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Diversification, efficiency and risk of banks: New consolidating evidence from emerging economies

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Abstract

This paper examines the impact of business diversification of banks on their risk, with efficiency taken into consideration as a conduit. Using bank-level data from more than 1400 commercial banks in 39 emerging economies during 2000-2016, we find that increased business diversification exerts two competing effects on bank risk, and overall reduces bank risk. The direct effect of increased diversification bolsters the stability of banks, but this is offset partially by the indirect effect of lowered efficiency, which increases the riskiness of banks. This provides a consolidating evidence on the competing arguments on the diversification-efficiency nexus in banking--the "diversification-premium" argument vs. the "diversification-discount" argument--with its extended implications on bank risk. In addition, we also present evidence that the diversification-bank risk nexus is heterogeneous on the bank size, market power and the ownership of banks, which provides useful policy implications for diversification strategies by bank managers as well as for the effective surveillance by bank regulators.

JEL classification: G21; G15; L25
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1. Introduction

The recent decades have witnessed a significant shift of banks' business to non-traditional areas in response to changes in the competitive environment, regulatory policies and the innovation of management skills and technology. Beyond the traditional lending and deposit-taking services, banks have been increasingly engaged in security underwriting, insurance brokerage, mutual fund services, fiduciary services and many other fee-generating activities for extra income and extended their sources of liabilities into wholesale funding. As a gauge of banks' diversification strategy on both the revenue and liability side, Demirgüç-Kunt and Huizinga (2010) record the average of non-interest income as a share of operating income at 0.353 and that of non-deposit funding as a share of deposit plus short-term liability at 0.081 across nearly one hundred countries.[3] Although the degree of diversification has declined relatively in some countries in the wake of the 2008-09 global financial crisis (Martel et al., 2012; Roengpitya et al., 2014), banks' income from non-interest generating business and the liabilities from non-deposit sources are still widely regarded as important determinants of their performance (Mergaerts and Vander Vennet, 2016).

Given the conventional wisdom to avoid venturing all eggs in a single basket to lower risk, it is not surprising that diversification has been long perceived as a relevant factor of financial soundness. Some prior literature provides supportive evidence that the riskiness of banks tends to ameliorate with the diversity of their activities (Lown et al., 2000; Cornett et al., 2002; Baele et al., 2007; Deng et al., 2007; Chiorazzo et al., 2008; Elsas et al., 2010; Altunbas et al., 2011; De Jonghe et al., 2015), in line with the views that banks benefit from the economies of scope, strengthened efforts to monitor loans, and the proprietary information collected via increased interaction with potential borrowers (Diamond, 1984; Cerasi and Daltung, 2000; Abedifar et al., 2018). Nevertheless, there is also a large body of works that find only contradictory results (Demsetz and Strahan, 1997; Stiroh, 2004a; Stiroh and Rumble, 2006; Acharya et al., 2006; Laeven and Levine, 2007; Lepetit et al., 2008; Berger et al., 2010; Demirgüç-Kunt and Huizinga,

[3] Stiroh (2006) notes that the earnings of banks in the United States from non-interest areas accounted for 42% in 2004, a significant increase from 32% in 1990. Goddard et al. (2007) also document that the share of non-interest income in European banks increased by more than 10 percentage points in a decade, even reaching as high as 50%.

2010; De Jonghe, 2010; De Young and Torna, 2013; Brunnermeier et al., 2019), usually interpreted as that the diversification benefits are offset by increased volatility of income, intensified agency problems, underpriced credit risk in order to facilitate non-interest transactions, and the shortage of managerial expertise on diversified business.

This paper aims to contribute to the bank diversification and risk literature by making supplementary extensions. We argue that, an additional reason that likely contributes to the documented weak evidence on the presumed stability-increasing force of diversification in earlier works is that, besides a direct impact, diversification may meanwhile exert an indirect effect on bank risk via an intermediary factor. Should this intermediary factor create a competing impact on bank risk, offsetting the direct effect of diversification, the overall effect of diversification might be ambiguous. Without distinguishing the direct and the potential indirect impact that banks' diversification may exert on their risk, most prior works only focus on investigating the *overall* relationship of these two variables, and there are only few attempts to identify the channels that link the diversification and risk of banks.

In this paper, we propose efficiency as such a conduit that transmits the impact of banks' diversification to their risk, based on the literature that efficiency is found affected by the diversity of banks' activities and meanwhile to impact banks' stability as a critically important determinant.[4] Despite some conflicting results, the diversification of bank activities is found to play a detrimental role on their operational efficiency in many works. The likely reasons why diversification could hinder banking efficiency include: more costly monitoring when banks are exposed to more diverse business lines and customers, increased agency problems with diversification, higher managerial costs when banks' activity mix is "too complex to manage", the "quiet life" incentive when a bank forms a multi-service financial conglomerate with a predominant market status, and the loss of "core competence" when banks are increasingly engaged in unrelated diversification (Ferrier et al., 1993; Markides and Williamson, 1994; Rossi et al., 2009; Elyasiani and Wang, 2012; Curi et al., 2015). Meanwhile, Berger and De Young (1997), Kwan and Eisenbeis (1997), Fiordelisi et al.(2011) and a long list of others

[4] In this paper, we do not aim at distinguishing all potential conduits via which diversification may impact on bank stability. Proposing efficiency as such a conduit between diversification and risk in this paper does not rule out the possibility of other conduits, which are left for our future research.

find consistent evidence that subdued efficiency increases the chance of bank failure, as less efficient banks may attempt to boost their performance via less stringent lending standards, or take greater risk in order to compensate for their lower return. In the light of these findings, we posit that efficiency could play an intermediary role via which diversification passes its impact onto the stability of banks. Taking this efficiency conduit into consideration, we investigate the bank diversification-risk nexus by hypothesizing that increased business diversification creates two competing effects on bank risk: diversification may directly bolster the stability of banks, but the lowered efficiency with increased business diversity, which leads to a higher riskiness, may counteract the direct beneficial effect of diversification.

