrictions as they are written 'on the books' (the information reported in the IMF's *AREAER* the index draws from) not the effectiveness of enforcement of capital controls, which as observed by Kose et al. (2009), can change over time even if the legal restrictions themselves remain unchanged. Also, the index is hampered by a lack of granularity, and the assumption of equal importance of its asset categories (Fernández et al. 2016).

Fernández et al. (2016) present a new dataset of capital control restrictions of several categories of assets for 100 countries over the 1995–2013 period (updated to 2017, see http://www.columbia.edu/~mu2166/fkrsu/). By building on the data in Schindler (2009) and other datasets based on the analysis of the IMF's *AREAER*, this measure too draws on purely *de jure* information, but it benefits from the inclusion of additional asset categories, disaggregation by whether the capital controls are on inflows or outflows, more countries, and a longer time period than Schindler's dataset.

The most popular *de facto* measure of financial openness comes from the financial integration index developed and continuously updated by Lane and Milesi–Ferretti (2001, 2007). This index is calculated by the sum of the gross stocks of foreign assets and liabilities over GDP. Recognizing the large cross–country variation in the reliability of data on capital flows and estimated stock positions, Lane and Milesi–Ferretti

use various techniques to derive the series for each country. The obvious advantage of a quantity–based indicator based on actual flows or stocks of foreign capital, is that it provides a more accurate measure of a country's *de facto* integration with global financial markets. The use of stocks instead of flows has the advantage that stocks reflect outstanding amounts of international capital, while flows provide a snapshot that is insufficiently informative about long–run trends.[2] Another merit of this index in the context of the present application is that while in general *de facto* indicators are likely to be endogenous in growth regressions, thus making it difficult to pin down causal effects (Kose et al. 2009), this problem is unlikely to apply when using them in bank cost efficiency regressions since we can plausibly exclude the possibility that bank cost efficiency may have a causal effect on liberalization policies.

The final category of liberalization indicators relates to equity market liberalizations, which "give foreign investors the opportunity to invest in domestic equity securities and domestic investors the right to transact in foreign equity securities" (Bekaert et al. 2003; p. 275). We do not consider these specific indicators in this paper due to a lack of adequate data since no up–to–date dataset is available. However, to mitigate concerns about excluding this dimension, it should be noted that several measures we consider account for an equity component which is implicit in the foreign ownership of domestic resources.

Despite the widespread use of the many financial liberalization proxies reviewed above, there is still no consensus as to which measure should be used, conflicting results obtained from such measures notwithstanding. Equally scant is proper consideration of the question of how to match available measures of financial liberalization to the specific research question in hand (Quinn et al. 2011) in order to produce more reliable and economically meaningful results. Evidently, each measure has merits and drawbacks. Nevertheless, these proxies appear to be used indiscriminately as 'substitutable' in empirical regressions leaving to individual researchers a somewhat ad hoc choice in selecting one measure over others and, consequently, in the interpretation of results. Mindful of such concerns, our investigation of the impact of financial liberalization on bank cost efficiency is complemented by a comparative analysis of results obtained from the use of five different liberalization measures to test the relationship.

2.2 Channels through which financial liberalization affects bank cost efficiency

The basic theoretical premise underlying economic freedom rests on the neoclassical view that markets are most efficient in allocating scarce resources. Thus, if financial liberalization is to have a uniformly positive and lasting effect on bank cost efficiency worldwide, it must be by moving banks closer to a common (global) cost frontier as the inefficiency–inducing market distortions from financial repression are eliminated. This process is accomplished via a market mechanism expected to foster better

[2] Kose et al. (2009) note that both de jure and de facto indictors contain valuable information. However, they favor the latter. Their preferred measure is the sum of gross inflows and outflows as a ratio to GDP. However, because of the volatility of flows, they prefer the stocks measure developed by Lane and Milesi–Ferretti.

financial intermediation and technological progress. However, in practice, there are specific barriers, both bank– and country–specific, which can hinder the scope of banks to achieve cost efficiency enhancements. For instance, financial frictions and market imperfections may alter the incentives of banks to mobilize resources effectively (thus also affecting the relationship between efficiency and lending quality) and increase their costs in terms of adapting new technologies or acquiring better skills in risk management. At the extreme, financial liberalization could impose significant economic costs on banking sectors which, after having to undergo a prolonged period of consolidation and restructuring when faced with large–scale inefficiencies, can induce a negative overall impact on efficiency (Denizer et al. 2007). In this section, we outline some theoretical arguments that shed light on the channels through which financial liberalization influences bank cost efficiency, both positively and negatively, by focusing on the three main avenues that we consider in our empirical analysis, namely financial freedom, foreign bank presence and financial (or capital account) openness.

The removal of interest rate ceilings and other government–imposed controls that traditionally limited the activities of banks in borrowing and lending – aspects of banking sector liberalization which we term, more generally, as financial freedom – serves to facilitate better use of the market/price mechanism by increasing the availability of funds (savings) for productive investment opportunities. In turn, banks are stimulated to engage in greater financial intermediation and portfolio diversification, thus achieving greater economies of scale/scope via pooling of funding resources. As a result, banks may achieve higher cost efficiencies by reducing transaction, information and overhead costs, improving on risk and overall bank management, and offering new financial instruments and services to keep up with market competitors (Levine 2001; Hermes and Meesters 2015). On the other hand, competition puts pressure on the profit margins of banks. This pressure encourages banks to engage in riskier activities, including imprudent lending and lax screening and monitoring functions, which may reduce their cost efficiency through increased loan loss provisions. The literature suggests a negative association between bank efficiency and nonperforming loans attributed to ‘bad management’, due to inadequate allocation of resources to manage, monitor and control the loan portfolio (Berger and DeYoung 1997). Additionally, financial freedom may induce pressures on banks to engage in consolidation and restructuring operations that could undermine the efficacy of corporate control and management ‘best practice’, creating implicit costs which, in turn, would adversely affect efficiency (Luo et al. 2016). These considerations suggest that the relationship between financial freedom and bank cost efficiency can be either positive or negative, being influenced, among other things, by the trade–off between efficiency and risk that is inherent in bankers’ tendencies to take advantage of moral hazard incentives or other frictions (e.g., agency costs) prevalent in financial markets.

Turning our attention to foreign presence, entry of foreign banks, especially from advanced countries, can be beneficial for the host banking market by facilitating the transfer of modern banking technologies, increasing competition in financial services, and enhancing local access to international capital markets (Claessens et al. 2001; Levine 2001). Greater presence of foreign banks could, therefore, enable domestic banks to benefit from know-how spillovers by incorporating superior bank-

ing techniques into their operation and management practices, which ultimately lowers their costs of financial intermediation and contributes to higher cost efficiency as they experience heightened competition.

Nevertheless, the positive impact of foreign presence may not be apparent in the data as many domestic banks previously exercising a 'quiet life' with market power had to restructure and consolidate their operations after financial deregulation altered the competition landscape within the industry. By arguing that "the best of all monopoly profits is the quiet life", Hicks (1935; p. 8) was the first to suggest that the exercise of market power could lead, in addition to the social loss that occurs due to mispricing, to lower efforts in seeking cost efficiency (which instead is heightened by competition).

While the consensus view in the literature is that the benefits of foreign ownership outweigh the costs, some studies, particularly in the wake of the global financial crisis, have shown that foreign bank presence can also incur costs and risks for the host country. For example, as Claessens and van Horen (2013) claim, recent evidence supports the view that foreign banks 'cherry pick' the best customers to benefit their own profitability at the expense of worsening the credit provision of domestic banks to the rest of the private sector. On balance, therefore, the net impact of foreign bank presence on cost efficiency is *a priori* ambiguous.

By financial openness, we refer to greater interdependence of the economy with respect to international capital flows and foreign ownership of domestic resources, including equity. This process brings with it several potential benefits and costs to the banking sector. The availability of capital from abroad increases the funds intermediated by banks and thereby the scope for further diversification of their asset portfolios including higher propensity to channel funds towards higher expected return projects. To this effect, as Clark and Siems (2002) point out, many banks around the world have broadened their portfolios to offer non–traditional services, enhancing their potential to earn fee–based income from off–balance sheet activities (such as securitization and derivatives), which, in principle, may positively influence bank cost efficiency (for supportive evidence, see Lozano-Vivas and Pasiouras 2010). Yet, the literature also highlights adverse consequences on bank performance from financial openness. These relate to increased co–dependence of default risks from economic, liquidity and information shocks (Anginer and Demirguc–Kunt 2014) and increased market risk offsetting potential risk–reducing gains from diversification into foreign markets (Berger et al. 2017). Nevertheless, overall, the effect of financial openness on bank cost efficiency is difficult to ascertain theoretically, and mixed empirical evidence mirrors this uncertainty.