We examine two specific questions in this work. First, gauging banks' diversification on both income and funding, we ask if banks' efficiency tends to decrease with the extent of their business diversity. Second, we observe if efficiency plays a significant role on bank risk, which supplies evidence if diversification exerts an indirect impact on bank risk via efficiency, and meanwhile how diversification affects bank risk directly. Our findings are summarized as below. We find consistent evidence that banks' efficiency decreases with the level of their business diversification. As efficiency is also found positively associated with the proxy of banks' stability, our result is interpreted as favorable evidence for the efficiency conduit that connects the activity diversification and risk of banks. Having controlled for the efficiency conduit, we find that diversification exerts an extra impact on the stability of banks positively and significantly, implying that there is a beneficial direct impact of diversification on the stability of banks, which is nevertheless partially offset by the deteriorated efficiency that induces a higher risk in banks. This finding is robust as we use alternative indicators of bank diversification, efficiency and riskiness. In addition, the indirect effect of diversification via the efficiency conduit is found more conspicuous on banks' profitability and portfolio risk, but less significantly on their leverage risk. We also investigate if the relationship between diversification and risk, with the efficiency conduit considered, may vary with a number of bank specific characteristics, and find some evidence for the heterogeneity of this nexus on banks' size, market power and foreign/state ownership.

Our paper differs from the existing literature in several dimensions. First, unlike most earlier

works that examine the overall impact of diversification on bank risk, we propose that the effects of diversification may be distinguished as a direct and an indirect impact, where the latter is realized via efficiency as a conduit. Our investigation sheds some light on how the competing theoretical arguments may co-exist in the bank diversification-risk nexus. The finding that diversification affects the stability of banks positively, with the efficiency conduit being controlled for, can be viewed as consistent with the hypothetical "diversification benefits" from the economies of scope or more committed monitoring on bank clients, whereas the "diversification costs" arising from intensified agency problems, the difficulty of "too complex to manage" or the shortage of managerial expertise on diversified business are likely converted to lower efficiency and thus play an offsetting force to the "diversification benefits". To our best knowledge, our work is among the first to investigate the countervailing forces of the direct risk impact of diversification and the indirect one through the efficiency conduit.

Second, different from many others that only focus on the diversification of banks on their operating income (for example, Stiroh, 2004; De Young and Rice, 2004; De Jonghe, 2010; Brunnermeier et al., 2019), we gauge the diversity of bank activities on both the income and funding side, which is expected to provide a more complete depiction of banks' diversification strategy. As Demirgüç-Kunt and Huizinga (2010), Bertay et al. (2013) and Köhler (2015) note, banks' earning and funding strategies may have different implications on their performance, raising an interesting question as to whether the reliance on non-interest income and non-deposit liabilities could also affect the efficiency conduit of diversification differently, or create different direct effects on bank risk. Having detected a general relationship between the earning and funding diversification on bank stability, with the efficiency conduit considered, we further examine if this relationship tends to vary heterogeneously across banks of different size, market power and ownership status.

Third, we focus on emerging economies, which provide an ideal context for our investigation on the bank diversification-risk linkage. Financial turbulence with costly output and welfare loss have occurred frequently in emerging countries (Laeven and Valencia, 2018), thus making the stability of financial sectors among the foremost priorities of decision makers. Perceiving that a shift to the universal banking model could diversify banks' business lines and reduce their

susceptibility to underlying risk, many emerging economies have been promoting greater liberalization in their financial markets, allowing for a wider business area beyond banks' traditional lending and deposit-taking services. In a stark contrast, some other emerging economies still enforce stringent limitations on banks' activity mix, with the result of notably lower non-interest income and non-deposit funding than their peers. Moreover, the 2008-09 global financial crisis saw banks in some emerging economies resort to traditional financial services, amid a decline in non-interest income and non-deposit funding. The remarkable variation of banks' income mixes and funding patterns across and within countries is believed to be one of the advantages of employing emerging economies in research sampling. However, the association between bank diversification, efficiency and stability in emerging economies is surprisingly insufficiently studied in previous related works.[5]

The remainder of the paper is organized as follows: Section 2 briefly reviews extant literature on the risk impact of business diversification of banks, the association between banks' diversification and efficiency, and the force of efficiency on bank risk. Section 3 introduces our empirical model to investigate the diversification-risk nexus and the efficiency conduit of banks, followed by the descriptions of our data and main variables in Section 4. Section 5 presents the empirical results of our baseline model and a series of robustness examinations. We also introduce the results as we decompose our main risk indicator into its three components, i.e., bank profitability, leverage risk and portfolio risk. We extend our investigation on the heterogeneity of the diversification-risk nexus on banks' size, market power and ownership in Section 6. Section 7 concludes.