In summary, from the above synthesis of three main dimensions of financial liberalization policy we can conclude that its nexus with bank cost efficiency cannot be conclusively determined from theoretical analysis alone. This leaves the question of the impact of financial liberalization on bank cost efficiency as one to be resolved empirically.

In this endeavor, an important caveat is in order regarding the role of regulation in the financial liberalization process. Broadly speaking, as Casu et al. (2017) explain, we can classify regulations into rules that foster financial liberalization and rules that impose restrictions on activities. While the former set of rules aligns, in the

main, with the principles of financial freedom and the traditional view that deregulation–induced competition from foreign entrants can lead to incentives for managers to improve efficiency (see, e.g., Leibenstein 1966), most researchers assume that prudential (re)regulation aimed at fostering financial stability and discouraging excessive risk–taking by banks would, by default, have effects running counter to liberalization reforms, thus adversely affecting cost efficiency. However, this is not necessarily the case. For instance, some authors state that the introduction of stringent capital adequacy requirements tends to reduce excessive risk–taking by banks (Barth et al. 2004), which, in turn, induces them to behave more cautiously, and prudently seek cost efficiencies. Higher capital requirements can also lower banks' cost of borrowing since higher capitalization offers greater assurances against the risk of bankruptcy. In short, just like the case of deregulation, a conclusive answer to the question of how prudential re–regulation (particularly in the post–crisis period of strengthened regulatory requirements associated with the Basel II and III accords) affects bank cost efficiency, remains elusive.

2.3 Empirical evidence

Theory postulates positive as well as negative effects of financial liberalization on bank cost efficiency, and the empirical evidence from both single– and cross–country studies is equally mixed. Among single–country studies, Bonaccorsi di Patti and Hardy (2005) find that cost efficiency of banks in Pakistan improved only in the period immediately following their privatization, but in the subsequent years there were no significant gains *vis–à–vis* the remaining state–owned banks. A diametrically opposed finding was reported in Mahmood and Loan's (2006) analysis of the impact of liberalization reforms on Pakistan's banking sector over the 1994–2000 period. They observed a U–shaped pattern of efficiency against time, implying that deregulation led to a fall and then an increase in bank efficiency. Havrylchyk (2006) investigates the efficiency of the Polish banking industry over 1997–2001 and finds that while greenfield banks achieved higher levels of efficiency than domestic banks, foreign banks that entered the Polish market via acquisitions did not experience any gains in efficiency. Chen et al. (2005) investigate the cost, technical and allocative efficiency of 43 Chinese banks over the 1993–2000 period and find that financial deregulation improved cost efficiency levels. Chortareas et al. (2016) examine the impact of credit market freedom on cost efficiency of banks operating across 48 US states over 1987–2012 and find that banks operating in states that enjoy a higher degree of economic freedom and independence from government controls, are more cost efficient.

It is important to observe at this point that, in single–country studies, the detection of financial liberalization effects is often left to the crude use of dummy variables or the separation of estimation periods around often arbitrarily chosen and anything but unique dates of financial reforms. The 'subperiods approach' is inevitably hampered by the approximation inherent in attempting to pinpoint specific dates of reforms that in most countries have occurred gradually rather than as a single package at a particular point in time.

Taken collectively, the empirical literature based on cross-country studies, is equally conflicting and, ultimately, inconclusive as to the impact of liberalization on bank cost efficiency. Yildirim and Philippatos (2007) investigate the cost (and profit) efficiency of banking sectors in 12 transition economies of Central and Eastern Europe (CEE) over the 1993–2000 period. They find that following privatization, foreign banks are more cost efficient (but less profit efficient) relative to domestically owned private banks and state–owned banks. Yet, like many other cross-country studies, they rely on a single measure of financial liberalization, foreign presence. A similar measure is employed by Lensink et al. (2008), whose interest centers on estimating how bank cost efficiency is influenced by foreign ownership and institutional quality. Using a sample of 2,095 commercial banks in 105 countries for the years 1998–2003, they find that foreign ownership negatively affects bank cost efficiency, though in countries with good governance this effect is less pronounced.

Brissimis et al. (2008) examine the relationship between banking sector reform and bank efficiency on a panel of bank level data from 10 newly acceded EU countries over 1994–2005. They find that banking sector reform has a positive effect on bank efficiency, which is partly channelled through the resulting effects of competition and risk–taking of banks. However, they employ a rather broad and now outdated (updated only up to 2014) 'transition' index, originally developed by the European Bank for Reconstruction and Development (EBRD) with the primary purpose of assessing the progress of formerly centrally planned economies in transition towards a fully industrialized market economy.[3]

Using panel data for 27 EU member states from 2001 to 2009, Chortareas et al. (2013) find that the higher the degree of an economy's financial freedom (measured solely using the Heritage Foundation index), the higher the benefits for banks in terms of cost advantages and overall efficiency (and that such effects tend to be more pronounced in countries with higher quality governance). Hermes and Meesters (2015) examine the impact of financial liberalization on bank cost efficiency for 61 countries over the 1996–2005 period. Using four dimensions of financial liberalization drawn from Abiad et al.'s (2010) dataset, they report a positive association between liberalization programmes and increased bank efficiency that is contingent upon the quality of bank regulation and supervision, in the absence of which, liberalization policies may, in fact, decrease rather than increase bank efficiency.

Casu et al. (2017) investigate the impact of deregulation policies and 'concomitant' prudential re-regulation initiatives (a critical and heavily under–researched aspect in the study of the liberalization–bank cost efficiency nexus) on the performance of banks from eight Asian economies over the 2001–2010 period. Their results suggest that liberalization (deregulation) policies have a positive impact on technological progress and cost efficiency. In contrast, prudential re–regulation policies tend to negatively affect banks' cost efficiency although they do not significantly impact on

[3] Although some dimensions of the index are relevant to banking liberalization, we do not consider this measure because its coverage is limited to 46 countries. We also exclude consideration of the freedom index of the Fraser Institute, since it is mostly based on economic freedom rather than financial liberalization, measuring mainly the size of government (expenditures, taxes, legal structure), property rights, freedom to trade internationally (buying, selling, making contracts), and regulation of labor and business operations.

cost technology. Yet, this is the only study that computes aggregate measures of liberalization ("deregulation") and "prudential re-regulation" by averaging indices and data from different datasets. The former is obtained by averaging the credit market deregulation data from the Heritage Foundation index with the average of the (normalized) activities restrictions from the Barth et al. (2013) dataset, while the latter is based on the average of capital stringency, supervisory powers, and market discipline data.

To sum up, despite decades of empirical research, the answer to the question of how the banking sector worldwide reacted to financial liberalization in terms of bank cost efficiency levels, remains elusive. Mixed evidence clearly fails to square competing theoretical predictions. With few notable exceptions, a lacuna in previous cross–country studies, appears to be a single measure being used as the sole proxy for financial liberalization. Given the intrinsically multifaceted nature of the construct, and the inevitable trade–offs in each index, each with its own merits and limitations and each potentially suited to capture some facets of liberalization but not others, this approach leaves us with the unanswered question of whether the individual indices chosen in such studies, as if they were equivalent representations of those not chosen, do in fact produce similar results and, if not, why this may be the case.

Doubtless, the insufficient attention paid in most studies to establishing, concomitantly to the empirical testing of the relationship in hand (the liberalization–cost efficiency nexus), the comparative performance of different financial liberalization proxies, constitutes a significant omission. We contend that failing to square the measurement ambiguities inherent in the use of what continue to be treated as alternative and seemingly interchangeable proxies for financial liberalization, is unlikely to lead to resolute empirical endeavours aimed at obtaining reliable, economically meaningful, conclusive results. These considerations constitute the rationale for our emphasis on how different financial liberalization indices fare in application to the analysis of the impact of financial liberalization on bank cost efficiency.

3 Methodology

To examine the impact of a range of financial liberalization measures on bank cost efficiency, we employ, as our methodological framework, SFA, incorporating a multi–product translog cost function and time–varying inefficiency specification in a single step Battese and Coelli (1995) model. This one–step method (using maximum likelihood estimation) is commonly adopted in the literature (e.g., Pasiouras et al. 2009) as it allows for the measurement of inefficiency from the best–practice frontier while simultaneously accounting for bank level and country–specific influences on the inefficiency of banks.

We adopt the conventional intermediation approach for selecting input and output variables in the specification of the stochastic frontier. This approach treats banks as collecting funds (deposits) as inputs and transforming them into loans and other assets. Specifically, we choose three inputs and three outputs. The inputs are: cost of borrowed (loanable) funds (W_1), calculated by the ratio of interest expenses to total deposits (this includes wholesale funding given it is relatively large for many

banks); cost of physical capital (W_2), measured by the ratio of overhead expenses net of personnel expenses to book value of fixed assets; and cost of labor (W_3), represented by the ratio of personnel expenses to total assets. The third input, W_3, is used to normalize the dependent variable and input prices to impose linear homogeneity in the cost function. The three outputs are: loans (Q_1), other earning assets (Q_2), and non–interest income (Q_3). The latter is included to account for non–traditional activities (e.g., commission and fee–related services). In addition, equity (E) is considered as a quasi–fixed input in the cost function to control for differences in risk preferences. Finally, country and year dummies are included in the cost function to allow for country–specific changes in technology and over time.

Furthermore, given that risk–taking is an integral part of banking, and since financial liberalization can potentially increase the risk exposure of banks, we estimate 'risk–adjusted' cost efficiency scores where the dependent variable in the translog cost function is also divided by the standard deviation of profit (σ_p) to represent cost efficiency per unit of risk.[4] Thus, with the above inputs and outputs, and using observed total cost (TC) as a measure of bank cost, the formal specification of the cost efficiency equation is:

$$
\begin{aligned}
&ln\tfrac{TC_{it}}{\sigma_p W3_{it}} = \beta_0 + \beta_1 \ln(Q1_{it}) + \beta_2 \ln(Q2_{it}) + \beta_3 \ln(Q3_{it}) + \beta_4 \ln\left(\tfrac{W1_{it}}{W3_{it}}\right) \\
&+\beta_5 \ln\left(\tfrac{W2_{it}}{W3_{it}}\right) + \beta_6 \tfrac{1}{2} (\ln(Q1_{it}))^2 + \beta_7 \ln(Q1_{it}) \ln(Q2_{it}) + \beta_8 \ln(Q1_{it}) \ln(Q3_{it}) + \beta_9 \tfrac{1}{2} (\ln(Q2_{it}))^2 + \\
&\beta_{10} \ln(Q2_{it}) \ln(Q3_{it}) + \beta_{11} \tfrac{1}{2} (\ln(Q3_{it}))^2 + \beta_{12} \tfrac{1}{2} \left(\ln\left(\tfrac{W1_{it}}{W3}\right)\right)^2 + \beta_{13} \ln(Q1_{it}) \ln\left(\tfrac{W1_{it}}{W3_{it}}\right) \\
&+\beta_{14} \ln(Q2_{it}) \ln\left(\tfrac{W1_{it}}{W3_{it}}\right) + \beta_{15} \ln(Q3_{it}) \ln\left(\tfrac{W1_{it}}{W3_{it}}\right) + \beta_{16} \tfrac{1}{2} \left(\ln\left(\tfrac{W2_{it}}{W3_{it}}\right)\right)^2 + \beta_{17} \ln(Q1_{it}) \ln\left(\tfrac{W2_{it}}{W3_{it}}\right) \\
&+\beta_{18} \ln(Q2_{it}) \ln\left(\tfrac{W2_{it}}{W3_{it}}\right) + \beta_{19} \ln(Q3_{it}) \ln\left(\tfrac{W2_{it}}{W3_{it}}\right) + \beta_{20} \ln\left(\tfrac{W1_{it}}{W3_{it}}\right) \ln\left(\tfrac{W2_{it}}{W3_{it}}\right) + \beta_{21} (E_{it}) + \beta_{22} (E_{it})^2 \\
&+\beta_{23} (E_{it}) \ln(Q1_{it}) + \beta_{24} (E_{it}) \ln(Q2_{it}) + \beta_{25} (E_{it}) \ln(Q3_{it}) + \beta_{26} (E) \ln\left(\tfrac{W1_{it}}{W3_{it}}\right) + \beta_{27} (E) \ln\left(\tfrac{W2_{it}}{W3_{it}}\right) \\
&+ yeardummies_t + countrydummies_i + u_{it} + v_{it}
\end{aligned}
\tag{1}
$$

where $v_{i,t}$ is the random error assumed to be $N(0, \sigma_v^2)$ and $u_{i,t}$ is the non–negative inefficiency term assumed to be independent but not identically distributed. Following Battese and Coelli (1995), the inefficiency term can be expressed as a function of some variables Z by modelling it as a truncated normal distribution with variable

[4] There is really no consensus on the preferred method for determining the best-practice frontier against which relative efficiencies are measured (and, in fact, a recent study by Nguyen and Pham 2020; suggests that cost efficiency estimates derived from SFA models – like the one we employ in our study – are more consistent than those obtained from Data Envelopment Analysis models). In short, no approach can be said to be 'the best' (despite the methodological developments over the last 30 years), with each method presenting its own drawbacks. In adopting a preferred frontier model over others, the researcher's choice boils down to a difference of opinion regarding the lesser of evils, and the researcher's task is to then address the specific limitations of the chosen approach. That is exactly what we do here. In this study we do not just specify a translog cost function to represent a global frontier, and an inefficiency (one-step) model based on Battese and Coelli (1995) to simultaneously control for time–varying inefficiency, unobserved banks' heterogeneity and a range of bank– and country–level influences, we also address potential limitations by additionally using 'risk-adjusted' cost efficiency scores. We follow the approach of Lozano–Vivas and Pasiouras (2013) who use the standard deviation of total profits before taxes as a proxy for σ and p, which we consider as a measure of risk. This adjustment, however, does not make much difference to our results as opposed to using unadjusted cost efficiency scores or when a separate risk variable (equity over assets) is incorporated explicitly in our cost inefficiency regressions (results available upon request).

mean and constant variance, that is $u_{it} \sim N^{+}\left(Z_{i,t}\delta, \sigma_u^2\right)$, as in $u_{it} = Z_{i,t}\delta + e_{it}$. To account for the effects of financial liberalization and other determinants on inefficiency, as well as to allow for unobserved country and time fixed effects, we specify u_{it} more fully as:

$$\begin{aligned} u_{it} &= \delta_0 + \delta_1 FINLIB + \delta_2 FOREIGN + \delta_3 ACTRES + \delta_4 CAPREQ + \delta_5 MARDIS \\ &+ \delta_6 SUPPOW + \delta_7 QUALITY + \delta_8 CONC + \delta_9 CLAIM + \delta_{10} GDPG \\ &+ \delta_{11} INFA + \delta_{12} CRISIS + year\ dummies_t + country\ dummies_i + e_{it}. \end{aligned} \tag{2}$$

In Eq. (2), *FINLIB* represents the effect of financial liberalization, whereas *FOREIGN* represents the percentage of foreign–owned banks operating in the domestic market.[5] Together, these two variables capture the broad influence of liberalization on the mean inefficiency of banks. However, we distinguish between the two variables because in the empirical analysis we control for foreign presence while investigating the effects of *FINLIB*.

We use four alternative proxies for *FINLIB*, which taken together encompass both the domestic and international dimensions of financial liberalization. First, we use the financial freedom index (*FREEDOM*). As noted earlier, this index is domestically oriented in scope, being determined by its five main components, namely, (i) the degree of state intervention in financial services, (ii) the extent of financial and capital market development, (iii) the extent of government regulations, (iv) government influence on the allocation of credit, and (v) openness to foreign competition. The index assigns an overall score on a scale of 0–100, with higher values implying less government influence and, therefore, greater financial freedom.

The other three measures of *FINLIB* represent the effect of financial openness as captured by the degree of capital mobility across countries. Both *de jure* indicators derive information from the IMF *AREAER*, but they differ in the way data is collected from the *AREAER* categories of restrictions. The Chinn-Ito index (*KAOPEN*) is a table–based *AREAER* measure focusing on regulatory restrictions of capital account transactions. The index is constructed using binary coding with principal components analysis applied on four major categories in the *AREAER* report, (1) the presence of multiple exchange rates, (2) restrictions on current account transactions, (3) restrictions on capital account transactions, and (4) the requirement of the surrender of export proceeds. Assigned a score of 0–4, higher values imply more capital account openness. The other *de jure* indicator we use is a text–based *AREAER* measure (*KACON*), developed by Schindler (2009) and extended by Fernández et al. (2016). Assigned a score between 0 and 1, higher scores indicate lower capital account liberalization. Finally, we use a *de facto* measure from Lane and Milesi–Ferretti (2001,

[5] The effect of FOREIGN can be captured more generally using 'foreign bank share', measured either as the number of foreign banks to total number of banks or as the ratio of foreign bank assets to total bank assets (Claessens et al. 2001; Claessens and Van Horen 2013). We do not use the latter measure due to unavailable asset data for a large number of banks in our sample. Similarly, we cannot use the country-level measures of foreign claims based on 'the aggregate amount of cross-border credit' as constructed by the Bank of International Settlements (www.bis.org) due to limited number of countries for which the BIS measures are constructed.