2. Literature review

2.1 Diversification and risk of banks

Whether banks benefit from business diversification has engendered an extensive but

[5] Most of the previous research uses samples from more advanced economies, other than emerging or developing countries. For example, Demsetz and Strahan (1997), Stiroh (2004a, 2004b), Stiroh and Rumble (2006) and Brunnermeier et al. (2019) use the data from the United States. Altunbas et al. (2011) adopt the sample of listed banks in the European Union and the United States. Chiorazzo et al. (2008) address the relationship between income diversification and bank return in Italy. Elsas et al. (2010) analyze the impact of bank diversification based on the data from 9 developed economies.

inconclusive debate in earlier literature. The proponents suggested a number of diversification gains that may contribute to lower financial fragility with banks' expanded business area. First, as suggested by Gilligan et al. (1984), Ferrier et al. (1993), Pulley and Humphrey (1993) and some others, the economies of scope in banks not only spread the fixed costs (including those on structure, human capital, information and technologies) over an expanded mix of financial services, but also make consumers more willing to pay a higher price since the "one-stop shopping" of multiple financial services in a single bank can save their time costs, which consequently increase the net return of banks. A number of works find that combining banks with other financial firms can have some risk mitigation benefits (Boyd et al., 1993; Lown et al, 2000). Cavallo and Rossi (2001) find evidence for increased economies of scope as banks move towards the universal banking model, while Ramírez (2002) find that the cost advantage of more diversified banks, highly likely because of their economies of scope, can be translated into a premium to their market value.[6]

Second, as modelled by Kanatas and Qi (1998, 2003), banks can acquire proprietary information about clients in the process of extending loans that facilitates the supply of other financial services, and the latter services can also generate the information necessary for loans. That is, more diversified banks would be more likely to overcome the problems of information asymmetry. In line with this argument, Drucker and Puri (2005) find that when a bank is concurrently lending to a firm and underwriting its public security offering, the firm benefits from lower underwriting fees and discounted loan yield spreads.

Third, diversification may augment banks' incentives of more committed monitoring, thus likely reduce their riskiness. Diamond (1984) and Hellwig (2000) model the relevance of diversification in reducing the costs to generate the incentives of delegating monitoring by a financial intermediary. Cerasi and Daltung (2000) suggest that, when banks are less motivated to monitor their clients as they share the gains from monitoring with investors while bearing all the costs of monitoring by themselves, business diversification would strengthen their incentive of monitoring, because the gains of monitoring accrue to bankers as long as the bank is not

[6] Some works such as Berger et al. (1987) and Altunbas and Molyneux (1996), however, only find limited evidence for the cost savings in banks due to economies of scope.

insolvent and diversification reduces the probability of bank failure. Investigating the implications of banks' diversification on funding, Calomiris (1999) and Demirgüç-Kunt and Huizinga (2010) imply an advantage of non-deposit funding that lies on the function of monitoring carried out by the creditors of non-deposit funding when it is not covered by deposit insurance, thus a higher proportion of non-deposit funding in banks' liabilities may reduce their fragility due to creditors' closer monitoring.[7]

In contrast to the hypotheses of "diversification benefits", many competing views warn of the "diversification costs", i.e., the adverse effects of diversification on financial stability. At first, non-interest income may add more volatility to banks' operating income and profits. De Young and Roland (2001), Stiroh (2004a) and Stiroh and Rumble (2006) find that, opposite to the common expectation that an increased reliance on non-interest income would reduce the cyclicality in banks' revenue (Smith et al., 2003), non-interest income of banks has been more volatile and has an increasingly positive correlation with net interest income.[8]

Next, some theories in corporate finance suggest that diversification might be associated with more severe agency problems. Diversification may benefit managers' self-interest but at the cost of the corporate interest if managers push forward the firm diversification either because of the power and prestige associated with managing a larger firm or the managerial entrenchment that lowers their probability to be replaced (Jensen 1986; Shleifer and Vishny, 1989; Aggarwal and Samwick, 2001). Denis et al. (1997) find supportive evidence that agency problems are a driving reason for the value-reducing diversification strategies. Laeven and Levine (2007), along with Schmid and Walter (2009) but in contrast to Baele et al. (2007), also find evidence for the hypothesis that intensified agency problems lead to "diversification discounts", i.e., the market values of financial conglomerates engaged in multiple financial services are lower than specialized financial institutions. Other than the agency problems, the incentive conflicts within a diversified bank may also add financial instability by inducing

[7] Huang and Ratnovski (2011) question the incentive of wholesale financiers to conduct costly monitoring and warn that they may withdraw their funding based on negative public signals, which may result in inefficient liquidations.

[8] The reasons that lead to the higher volatility of non-interest income may include the lower switching costs that allow their clients to easily shift away, the different mixes of inputs to produce the fee-based services which likely result in extra operating costs, and/or banks' incentive to arbitrage risk-based capital regulations by substituting their balance sheet risk with off-balance sheet risk (De Young and Roland, 2001).

underpriced credit risk, reputational risk or higher leverage costs (Schmid and Walter, 2009). For example, a bank likely extends loans to less creditworthy borrowers in order to gain the chance as the security underwriter of the borrowers (Ramakrishnan and Thakor, 1984). Lepetit et al. (2008) find that a higher reliance on fee-based activities is associated with lower lending rates in banks, seemingly implying that banks may underprice borrowers' default risk in order to facilitate their fee-based business.[9]

Third, banks may diversify their activities into areas where they lack expertise or comparative advantage, thus resulting in weaker performance (Stiroh, 2004b). In line with this argument, Acharya et al. (2006) question the effectiveness of monitoring as banks diversify their business into an area where they are not familiar, and Shaban et al. (2014) find some evidence that diversified banks may have a lower capacity to monitor their new bloc of clients, thus resulting in higher risk.[10]

The theoretical ambiguity on the diversification benefits and costs underlies the inconclusive results in empirical research. Elsas et al. (2010) find that diversification increases the profitability of banks and consequently their market value. Sawada (2013) reports positive evidence that revenue diversification bolsters banks' market value but no significant mitigating effect on bank risk in Japan. Köhler (2015) finds that banks' stability and profitability strengthen significantly with their share of non-interest income, but likely weaken with the share of non-deposit funding. Guerry and Wallmeier (2017) find the "diversification discounts" vary with time and vanish after the global financial crisis. In comparison, the research by Chen et al. (2017) reveals a detrimental impact of non-interest income on bank stability and Brunnermeier et al. (2019) find that banks' contributions to systemic risk tend to increase with their share of non-interest income. Some other works document only mixed results, such as De Young and Torna (2013) finding that the probability of distressed bank failure declines with some fee-based activities but climbs with some other non-traditional activities, and

[9] Some counterarguments question the existence of the incentive conflicts of business diversified banks (for example, Kroszner and Rajan (1994)).

[10] Some related literature introduced the negative externalities that may arise if banks' diversification strategy is optimal to themselves but sub-optimal to the society. In light of Shaffer (1985), Wagner (2010) and Ibragimov et al. (2011) suggest that despite the potential benefits to reduce banks' idiosyncratic risk, diversification may increase the similarity of banks and thus the probability of joint failures or systemic crises. De Vries (2005) also reaches a similar conclusion by modeling the similarity in the exposures of banks that carries the potential of systemic breakdowns.

Hryckiewicz and Kozłowski (2017) suggesting that a nontraditional funding structure intensifies crisis depth but does not lengthen crisis duration.

In comparison to a rich body of works that focus on more advanced economies, only a limited number of researches examine the linkage between diversification and risk of banks in emerging markets. Berger et al. (2010a, 2010b) investigate the implications of bank diversification on bank performance in Russia and China, respectively. Pennathur et al. (2012) find that income diversification benefits the public sector banks in India, in line with the finding of Meslier et al. (2014) that a shift toward non-interest activities increases the risk-adjusted profits of banks in the Philippines. Sanya and Wolfe (2011), employing a sample of 11 emerging economies, also reach a favourable conclusion on the impact of revenue diversification on the soundness of banks. Nevertheless, Shaban et al. (2014), Baek et al. (2018) and Abuzayed et al. (2018) only find opposite results that more diversified income sources seemingly fail to aid the banking stability in Indonesia, Korea and the Gulf Cooperation Council countries.

2.2 Diversification and efficiency of banks

Relative to the size of the research on the nexus between diversification and banks' market value/profitability/risk, there are only a smaller number on the question of whether diversification affects the efficiency of banks. As commonly expected, the combination of related activities can lower banks' operating costs, or shift resources more flexibly across banks' services, which can be converted into efficiency gains consequently (Gertner et al., 1994). Rhoades (1998) conducted case studies on nine large horizontal mergers in the American banks and found that all mergers resulted in significant increase in cost efficiency. However, several factors may outweigh the potential efficiency improvement in banks with greater activity diversity.

First, more diversified business lines and customers may increase the monitoring cost of banks without increasing the total output of their financial services, which thus dampens cost efficiency. In particular, the bankers who are more risk averse would be more likely to engage in costly monitoring in order to secure a less risky portfolio, even this monitoring could result in not only lower cost efficiency but also lower profit efficiency (Rossi et al., 2009). Second,

as Rajan et al. (2002) note, the inefficiency in resource allocation arises in diversified firms when resources flow toward the most inefficient divisions as their diversity in resources and opportunities increases, hence leading to more inefficient investment and lower market value. Meanwhile, bank managers likely become more entrenched with more costly diversification strategy, which causes inferior efficiency (Hughes et al., 2003).

Next, banks may become "too complex to manage" as their business diversity increases, which demands a higher cost to increase human capital or more sophisticated management know-how. Krause et al. (2017) find that banks with a higher degree of complexity seem to be less stable, and Chernobai et al. (2016) show that operational risk events in US bank holding companies have been significantly more frequent with their business complexity. Fourth, when banks expand their business into multiple financial services, they may gain dominant market status and thus may be complacent to enjoy a "quiet life" with decreased incentive to enhance their efficiency. Berger and Hannan (1998) and Koetter et al. (2012) both find evidence that banks with greater market power exhibit lower efficiency. Finally, entering new or unrelated business areas may weaken the "core competence" of banks, and consequently undermine their efficiency (Wernerfelt and Montgomery, 1988; Markides and Williamson, 1994).

There are only mixed results within prior works on the relationship between bank diversification and efficiency. Vander Vennet (2002) finds that financial conglomerates in Europe are more cost efficient than specialized banks, although there are only seemingly weak effects of diversification on their profit efficiency. Deng et al. (2007) find that diversified bank holding companies pay a lower cost of debt, consistent with Lozano-Vivas and Pasiouras (2010) who find an increase in cost efficiency with banks' non-traditional activities. Elsas et al. (2010) document that more revenue diversified banks are characterized by lower cost of equity and lower cost-to-income ratio.