2007), the ratio of sum of the total gross stocks of foreign assets and liabilities to GDP (hereafter *LMFTOT*).

The control variables used in the mean inefficiency specification account for cross–country differences in regulations, institutions, market structure, financial development, macroeconomic conditions, banking crises, and economic development. Consistent with prior studies, we use four measures to control for cross-country differences in banking regulations, with data drawn from Barth et al.'s (2013) dataset. *CAPREQ* measures both initial and overall capital stringency as a proxy of Basel II first pillar. The former examines whether certain funds may be used to initially capitalize a bank and whether they are officially verified, while the latter estimates whether capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined. *SUPPOW*, as a proxy for the second pillar of Basel II, measures the official power of supervisory authorities. *MARDIS* is a proxy for the third pillar of Basel II, measuring the degree of regulations that require banks to release accurate and comprehensive information to the public and empower the private sector to monitor banks. Finally, *ACTRES* measures the degree of restrictions on bank activities. As other researchers have argued (e.g., Delis et al. 2011; Quintyn and Taylor 2003), these regulatory influences can affect the risk–taking incentives of banks differently in different environments, so, there are no determinate *a priori* expectations as to their impact on cost efficiency.

We additionally control for the institutional environment by including a proxy for institutional quality (*QUALITY*) with data drawn from the World Governance Indicators (WGI) of the World Bank. As done by several studies (e.g., Tanna et al. 2017), we take the sum of the following indicators: voice and accountability, government effectiveness, rule of law, political stability, quality of regulation and control for corruption.

We also incorporate appropriate controls for market structure, financial development and macroeconomic environment as follows. *CONC* measures banking sector concentration, 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; the higher the value of the ratio, the less the competition. *CLAIM* is the ratio of banking sector claims on the private sector to GDP, to capture the extent of activity in the banking sector. *GDPGR* denotes the real GDP growth rate, and *INFA* the annual inflation rate. A higher rate of economic growth rate might stimulate bank lending that positively affects bank efficiency. On the other hand, an increasingly prosperous economic environment, leading to higher profits, might allow banks to enjoy 'a quiet life' and relax their drive to be more cost efficient. Similarly, inflation (*INFA*) can be expected to adversely affect savings and the interest rate revenue of banks, but also encourage further borrowing and lending, thus having a negative or positive effect on bank efficiency. Finally, we account for the effect of systemic banking crises, a recurrent consequence of liberalization typically caused by excessive risk–taking. To capture this effect, we use a dummy variable, *CRISIS*, which takes the value 1 for three years from the inception of the crisis in the country (as reported by Laeven and Valencia 2013), and 0 otherwise.

4 Empirical analysis

4.1 Data

Since SFA estimates efficiency scores of banks by measuring their distance relative to a common (global) cost frontier, the underlying assumption is that the production technology is similar across units. This methodology, therefore, imposes the restriction of a fixed best–practice efficiency frontier across countries (Berger 2007). However, our purpose here is not that of comparing efficiency across countries but how liberalization has affected cost efficiency at a global level in the banking sector. Furthermore, we control for country–specific as well as time–specific effects in our estimations, both in the translog function to derive the best practice frontier and in the inefficiency equation to assess the distance relative to the frontier, thereby alleviating potential problems stemming from how differences in economic environments and over time may affect the relative cost efficiency of banks in different countries. To reduce differences in efficiency scores due to unobservable effects, we also restrict our sample to commercial banks only[6], and we later relax the SFA assumption of a global common efficiency frontier by re-estimations using regional efficiency frontiers as well as a single-country efficiency frontier (for the US).

Starting with the population of all commercial banks that had financial records in the Bankscope/Orbis (Bureau van Dijk) database, we excluded banks with missing data on bank–specific (input–output) variables, and banks for which the relevant country–specific variables were not available. After 'winsorizing' all bank–level data at the top and bottom 5 percentiles to discard extreme values and outliers, we ended up with a final unbalanced panel of 20,576 bank–year observations, covering 3,075 banks and 104 countries over the period 1999–2017.[7] All inputs and outputs variables were adjusted in real terms using GDP deflators with data for each individual bank expressed in US million dollars. Table A1 presents the descriptions and data sources for all the variables, while Table A2 and A3 present descriptive statistics and correlation coefficients, respectively. Table A4 lists the set of countries, the number of banks per country, and the classifications of countries by level of development and income groups.

[6] We later test the sensitivity of our results to the derivation of global best–practice efficiency frontier for different countries by re-estimating our model both by separate frontiers specified according to countries' level of economic development and by re-estimating our regressions for a single country (USA), and the results for our main FINLIB variables are robust.

[7] The start and end date of our sample were dictated by data availability. The start year of 1999 is due to the availability of data for our four regulatory variables from the World Bank. The main reason why our dataset ends in 2017 is that we rely on data from BankScope, which was only openly accessible until 2017. Since then, BankScope has undergone a transformation, changing its data source and rebranding as Orbis Bank Focus. This transition also marked the end of our subscription, limiting our access to updated data (https://eservices.blog/2017/02/14/bankscope-renamed-as-orbis-bank-focus/). In addition, the latest available data from the Bank Regulation Survey correspond to the year 2017.

Table 1 Cost efficiency estimates

	No. of Obs.	Mean	Std. Dev.
Panel A: Efficiency by year			
Year			
1999	595	0.8259	0.1066
2000	787	0.8288	0.1073
2001	823	0.8253	0.1095
2002	855	0.8258	0.1075
2003	927	0.8205	0.1090
2004	1160	0.8097	0.1079
2005	1382	0.8016	0.1064
2006	1553	0.7983	0.1068
2007	1682	0.7950	0.1071
2008	1671	0.7940	0.1065
2009	1688	0.7917	0.1071
2010	1830	0.7941	0.1084
2011	1785	0.7935	0.1079
2012	440	0.7949	0.0948
2013	707	0.7878	0.0965
2014	762	0.7876	0.0934
2015	762	0.7909	0.0954
2016	723	0.7907	0.0985
2017	444	0.7922	0.0927
Panel B: Income groups			
High income	9930	0.8197	0.1059
Middle income	9481	0.7845	0.1044
Low income	1165	0.7745	0.0928
Panel C: Development level			
Developed	11,220	0.7838	0.1036
Developing	9356	0.8215	0.1053
Transition	4688	0.7349	0.0768

NOTE: All efficiency scores are averaged by year and by relevant income groups and development level. The classification for the income groups is drawn from the World Bank database, and that for the development level follows the IMF classification system

4.2 Cost efficiency scores

The results for bank cost efficiency are presented in Table 1, showing the average scores by year (panel A), and by income groups and developmental level (panels B and C). Efficiency scores are calculated using a global frontier embedded with the bank level and country–specific controls, as well as unobserved country level and time effects, as in Eqs. (1) and (2) above.[8]

The results show that the average cost efficiency of commercial banks generally declines over the period 1999–2017, ranging between the highest value of 0.8288 in 2000 and the lowest value of 0.7907 in 2016. On average, between 17.1% and 20.9% of the commercial banks' costs are wasted relative to the best–practice banks in the sample in order to produce the same outputs from the same inputs with similar tech-

[8] For ease of comparison, we calculate the cost efficiency scores from the estimated (stochastic) frontier (Eq. 1) as the inverse of CEit = exp (uit), so that the efficiency scores lie between 0 and 1, with 1 indicating the highest level of efficiency ('best practice' banks).

nology. The observed decline in average cost efficiency over time is a trend reflected also in the findings of Pasiouras et al. (2009), which supports the consistency of the pattern our data unveil. A plausible explanation for the decline in average cost efficiency is the increased burden of regulatory compliance costs. A comprehensive study by Barth et al. (2013) highlights the numerous banking regulatory reforms across countries over that period and their analysis of the regulatory environment for banks in 1999 (using Survey I) compared to 2006 (using Survey III) reveals a general tightening, which may contribute to the observed cost efficiency declines. As can be seen from the standard deviation values reported in Table 1, the range of variability in the average efficiency scores marginally declines over time, although this may be attributed to the reduced number of bank–year observations. Comparing the average efficiency scores by other categories, banks in developing countries have slightly higher cost efficiency (0.8125) than banks in developed countries (0.7838) and economies in transition (0.7349). The lower average efficiency scores in developed countries compared to developing countries could also be partly explained by differences in regulatory environments, as documented by Barth et al. (2013). Their survey shows that banking regulation is, on average, stricter in developed countries than in developing countries. The stricter market discipline/private monitoring framework in developed countries could potentially hinder bank cost efficiency to a greater extent, contributing to the observed difference in average cost efficiency levels between developed and developing countries. Banks in high–income countries record higher average cost efficiency (0.8197) than in middle– (0.7845) and low–income (0.7745) countries. Despite such minor differences, the average scores are similar in magnitude to those reported in previous studies (e.g., Lozano–Vivas and Pasiouras 2010).