In comparison, many other works reveal competing evidence against the efficiency-increasing impact of diversification. Ferrier et al. (1993) find that banks with diversified product lines are associated with higher cost inefficiency, in favor of the hypothesis of diseconomies of diversification. Jagtiani and Khanthavit (1996), although using only a limited sample of large banks, find that the regulations that encourage the expansion of banks' product mix results in a

less efficient banking industry. Klein and Saidenberg (1997) find that the diversification benefits of bank holding companies are failed to translate into higher profits, implying some underlying inefficiency problems that offset banks' gains from diversification, consistent with the evidence of Elyasiani and Wang (2012) that the efficiency of bank holding companies is on average negatively associated with their activity diversification. Berger et al. (1999) find that the consolidation between banks and other financial service institutions leads to little or no improvement on their cost efficiency, and Berger et al. (2010b) find only higher operating costs in more diversified banks in China. Rossi et al. (2009) find a negative impact of diversification on banks' cost efficiency, but a positive one on their profit efficiency. Fiordelisi and Ricci (2011) find no evidence that banks entering insurance business outperform their more specialized peers in terms of both cost and profit efficiency. Curi et al. (2015) find that foreign banks with a more focused business model exhibit higher efficiency. [11]

2.3 Efficiency and risk of banks

There has been a long list of literature that address the relationship between bank efficiency and risk. Earlier works such as Berger and De Young (1997) point out that efficiency plays a crucial role in determining the riskiness of banks. Under the "bad management" hypothesis, low efficiency is a signal of poor senior management practice, including their subpar skills in credit scoring and decision, lower competence in appraising the value of collateral pledged against the loans, and the difficulty to monitor the borrowers to ensure the loan contracts are enforced. Therefore, lower efficiency likely induces higher riskiness in banks. Kwan and Eisenbeis (1997) argue that banks with higher efficiency may have a higher franchise value, which in turn restrains their incentive to take excessive risk. Fiordelisi et al. (2011) suggest that low levels of efficiency might intensify the agency problems as banks may attempt to boost returns by lowering their lending standards or relaxing their efforts to monitor clients.

With some works finding a positive association between bank efficiency and risk (Altunbas et

[11] Boot and Thakor (1997) and Kanatas and Qi (2003) both suggest that financial innovation would be lower in a universal banking system than that in a system where the business of financial institutions is more specialized. If the financial innovations introduced by banks tend to improve their efficiency, then it is expected that banks' efficiency and their business diversity would be negatively associated.

al., 2007; Hou et al., 2014), the majority of prior literature suggests a beneficial effect of efficiency on the stability of banks. For example, Barr et al. (1999) find that banks' non-performing loan ratio is negatively associated to their efficiency in the US. Williams (2004), Podpiera and Weill (2008) and Tabak et al. (2011) also find that deteriorations in cost efficiency precede increases in non-performing loans, consistent with the "bad management" hypothesis. Eisenbeis et al. (1999), Shamsuddin and Xiang (2012) and Fu et al. (2014) find a positive nexus between the shareholder value and strengthened efficiency of commercial banks in the US, Australia and the Asia-Pacific region, respectively. Luo et al. (2016), using a large cross-country sample, find that banks' efficiency tends to decrease with financial openness and then increases the fragility of banks.[12]

3. Model

In order to investigate how banks' diversification affects their risk, in particular whether there is an efficiency conduit via which diversification affects risk indirectly, we estimate the following system of equations:

$$Risk_{ijt} = \alpha \cdot Diversification_{ijt-1} + \rho_1 \cdot Bankchar_{ijt-1} + \sigma_1 \cdot Macro_{jt} + \lambda_1 \cdot Regu_{jt} + \phi_1 \cdot Others_{jt} + f_i + \varepsilon_{ijt} \quad (1)$$

$$Efficiency_{ijt} = \beta \cdot Diversification_{ijt-1} + \rho_2 \cdot Bankchar_{ijt-1} + \sigma_2 \cdot Macro_{jt} + \lambda_2 \cdot Regu_{jt} + \phi_2 \cdot Others_{jt} + f_i + \varepsilon_{ijt} \quad (2)$$

$$Risk_{ijt} = \delta \cdot \hat{Efficiency}_{ijt} + \eta \cdot Diversification_{ijt-1} + \rho_3 \cdot Bankchar_{ijt-1} + \sigma_3 \cdot Macro_{jt} + \lambda_3 \cdot Regu_{jt} + \phi_3 \cdot Others_{jt} + f_i + \varepsilon_{ijt} \quad (3)$$

where *Risk* represents the level of risk for banks, *Diversification* the diversity of banks' business, and $Efficiency_{ijt}$ the operating efficiency of banks. We also control for four groups of risk determinants in our model, denoted as *Bankchar*, *Macro*, *Regu* and *Others*, respectively. *Bankchar* includes a series of bank specific characteristics, while *Macro* is a vector of macroeconomic conditions. *Rugu* proxies the stringency of financial regulations and *Others* represents some other controlled variables that may also affect the riskiness of banks. *f* is the bank-specific time invariant effect. ε is the idiosyncratic error. The subscripts of each variable, *i*, *j* and *t*, refer to bank, country and year, respectively. We use the one-year lagged observations

[12] Delis et al. (2017) suggest a two-way causality for the negative relationship between efficiency and risk.

for bank diversification and specific characteristics in each equation to mitigate the problems of endogeneity. Although not presented in the equations for the purpose of brevity, we also include both year effects and the lagged dependent variable in each equation to capture the dynamic nature of efficiency and risk of banks. We introduce all variables in our model in more detail in Section 4.

We first estimate eq. (1) to observe the *overall* effect of diversification on bank risk, which is captured by the coefficient α, without considering efficiency as a potential conduit to link diversification and bank risk. Although not disentangling the direct impact of diversification and the channel via which the impact of diversification is shipped to risk indirectly, this estimation indicates the aggregate effect of diversification. Were there a trade-off between the stability-increasing and stability-decreasing forces of diversification, the coefficient α might only suggest an ambiguous association between diversification and bank risk.

Eq. (2), regressing the efficiency of banks on their business diversification and other controlled variables, examines the impact of diversification on banks' efficiency, which is manifested by coefficient β. If banks' diversification tends to hinder their efficiency, as many noted in prior literature, we would expect a negative coefficient for β. As it is difficult to argue that any factor may affect banks' risk but not their efficiency, we use the same set of control variables as eq. (1). The estimation of eq. (2) allows us to derive the predicted value of efficiency, which is denoted as $\widehat{Efficiency}$ (efficiency hat), and we next include $\widehat{Efficiency}$ into eq. (3) with the same set of control variables as eq. (1). The coefficient δ on $\widehat{Efficiency}$ would suggest the risk impact of efficiency, which is affected by diversification, and is interpreted as the conduit via which diversification exerts its impact on bank risk indirectly. The size of the indirect impact of diversification on bank risk via efficiency is quantified as $\beta \times \delta$. As the indirect impact of diversification has been captured by δ, the coefficient of η on *Diversification* in eq. (3) implies the extra, or say, direct effect of diversification on bank risk.[13] We depict this estimation strategy as Figure 1.

[13] Since our analysis is focused on the impact of diversification—direct and indirect—on bank risk, we identify the efficiency hat in eq. (3) as diversification-induced (in)efficiency, rather than a general 'efficiency'. We do not argue that efficiency affects bank risk *only* through diversification in general. We thank the anonymous referee for this point.

We use the system generalized method of moments (GMM) to estimate our equations. The system GMM is selected because of its advantages when our model allows for the presence of unobserved bank-specific time invariant effect, the autoregressive process of efficiency and risk of banks and the likely endogeneity of bank explanatory variables (Arellano and Bover 1995; Blundell and Bond 1998). Meanwhile, the GMM estimator is recommended as a proper econometric method for our "small *T*, large *N*" panel dataset, which includes more than 1400 banks but only a small number of periods for each. We assume that the lagged dependent variable in each equation, diversification, efficiency and other bank characteristics are more than likely endogenous while the other factors are exogenous. The system GMM estimator addresses this concern on possible endogeneity by adopting moment conditions in which lagged differences are used as instrumental variables (IV) for the level equation in addition to the moment conditions of lagged levels as instrumental variables (IV) for the differenced equation. We use the two-step estimator in the system GMM as it is efficient and robust to various patterns of heteroskedasticity and serial correlation within idiosyncratic disturbances. Moreover, we use the Windmeijer (2005) finite-sample correction to the standard errors to reduce their likely downward bias. We conduct the Arellano-Bond test for serial correlation in the first-differenced errors to detect if there is any evidence that our model is misspecified, and the Hansen J test of over-identifying restrictions, which checks the overall validity of the instrumental variables.

4. Data and variables

We employ unbalanced bank-level panel data of more than 1400 banks in 39 emerging economies in Central and Eastern Europe, Latin America, and Asia with annual observations during the period of 2000-2016.[14] Only commercial banks are selected in our sample, to minimize any possible bias due to the different nature and business scope among banks. In order to avoid the potential problems of selection bias, we include in our dataset not only existing banks but also those that have ceased business operations.[15] We collect the data used

[14] To be specific, the selected economies include: Albania, Belarus, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Serbia, Slovakia, Slovenia, Ukraine (Central and Eastern Europe); Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Paraguay, Peru, Uruguay, Venezuela (Latin America); China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Singapore, Thailand, Vietnam (Asia).

[15] When there is a merger & acquisition between banks, we treat the existent bank as a newly established bank.

to measure banks' risk, diversification, efficiency and their characteristics from Bureau van Dijk's *Bankscope* database, and then construct the needed variables with our own calculation.[16]

4.1 Bank risk

Following the common practice in prior literature (Laeven and Levine, 2009; Houston et al., 2010; Demirgüç-Kunt and Huizinga, 2010), we use the Z-score (*Z*) as our primary indicator of bank risk, which is defined as:

$$Z_{ijt} = \frac{ROA_{ijt} + EA_{ijt}}{\sigma(ROA)_{ijt}} \tag{4}$$

where *ROA* represents the return on assets, *EA* denotes the ratio of equity to assets, and *σ(ROA)* is the standard deviation of return on assets. Following Beck et al. (2013), we use a three-year rolling time window to calculate *σ(ROA)*, rather than the full sample period.[17] Interpreted as the number of standard deviations by which returns would have to fall to wipe out all equity of the bank (Roy, 1952), the Z-score can be viewed as the inversed probability of bank failure. A higher value denotes a higher level of stability in the bank, or alternatively speaking, a lower value suggests the bank's higher exposure to insolvency risk.