4.3 Financial liberalization and bank efficiency

Table 2 presents the main results. We perform several estimations to reflect the impact of each measure of liberalization on bank cost 'inefficiency' while controlling throughout for foreign bank presence (*FOREIGN*) along with other explanatory variables. In this baseline specification, inclusion of *FOREIGN* as a control variable allows for the effect of *FINLIB* to be determined conditional on the effects of foreign banks' presence in the domestic economy. We also account for the effect of different income groups using the World Bank's classification of the world's economies based on countries' GNI per capita. To this end, we include two additional dummies, *HIGH* and *LOW*, representing high– and low–income country groups.

Starting with Column (1) in Table 2, *FREEDOM* has a statistically significant, negative impact on cost inefficiency with a coefficient estimate of -0.0368, implying that greater financial freedom leads to higher bank cost efficiency. A similar effect is recorded for the influence of financial openness, Columns (2)–(4), with both *de facto* and *de jure* measures, *LMFTOT* and *KAOPEN*, displaying negative coefficients on cost inefficiency (-0.0256 and −0.0842, respectively). In all such cases the coefficients are statistically significant at 1%. A potential explanation for this effect is the greater opportunities for enhanced capital allocation through international risk sharing, which yields improvements in average bank cost efficiency. However, this result is not corroborated by the coefficient (0.0481) of the *de jure KACON* index in

Table 2 Determinants of cost inefficiency in overall sample

	(1)	(2)	(3)	(4)
FREEDOM	-0.0368***			
	(0.0024)			
LMFTOT		-0.0256***		
		(0.0005)		
KAOPEN			-0.0842***	
			(0.0418)	
KACON				0.0481
				(0.1520)
FOREIGN	-0.0424***	-0.0025***	-0.0426***	-0.0463***
	(0.0094)	(0.0003)	(0.0076)	(0.0117)
SUPPOW	0.0010	-0.0097***	-0.0040	-0.0028
	(0.0033)	(0.0014)	(0.0070)	(0.0081)
ACTRES	-0.0549***	0.0266***	-0.0427***	-0.0513***
	(0.0097)	(0.0012)	(0.0099)	(0.0114)
CAPREQ	-0.0055	0.0139***	-0.0076	-0.0005
	(0.0150)	(0.0017)	(0.0136)	(0.0218)
MARDIS	0.1443***	0.0005	0.0964***	0.0990***
	(0.0096)	(0.0010)	(0.0186)	(0.0200)
CLAIM	0.0173***	0.0057***	0.0167***	0.0175***
	(0.0007)	(0.0003)	(0.0010)	(0.0015)
CONC	-0.0202***	-0.0132***	-0.0214***	-0.0228***
	(0.0010)	(0.0003)	(0.0012)	(0.0015)
GDPGR	-0.0056	-0.0249***	-0.0110***	-0.0084***
	(0.0056)	(0.0006)	(0.0055)	(0.0074)
INFA	-0.0189***	0.0147***	-0.0218***	-0.0227***
	(0.0024)	(0.0004)	(0.0023)	(0.0026)
CRISIS	0.6123***	0.0400***	0.8519***	1.0548***
	(0.0252)	(0.0157)	(0.0586)	(0.0906)
QUALITY	0.2764***	0.0154***	0.1076***	0.0863***
	(0.0289)	(0.0029)	(0.0316)	(0.0327)
HIGH	-1.8703***	0.0295	-0.2639***	-0.4531
	(0.6071)	(0.1769)	(0.1482)	(1.0773)
LOW	-0.2030***	0.1937	-0.7358***	-0.5434
	(0.0517)	(0.2135)	(0.3071)	(1.3632)
Sigma–squared	0.2732***	0.1210***	0.2729***	0.2805***
	(0.0060)	(0.0019)	(0.0065)	(0.0079)
Gamma	0.7464***	0.0000***	0.7499***	0.7825***
	(0.0100)	(0.0000)	(0.0083)	(0.0098)
Log–Likelihood	-3407.9	-3474.8	-3427.9	-2926.0
LR–tests	3110.6***	814.3***	3070.7***	1560.6***
Banks	3075	3064	3075	2791

Table 2 (continued)

	(1)	(2)	(3)	(4)
Countries	104	104	104	92
N	20,576	19,459	20,576	18,659

NOTE: All estimations include country and time fixed effects, and use the maximum number of available bank–year observations. Variable definitions are given in Table A1. The estimates reported, which give the effect of the environmental variables on cost inefficiency, were obtained simultaneously with the parameter estimates of the stochastic frontier using one–step Battese and Coelli (1995) method. The LR–tests confirm the overall statistical significance of the estimation of the inefficiency equation. Sigma–squared and Gamma are two statistics driving the likelihood function, where Sigma-squared = $\sigma_\mu^2 + \sigma_v^2$ and Gamma = σ_μ^2/σ_v^2. ***, ** and *, denote statistical significance at the 1%, 5% and 10% level, respectively

Column (4), which albeit positively signed (lower values of this index imply greater capital account openness) is not statistically significant. The lack of statistical significance of *KACON* may stem from the construction of this index, which due to its finer granularity may place greater weight to categories that do not properly capture meaningful facets of bank sector liberalization.[9] Another explanation may relate to the smaller sample that *KACON* covers (92 countries in our estimations due to bank level data availability), which could make it less sensitive in terms of its impact on cost efficiency. In contrast, foreign bank presence (*FOREIGN*) displays a consistent result with that obtained from *FREEDOM*, *LMFTOT* and *KAOPEN*, recording a significant (at 1%) and uniformly positive impact on cost efficiency under all specifications of Table 2, Columns (1)–(4). Foreign bank presence, thanks to its narrow, 'domestic banking sector openness to foreign competition' focus, could well be regarded as an appropriate *de facto* indicator of banking sector liberalization, especially when targeted at assessing its impact on bank cost efficiency. Indeed, while it is true that a country can be fully financially liberalized with hardly any foreign banks present, foreign bank presence more precisely captures the greater competition in the domestic banking sector resulting from opening the sector to foreign private entry or participation, which as discussed in our review of theoretical channels, constitutes a critical transmission mechanism for positive as well as negative effects on bank cost efficiency.

Overall, out of the five measures of financial liberalization considered (including *FOREIGN*), only the *de jure* measure of capital account openness, *KACON*, fails to suggest a significant improvement of bank cost efficiency. Previous literature has noted that the intensity of legal controls in current account restrictions as captured by *de jure* measures may not reflect the effectiveness of enforcement of such regulatory restrictions (Kose et al. 2009), and may, therefore, differ from the actual outcomes of *de facto* capital account liberalization, which in turn, may be driven by a range of factors besides the relevant laws of financial sector reforms. While these considerations have been advanced as reasons as to why *LMFTOT* may unveil a different effect from *de jure* measures (outcomes observed, among others, by Kose et al. 2009; and Quinn et al. 2011), our data show that with the sole exception of the *KACON* index, the rela-

[9] Although all de jure indicators draw on the same information of the IMF's AREAER, methodological subjectivities in coding textual information means they capture different facets of international financial openness (with little overlap among them, as evidenced by the low correlations displayed in Table A3).

tionship between 'legal' openness and 'realized' international financial transactions is fairly consistent in terms of their effects on bank cost efficiency.

Although our interest centers on the relationship between different measures of financial liberalization and bank cost efficiency, it is worth mentioning briefly the impact of control variables. Official supervisory power (*SUPPOW)* is statistically insignificant in three out of four specifications while, with the sole exception of the *LMFTOT* regression, greater activity restrictions (*ACTRES)* are found to significantly improve cost efficiency. The effects of higher capital requirements (*CAPREQ*) are mostly insignificant. Consistent with the findings of Casu et al. (2017), we find market discipline (*MARDIS*) to have a significantly positive effect on cost 'inefficiency' in three out of four specifications. Better institutional quality (*QUALITY*) consistently reduces cost efficiency as more developed institutions demand stricter monitoring and legislative requirements, which increase costs. Higher bank concentration (*CONC*) improves cost efficiency while higher activity in the banking sector (*CLAIM*) has the opposite effect. GDP growth has mostly a positive impact on bank cost efficiency and so does inflation. The influence of banking crises on cost efficiency is consistently negative, as to be expected.