Because the Z-score is highly skewed, we apply the natural logarithm to (1+ Z-score) to smooth higher values (Beck et al., 2013). Using 1+ Z-score instead of simply Z-scores is to avoid the truncation of the Z-score at zero. We denote ln(1+ Z-score) as the Z-score in the latter part of the paper for brevity. Prior to our calculation of the Z-score, we removed the outliers of *ROA*， *EA* and *σ(ROA)* above the 99th percentile and below the 1st percentile of the sample distribution to rule out abnormality or probable measurement errors. In order to better understand how diversification may affect risk via the efficiency conduit, we later use the three components of the Z-score, i.e., *ROA*, *EA* and *σ(ROA)*, as alternative dependent variables, which are interpreted,

That is, if Bank 1 and Bank 2 are merged in year T, we assume both banks are closed in that year and a new bank, Bank 3, is established in year T + 1. Accordingly, the direct (and biased) impact of M&A and failed (ceased) cases on bank risk is kept minimized in our analysis.

[16] *Bankscope* database has been rebranded as *Orbis Bank Focus* since the end of 2016.

[17] We alternatively calculate *σ(ROA)* and then the Z-score by using a five-year rolling time window and find the results are qualitatively consistent. However, to use a longer rolling window leads to a considerable reduction in the number of our observations.

respectively, as banks' profitability, (inverse of) leverage risk and asset portfolio risk. We also employ some other indicators for bank risk in our later robustness tests.

4.2 Bank diversification

We differ from many earlier works, which focus on the implications of banks' revenue diversification only, by gauging the diversity of banks' activities on not only their income but also the funding side. The diversification on these two aspects is calculated, respectively, as below:

$$Income\ diversification_{ijt} = \frac{Non\text{-}interest\ income_{ijt}}{Net\ interest\ income_{ijt} + Non\text{-}interest\ income_{ijt}} \quad (5)$$

$$Funding\ diversification_{ijt} = \frac{Total\ liabilities_{ijt} - Deposits_{ijt}}{Total\ liabilities_{ijt}} \quad (6)$$

The diversification of income is defined as the non-interest income as a share of net operating revenue (i.e., net interest income plus non-interest income), which suggests the extent by which banks expand their earnings to commissions, service charges, fiduciary income, trading income and other fees. The diversification of funding is proxied as the non-deposit funding as a share of total liabilities that reflects the reliance of banks on wholesale funding sources, such as interbank borrowing, certificates of deposit, repo agreements, commercial papers and other debt securities.[18] Following the practice by Acharya et al. (2006), Deng et al. (2007), Elsas et al. (2010) and others, we also use the alternative measures of income and funding diversification in the fashion of Herfindal-Hirschman Index (HHI) in our robustness tests in Section 5.2.

4.3 Bank efficiency

Our indicator of bank efficiency is based on the estimation of a translog cost function of banks, described below, by applying the fixed-effect panel stochastic frontier approach (SFA) proposed by Wang and Ho (2010).[19]

[18] Unlike some works using the specific income or debts from non-traditional sources by banks in more advanced countries, the breakdown of banks' non-interest income and non-deposit funding is not available in many emerging economies.

[19] Traditional panel stochastic frontier models usually fail to distinguish unobserved individual heterogeneity from

$$\ln TC_{ijt} = c + \sum_{h=1}^{3} \alpha_h (\ln y_h)_{ijt} + \frac{1}{2} \sum_{h=1}^{3} \sum_{k=1}^{3} \alpha_{hk} \ln(y_h)_{ijt} \ln(y_k)_{ijt} + \sum_{m=1}^{2} \beta_m \ln(w_m)_{ijt}$$
$$+ \frac{1}{2} \sum_{m=1}^{2} \sum_{n=1}^{2} \beta_{mn} \ln(w_m)_{ijt} \ln(w_n)_{ijt} + \frac{1}{2} \sum_{h=1}^{3} \sum_{m=1}^{2} \phi_{hm} \ln(y_h)_{ijt} \ln(w_m)_{ijt} + \sum_{g=1}^{2} \delta_g \ln(NP_g)_{ijt}$$
$$+ \frac{1}{2} \sum_{g=1}^{2} \delta_{gg} (\ln(NP_g)_{ijt})^2 + \sum_{h=1}^{3} \sum_{g=1}^{2} \kappa_{hg} \ln(NP_g)_{ijt} \ln(y_h)_{ijt} + \sum_{m=1}^{2} \sum_{g=1}^{2} \rho_{mg} \ln(NP_g)_{ijt} \ln(w_m)_{ijt}$$
$$+ \pi t + \sum_{h=1}^{3} \theta_h t \ln(y_h)_{ijt} + \sum_{m=1}^{2} \gamma_m t \ln(w_m)_{ijt} + \sum_{g=1}^{2} \pi_g t \ln(NP_g)_{ijt} + \vartheta Macro_{jt} + f_i + \varepsilon_{ijt} \quad (7)$$

$$\varepsilon_{ijt} = v_{ijt} + u_{ijt} \quad (8)$$

where TC_{ijt} denotes the total cost of bank i in country j in year t. y_h (h = 1, 2, 3) represents the quantity of three bank outputs, namely, loans, securities and off-balance sheet activities. w_m (m = 1, 2) denotes two prices of inputs, the price of funds, measured by the ratio of interest expenses over total liabilities, and the average price of other inputs, proxied by the ratio of non-interest operational expenses to total assets, respectively.[20] We also include equity and fixed assets of banks as two netputs (*NP*) in the cost function. t denotes a time trend. We additionally control for a number of macroeconomic variables as some other cost determinants, such as GDP per capita, GDP growth rate, interest rate and a dummy for financial crises. Finally, f_i represents the bank-specific fixed effect.[21]

The error term in eq. (1), ε_{ijt}, is composed of two parts. The first part, v_{ijt}, which is assumed normally distributed, represents measurement errors and the idiosyncratic variation in cost, while the second part, u_{ijt}, reflects the inefficiency of banks in producing financial services that would render an optimal level of cost. Inefficiency is assumed to be an exponential function of a bank-specific effect u_i and time t, i.e. $u_{ijt} = u_i \cdot exp(\varpi t)$, where u_i is assumed half-normal

inefficiency, hence may create biased estimates by forcing all time-invariant individual heterogeneity into the estimated inefficiency. Different from many earlier SFA methods, Wang and Ho (2010) remove the fixed individual effects by performing first-difference and within transformation and avoid the incidental parameters problem in some alternative works.