The high– and low–income dummies present ambiguous, inconsistent results, possibly as a result of model over–parameterization, making their interpretation difficult. Accordingly, to probe further on whether the effect that each liberalization measure has on bank cost efficiency varies according to countries' level of traditionally defined economic development, we re–run regressions by disaggregating the sample into developed, developing and transition economies (as per the IMF rather than World Bank classification), thereby relaxing the 'common global efficiency frontier' assumption by computing efficiency scores relative to best practice frontiers for these distinct country groups.[10]

The results of this permutation (Table 3) validate inferences about our *FINLIB* measures from Table 2. *FREEDOM, LMFTOT* and *KAOPEN*, continue to hold mostly significantly positive effects on cost efficiency, displaying little variation across country groups (developed, developing and transition economies), suggesting that the state of economic development does not matter much in the relationship between liberalization and bank cost efficiency. The oddity of the result from *KACON* is confirmed in these new estimations, with it now displaying a consistently negative and significant impact on bank cost efficiency, thus augmenting our suspicions about the reliability of inferences to be drawn from this measure.

What is also interesting from these estimations is that the effect of *FOREIGN* on bank cost inefficiency is significantly positive for developed countries but significantly negative for developing countries, consistently so across all *FINLIB* specifications. On the other hand, the effect of *FOREIGN* for transition countries is ambiguous, with a mixture of significantly positive, significantly negative or statistically insignificant estimated coefficients across the four regressions. While the ambiguity regarding the economies in transition could be explained by a sub-sample classification

[10] In these estimations, the income group dummies (HIGH and LOW) are obviously excluded. An alternative is to split the sample into high–, middle– and low–income country groups but the results (not reported) are broadly consistent. See Table A4 for the classifications.

Table 3 Determinants of cost inefficiency using separate frontiers by development level

	FREEDOM			LMFTOT			KAOPEN			KACON		
	Developed	Developing	Transition	Developed	Developing	Transition	Developed	Developing	Transition	Developed	Developing	Transition
FREEDOM	-0.0053***	-0.0122***	-0.0043*									
	(0.0007)	(0.0022)	-0.0025									
LMFTOT				-0.0053***	-0.0010	-0.3470***						
				(0.0056)	(0.0057)	-0.0288						
KAOPEN							-0.1294**	-0.0115***	-0.1722***			
							(0.0778)	(0.0215)	-0.0517			
KACON										-0.0967***	-0.1519***	-2.6582***
										(0.0616)	(0.1035)	-0.5249
FOREIGN	0.0134***	-0.0119***	0.0004	0.0407***	-0.0053**	0.0030***	0.0434***	-0.0143***	0.0097***	0.0510***	-0.0132***	-0.1121***
	(0.0021)	(0.0045)	-0.0041	(0.0031)	(0.0030)	-0.0004	(0.0036)	(0.0048)	-0.0035	(0.0097)	(0.0066)	-0.0377
Sigma–Squared	0.0766***	0.1924***	0.1007***	0.1474***	0.0034***	0.0917***	0.1490***	0.1933***	0.0966***	0.1403***	0.2022***	0.1950***
	(0.0013)	(0.0061)	-0.0034	(0.0031)	-0.0026	-0.0019	(0.0032)	(0.0060)	-0.0035	(0.0271)	(0.0065)	-0.0184
Gamma	0.0000***	0.8435***	0.6637***	0.9335***	-0.0095***	0.0007***	0.9260***	0.8443***	0.6644***	0.9478***	0.8100***	0.7295***
	(0.0000)	(0.0077)	-0.023	(0.0046)	-0.0068	-0.0002	(0.0043)	(0.0075)	-0.0229	(0.0179)	(0.0098)	-0.0263
Log–Likelihood	-1208.7	-805.3	-410.9	-73.0	-409.4	-1038.9	-214.6	-824.7	-327.0	116.1	-860.3	-443.5
LR–tests	996.7***	4018.4***	706.8***	2620.1***	3393.3***	773.2***	2984.9***	3979.6***	1478.3***	2875.4***	2753.5***	1013.9***
Banks	1243	1025	807	1234	1023	807	1243	1025	807	1292	1500	699
Countries	23	62	19	23	62	19	23	62	19	22	55	15
N	8885	6989	4707	8225	6631	4607	8885	6989	4707	9195	9464	3959

NOTE: All estimations include country and time fixed effects, and they use the maximum number of available bank–year observations. Variable definitions are given in Table A1. To conserve space, we do not report the estimates for the control variables, but all estimates, including those reported, were obtained simultaneously with the parameter estimates of the stochastic frontier using the one–step Battese and Coelli's (1995) method. The distinction between developed, developing and transition countries is based on the IMF classification (see Table A4). The LR–tests confirm the overall statistical significance of the estimation of the inefficiency equation. Sigma–squared and Gamma are two statistics driving the likelihood function, where Sigma–squared = $\sigma_{\mu}^{2} + \sigma_{v}^{2}$ and Gamma = $\sigma_{\mu}^{2} / \sigma_{v}^{2}$. ***, ** and *, denote statistical significance at the 1%, 5% and 10% level, respectively

which has more to do with countries' political evolution than to changes in banks' best-practice efficiency frontier or strictly defined economic development level, the pattern unveiled with respect to the effect of *FOREIGN* in developed vs. developing countries suggests that when estimated in a full sample of countries, the parameter for foreign bank presence may mask significant differences across countries with a different level of economic development. That said, as noted in our review of the theoretical channels through which financial liberalization affects bank cost efficiency, the effect of foreign bank presence on bank cost efficiency also depends on initial conditions in individual banking markets, the extent to which existing banks enjoyed a 'quiet life' prior to the heightened competition brought about by foreign banks, the extent of bank restructuring and consolidations following financial deregulation, and the capacity of domestic banks to benefit from know-how spillovers by incorporating superior (foreign) banking techniques into their financial operations and management practices. The latter condition in particular may explain the cost efficiency benefits accruing from *FOREIGN* to banks located in developing countries, which stand to benefit the most from the transfer of modern banking technologies and greater access to international capital markets (see Claessens et al. 2001; Levine 2001). The effects of the other control variables (not reported to conserve space) are broadly consistent with the results of the full sample shown in Table 2.

4.4 Further analysis: pre- and post-crisis periods

We now extend the analysis by asking the question of how bank cost efficiency responded to the global financial crisis of 2007, which marked a turning point in the evolution of international financial integration with the strengthening of prudential re–regulation policies that run counter to the liberalization and banking sector reforms characterizing the pre–crisis period. The length of our time series allows us to split the sample period into a pre–crisis (1999 to 2006) and a post–crisis (2008 to 2017) period to examine this policy shift (our sample end date is dictated by the availability of the *Bank Regulation and Supervision Survey* data, which only go up to 2017).

Prudential re–regulation refers to a series of supervisory and restrictive policies associated with the Basel Accords set by Basel Committee of Banking Supervision (BCBS) aimed at protecting the banking sector from excessive risk–taking and at ensuring that banks and financial institutions have enough capital to absorb unexpected losses. Although the Basel Accords were developed over several years, beginning with Basel I (issued in 1988, and mostly concerned with the capital adequacy risk of financial institutions), the more stringent prudential restrictions on bank activities embedded in the 'three pillars' of *minimum capital requirements*, *supervisory review* of capital adequacy and internal assessment process, and effective use of private monitoring disclosure as a lever to strengthen *market discipline* of banks' activities and encourage sound banking practices, did not come to fruition until the implementation in early 2008 of the Revised Capital Framework Basel Accord, known as Basel II. In the wake of the financial crisis the BCBS decided to update and strengthen the Accords. As Basel III was negotiated in 2008, the crisis was of paramount con-

cern and even more stringent regularly standards[11] were agreed in 2010 and quickly adopted in many key countries including in Europe and the US. It is most useful, therefore, to explore the effect of this shift in 'policy' on bank cost efficiency in the post–crisis prudential re–regulation period, as captured by our sample sub–period from 2008 to 2017, compared to the pre–crisis, financial liberalization sub–period (1999–2006). Changes in prudential regulation will inevitably have had an impact on the financial liberalization measures under consideration, with the latter changing as a result of them, thus allowing us to make inferences about the impact of post-crisis tightening of prudential regulation on bank cost efficiency.

The results (Table 4) are very informative. Under both the *FREEDOM* and *LMFTOT* specifications in Column (1) and (2), the *FINLIB* measures hold consistently positive and statistically significant effects on bank cost efficiency, pre– and post–crisis. In Column (3) and (4), *KAOPEN* and *KACON* now display insignificant effects in both sub–periods at any reasonable level of significance but it is reassuring that *FOREIGN*, which acts as a control variable in the *FINLIB* regressions, corroborates the significantly positive effect that the prudential re–regulatory reforms had on bank cost efficiency post–crisis in three out of four specifications, as indicated by the *FREEDOM* index and the evolution of *de facto* gross stocks of foreign assets and liabilities (over GDP) captured by *LMFTOT.* This result assumes even greater importance when acknowledging that the *FOREIGN* coefficients turn statistically insignificant in the pre–crisis period in all regressions, Columns (1)–(4).

Hence, despite the inherent difficulty in adjudicating more or less credence to one measure over others, on balance, our main conclusion would suggest that in the post–crisis period, the Basel–driven prudential re–regulation policies did not have a detrimental impact on bank cost efficiency. If anything, and despite the 'anomaly' of inferences to be drawn from Fernández et al.'s (2016) index (*KACON*), by and large, our findings indicate that prudential re–regulation reinforced the positive effect that liberalization policies (such as the removal of activities restrictions, de–nationalization and opening the domestic market to foreign banks) had on bank cost efficiency.

Our findings contrapose the conclusions of Casu et al. (2017), the only previous study that attempts to ascertain the impact of both liberalization reforms and prudential re–regulation on bank cost efficiency. Several reasons can account for the difference. First, Casu et al. (2017) test data for eight Asian countries only and over a limited sample period (2001–2010), which makes their analysis inadequately short to capture the full impact of the strengthening of the prudential reforms of banking sectors worldwide. Second, their single country frontier estimations (their Table 4) are anything but consistent and their aggregate re–regulation coefficient is only statistically significant in the case of Japan, in fact indicating a positive impact of prudential re–regulation on cost efficiency. Third, their foreign bank ownership dummy displays conflicting results from country to country, thus making it difficult to draw reliable conclusions. Fourth, in their meta–frontier analysis (their Table 5) aimed at pooling together the results across the eight economies examined, their aggregate deregulation measure appears to significantly lower costs, but the aggregate pruden-

[11] Including the requirements for banks to have a minimum common equity and liquidity ratio, with special consideration of 'important banks' or 'too big to fail' financial institutions.

Table 4 Determinants of cost inefficiency in pre- and post-crisis periods

	Before (1999 to 2006)	After (2008 to 2017)	Before (1999 to 2006)	After (2008 to 2017)	Before (1999 to 2006)	After (2008 to 2017)	Before (1999 to 2006)	After (2008 to 2017)
FREEDOM	-0.0058***	-0.0393***						
	(0.0019)	(0.0033)						
LMFTOT			-0.1451***	-0.0437***				
			(0.0361)	(0.0013)				
KAOPEN					0.0162	-0.0463		
					(0.0151)	(0.0405)		
KACON							-0.1520*	0.0249
							(0.0794)	(0.1506)
FOREIGN	0.0041	-0.0518***	-0.0013	-0.0099***	-0.0008	-0.0348	-0.0044	-0.0471***
	(0.0047)	(0.0089)	(0.0038)	(0.0012)	(0.0040)	(0.0092)	(0.0051)	(0.0117)
Sigma–squared	0.0509***	2.6971***	0.0798***	1.9620***	0.0604***	0.2977***	0.1186***	0.0986***
	(0.0013)	(0.5379)	(0.0014)	(0.7272)	(0.0013)	(0.0508)	(0.0047)	(0.0043)
Gamma	0.6739***	0.9468***	0.6208***	0.9301***	0.0000***	0.9953***	0.8989***	0.9964***
	(0.0348)	(0.0105)	(0.3036)	(0.0272)	(0.0000)	(0.0009)	(0.0070)	(0.0005)
Log–Likelihood	1571.1	-3351.7	1576.7	-3289.4	1567.8	-3315.5	-1119.6	-2926.1
LR–tests	3006.7***	3223.1***	3017.9***	1185.3***	3000.2***	960.8***	3045.5***	834.7***
Banks	1815	2865	1815	2851	1815	2865	1634	1956
Countries	97	104	97	104	97	104	72	87
N	8087	10,794	8087	9677	8087	10,794	7367	6234

NOTE: All estimations include country and time fixed effects, and use the maximum number of available bank–year observations. Variable definitions are given in Table A1. To conserve space, we do not report the estimates for the control variables, but all estimates, including those reported, were obtained simultaneously with the parameter estimates of the stochastic frontier using one–step Battese and Coelli (1995) method. The LR–tests confirm the overall statistical significance of the estimation of the inefficiency equation. Sigma–squared and Gamma are two statistics driving the likelihood function, where Sigma–squared = $\sigma_\mu^2 + \sigma_v^2$ and Gamma = σ_μ^2/σ_v^2. ***, ** and *, denote statistical significance at the 1%, 5% and 10% level, respectively

tial re–regulation measure is not statistically significant. Reliability too can be called into question when considering the aggregation issues inherent in their unorthodox construction of the deregulation measure, which averages credit market deregulation data from the Heritage Foundation index with the activities restrictions from the survey–based dataset of Barth et al. (2013), that only provides four observations over their study's sample period. Overall, therefore, we take Casu et al. (2017)'s results to be insufficiently consistent or reliable to draw inferences compatible with their conclusions that prudential regulation policies tend to negatively affect banks' cost efficiency.

Although, as noted earlier in this paper, economic theory provides conflicting predictions about the effects of varying bank regulations and supervisory practices on bank development, performance, and stability (see, e.g., Barth et al. 2004), our finding that prudential re-regulation policies aimed at fostering financial stability may be pursued without any risks of lowering cost efficiency, is consistent with both: (a) the belief underlying the prudential re–regulation reform proposals associated with Basel I, II and III, according to which the banking sectors in countries adopting these regulations and practices will function better, thereby promoting growth and stability; and (b) some theoretical models predicting that, under certain conditions also associated with other policies and/or institutions, restrictions on bank activities via regulations that lower opportunities for excessive risk-taking by banks, foster bank development, better performance and greater stability, and can even enhance social welfare (see, e.g., Boyd et al. 1998).

4.5 Robustness

A robustness check entailing multiple permutations, addresses several outstanding issues which warrant further reassurance in order to increase our confidence about the validity of our previous inferences. First, as a sensitivity check with respect to our results based on the derivation of a global best–practice efficiency frontier for different countries, we re–estimate our regressions for a single country, and the US, having the largest number of banks (598) in our sample, presents itself as the obvious candidate for selection. Second, to ascertain how dependent our results are to the method employed, we use a different estimation approach from the one-step Battese and Coelli's (1995) model, one that combines derivation of efficiency scores from SFA with System Generalized Method of Moments (SYS–GMM) estimation of the impact of financial liberalization on cost efficiency. SYS–GMM allows us to account for potential endogeneity due to feedback effects or omitted variables (see De Vita et al. 2018) while also introducing, by construction, a lagged cost efficiency term, thereby capturing potential dynamic effects. Third, although we normalized the dependent variable by the standard deviation of profits that serves as a measure of risk, we now investigate whether our results hold when a non–normalized cost efficiency regression that includes a separate risk variable is used. For this purpose, we use Equity over Assets (E/O), as done in much previous literature (e.g., Delis et al. 2017). This allows us to account explicitly, and independently, for the role of bank risk. Finally, we also estimate a separate regression using *FOREIGN* as a *FINLIB* variable. The results of these SYS–GMM robustness permutations are presented in

Table 5 Determinants of cost efficiency for USA only

	(1)	(2)	(3)	(4)	(5)
	FREEDOM	*LMFTOT*	*KAOPEN*	*KACON*	*FOREIGN*
Panel A:	SYS-GMM				
LAG COST EFFICIENCY	0.2625	0.5789**	0.7128***	0.7547***	0.7406***
	(0.3443)	(0.2498)	(0.0807)	(0.0649)	(0.0637)
FREEDOM	0.0035**				
	(0.0017)				
LMFTOT		0.0419***			
		(0.0114)			
KAOPEN			0.0871***		
			(0.0242)		
KACON				-0.1939	
				(0.1312)	
FOREIGN	0.0069*	0.0061	0.0134**	0.0063***	0.0058***
	(0.0037)	(0.0048)	(0.0060)	(0.0016)	(0.0014)
E/A	0.4594*	0.2536	0.5476*	0.0217	0.0376
	(0.2685)	(0.1829)	(0.3212)	(0.0862)	(0.0897)
N	3050	2669	3050	3050	3050
Year Dummy	Yes	Yes	Yes	Yes	Yes
AR(2)	0.1281	0.2613	0.1104	0.4488	0.4191
Hansen–J	0.2692	0.1191	0.3961	0.1268	0.1128
Panel B:	Common Correlated Effects (CCE)				
FREEDOM	0.0131***				
	(0.0042)				
LMFTOT		0.2785***			
		(0.0210)			
KAOPEN			0.4972***		
			(0.1222)		
KACON				0.1964	
				(0.5229)	
FOREIGN	-0.0088	0.0195***	-0.0010	0.0096***	0.0261***
	(0.0089)	(0.0066)	(0.0007)	(0.0022)	(0.0093)
E/A	-2.2221	1.7369	-3.4196	0.8539	-3.4157
	(2.4220)	(2.3292)	(2.2205)	(0.6042)	(2.2205)
N	3882	3387	3882	3882	3882
R2	0.1041	0.3207	0.0550	0.2649	0.3256

NOTE: In Panel A, all estimations include time fixed effects and use the maximum number of available bank–year observations for the USA. Variable definitions are given in Table A1. To conserve space, we do not report estimates for the control variables aside from lagged cost efficiency and equity over assets (E/A). First lag of KAOPEN, FREEDOM, LMFTOT, KACON and FOREIGN, and first and second lags of E/A are used as GMM–type instruments. Estimation is by SYS–GMM with Windmeijer–corrected standard errors reported in parentheses. In panel B, the Common Correlated Effects (CCE) estimation method is used. Estimates are based on the mean group estimates. ***, ** and *, denote statistical significance at the 1%, 5% and 10% level, respectively

Panel A of Table 5. However, our robustness checks would be incomplete without also accounting for the possibility of cross section dependence. Accordingly, in Panel B of Table 5, we also report results based on the Common Correlated Effects (CCE) estimation method by Chudik and Pesaran (2015), which provides consistent estimates also in the presence of cross section dependence.

Starting with Panel A of Table 5, in terms of diagnostics, the Hansen–J and Arellano–Bond tests confirm instrument validity and the absence of correlation in the first–differenced residuals. Columns (1)–(5) indicate that our results are fairly robust to the multiple permutations embedded in the new SYS–GMM regressions (exceptions regarding *FOREIGN* in samples disaggregated by level of economic development and pre/post crisis periods notwithstanding), thus mitigating concerns that they may carry biases stemming from estimation method, endogeneity, normalization of our risk–adjusted dependent variables and derivation of a global best–practice frontier. In Panel B of Table 5, estimation results based on CCE to account for cross section dependence confirm the validity of our previous inferences.

5 Conclusion

We investigated the impact of financial liberalization on bank cost efficiency with a focus on comparing commonly used measures of financial openness. We also examined the effect of these proxies on cost efficiency across countries' level of economic development, and the pre– and post–crisis policy shift from liberalization to prudential re–regulation. The analysis is based on a large sample of bank–year observations across 104 countries over 1999–2017. We consider five main indicators of financial liberalization, three policy based indices (the Heritage Foundation financial freedom index, and the *de jure* financial openness indices by Chinn and Ito 2008; and Fernández et al. 2016), and two outcome–based measures (foreign bank presence, and Lane and Milesi–Ferretti's financial integration index). With the sole exception of Fernández et al.'s index, all other financial liberalization proxies, including foreign bank presence, agree in indicating an enhancement of bank cost efficiency resulting not only from financial liberalization but also from the prudential re–regulation reforms associated with Basel II and III that followed the financial crisis of 2007. The results for the main *FINLIB* measures examined hold irrespective of countries' stage of economic development and prove robust to re–estimations based on a single-country efficiency frontier, alternative model specifications and methodologies that account for endogeneity and cross section dependence.

Two important implications flow from our findings. First, with respect to the measurement of financial openness, we conclude that Fernández et al.'s (2016) index performs sub–optimally in the context of banking sector liberalization, at least insofar as its effect on bank cost efficiency is concerned. We lend greater credence to other *de jure* and *de facto* indicators of financial liberalization, including foreign bank presence, which thanks to its narrower 'domestic banking sector openness to foreign competition' focus, provides a reliable 'realised', outcome–based measure of banking sector liberalization by better capturing dimensions pertaining to the competition and internationalization of banking markets. On the other hand, the *KACON*

measure (calculated as an average of the level of controls in ten asset categories for capital inflows and outflows), by focusing on the intensity of legal controls in current account restrictions, suffers weaknesses that make it incapable of capturing the effectiveness of enforcement of such regulatory restrictions. Policy analysts as well as researchers, therefore, are well advised to consider this indicator as unreliable for rigorous policy analysis, at least in this context.

Second, with respect to the impact of financial liberalization and the attendant internationalization of banking markets, our evidence shows that the relaxation of bank activity restrictions, including the removal of restrictions on foreign entry, leads to an improvement of bank cost efficiency. However, even more significantly, our findings show that when accompanied by prudential policies, the effect on bank cost efficiency is reinforced not reversed. During the post–crisis period such prudential re–regulatory reforms have addressed the moral hazard problem created by the existence of large financial institutions, tackled the contagion risk posed by the joint pursuit of investment and retail banking by mandating the separation of such activities, exerted pressure on banks to de–diversify, reduce their size, and diminish their individual exposure to risk and fragility by tightening capital and liquidity requirements, and encouraged sound banking practices via stronger supervision and an effective use of private monitoring disclosure. It follows that, contrary to the generally held belief that excessive government interference in the financial sector and banks' activities may adversely affect the efficient operation of banks, the clear policy implication stemming from our findings is that prudential policies aimed at fostering stability and less risk–taking by banks, can be pursued without any risks of hindering financial intermediation and lowering bank cost efficiency. The key 'take away' message for countries' policy makers and bank chiefs, therefore, is that irrespective of economic and institutional conditions, including the level of economic development, the implementation of successive Basel prudential requirements, ranging from supervisory review of capital adequacy including a minimum common equity and liquidity ratio and an internal assessment process, and the strenthening of *market discipline* of banks' activities, reinforced the positive effect that liberalization policies (such as de–nationalization and the opening the domestic market to foreign banks) had on bank cost efficiency.

By way of acknowledgement of limitations, a few final caveats are in order. First, although we also controlled for development level in our analysis, in comparing the impact of liberalization reforms and prudential re-regulation, it would be interesting for future studies to explore further potential differences between developed, developing, and transition countries before and after the financial crisis through further cross-sectional analyses disaggregated at regional level. This additional analysis could be further enriched by a more granular investigation of country-specific factors or regulary differences that our broader categorization might have missed. This endeavor may entail, for example, a detailed examination of how specific country-level policies or economic conditions might have influenced the relationship between financial liberalization and bank efficiency at a local level, which may in itself offer additional insights.

Second, although our study adopted multiple *de jure* and *de facto* indicators of financial liberalization, our set of measures could be expanded in future studies by

also attempting to take into consideration indicators of contemporary developments that reflect, for instance, digital financial inclusion or the effects of technology-driven uncertainty, factors that are increasingly playing a role in terms of both access to banking services and the efficient operation of banks.

Third, although our study makes a significant empirical contribution by way of distinguishing the effects of different financial liberalization measures on bank cost efficiency, the theoretical underpinnings of why different financial liberalization measures might differently affect bank cost efficiency remains an area worthy of further investigation. This is the case particularly when considering that the relationship in question could be influenced by a multiplicity of factors not typically accounted for in growth-focused studies such as risk management practices, competitive industry dynamics, and bank-specific regulatory frameworks, that may themselves play a significant role in how each measure affects bank cost efficiency.

Finally, our analysis rests on the inputs-outputs, intermediation-based approach pioneered by Sealey and Lindley (1977), in which banks act as intermediaries between savers and borrowers. However, it is generally acknowledged that the intermediation approach fails to account for all essential banking transformation services as neither the overall risk of loans granted nor the maturity structure of loans and deposits are adequately considered. Although we mitigated some of the drawbacks of the approach employed by using 'risk-adjusted' efficiency scores, and tested the robustness of our results by estimating separate frontiers, a profitable avenue for future frontier efficiency studies might be to establish whether similar conclusions to our own can be obtained when adopting accounting measures of outputs or profits that rely on altogether different production-based or profit-oriented approaches. Such further validation of our chosen model and/or approach – possibly by also comparing our results across alternative estimation methods – would not only reinforce our findings but also square any remaining concerns about the specificity or generalisability of the methodology hereby employed.

These directions for future research located at the intersection of the fields of financial development and the efficient operation of the banking sector, which have long attracted attention of business economics researchers worldwide, offer an exciting agenda to advance the debate through the productive exchange of ideas between science and practice, as advocated by the aims and scope of this journal.

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Data availability Data are available from the authors upon request.

Declarations

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