[20] We experimented by assuming that there are three inputs, i.e., funds, labor and fixed assets, in banks' operation and calculated their respective prices. The price of labor is measured by personnel expenses divided by total assets, and the price of fixed assets is calculated as the ratio of overhead cost, after ruling out personnel expenses, over fixed assets. Correspondingly, we use equity as the only netput. Although our estimation of efficiency is consistent with the result when using two input prices, the number of our observations is reduced considerably due to the limitation of data.

[21] When estimating eq. (7), we impose the conventional symmetric restrictions that require $\alpha_{jk} = \alpha_{kj}$ and $\beta_{jk} = \beta_{kj}$ ($j \neq k$). We also apply the constraints of price homogeneity by letting $\sum_{m=1}^{2} \beta_m = 1$, $\sum_{n=1}^{2} \beta_{mn} = 0$ (m = 1, 2) and $\sum_{m=1}^{2} \phi_{hm} = 0$ (h = 1, 2, 3).

distributed, and ϖ captures the time effect on bank inefficiency. We follow Battese and Coelli (1988) to convert this inefficiency item into $exp(-u_{ijt})$ such that the efficiency indicator is ranged in (0,1) and a higher value indicates a higher efficiency associated with the bank. As we use total cost as the dependent variable in eq. (7), our efficiency indicator as a matter of fact measures the cost efficiency of banks. In our later robustness tests, we experiment by replacing the cost efficiency with revenue and profit efficiency of banks.

4.4 Bank characteristics

We control for a series of bank characteristics in order to assess the impact of bank diversification on efficiency and risk as these variables can be correlated with diversification and relevant to efficiency and risk. We first control for the size of individual banks, measured by the natural logarithm of their assets in terms of millions of US dollars. Banks with a larger scale may own more sophisticated risk-control skills, richer human capital and easier access to international capital markets, which may mitigate their susceptibility to potential risk. However, as our sample covers widely heterogeneous banking markets in dozens of emerging economies, bank assets may not be a proper indicator for their market power. A bank may have a dominant market status in its own country even though its assets are less sizeable relative to its counterparts in other emerging countries. Hence, we add into our regressors banks' assets as a share of the aggregate banking sector assets as the proxy of their market power.[22] We next control for the liquidity of banks, measured by the ratio of liquid assets to total assets. An increased holding of liquid assets may play a stabilizing role on bank credit (Cornett et al., 2011), while it is also likely that banks choose to hold more liquidity amid some expected distresses.

Fourth, we control for banks' ownership status by introducing two dummy variables, indicating if a bank is foreign-owned or domestically state-owned other than domestically private owned.[23] Foreign banks may have both pros and cons when operating in host markets. On one

[22] Our practice is similar to some earlier works. For example, Bertay et al. (2013) include in their empirical estimations both the absolute size of banks, denoted as the logarithm of total assets in US dollars, and the relative size, defined by the ratio of bank liabilities to GDP. Bertay et al. (2013) find that a bank's rate of return on assets and its return on equity increase with its absolute size but decline with its relative size.

[23] In line with the common practice of related works, we define a bank as foreign owned if more than 50% of its capital is held by foreign banks, firms, individuals or organizations. We track the year-by-year domestic/foreign

side, foreign banks may own reputational advantages and the financial assistance from their parent banks, which may probably reduce their funding costs, but on the other side, foreign banks may confront more severe information disadvantages, agency costs and the disparity between home and host markets (Chen et al., 2017). Therefore, whether the foreign ownership may bolster the soundness of banks might be ambiguous. It is also generally posited that state-owned banks are more likely to be inefficient and risky in comparison to their privately owned peers, due to either political interventions or implicit government protection (Iannotta et al., 2013). Finally, we control for the age of banks, calculated as the logarithm of its operational years. Banks with a more prolonged operating history likely have richer information on their local market and may better overcome the problems of information asymmetry.[24]

4.5 Macroeconomic conditions

We first include in our model the logarithm of GDP per capita in thousands of US dollars in each of our sampled economies, as the measure of their overall economic development level. A higher GDP per capita may be associated with more mature market regimes and business-friendly environments, which likely foster better financial performance. We next adopt two macroeconomic variables to control for the effects of business cycles, namely, the growth rate of real GDP and the inflation rate. We obtain real GDP by using nominal GDP adjusted by the GDP deflator, and the inflation rate is the percentage change in the consumer price index. Since some of the countries exhibit chronically higher/lower GDP growth rates or inflation rates than other countries, we apply the Hodrick-Prescott filter to these two macroeconomic series and use the cyclical parts as the proxies of business cycles. Interpreted as the extent by which a variable in a specific year deviates from its long-term trend, a positively higher value suggests

ownership status for each bank in our sample by taking the following steps. We first check *Bankscope* for banks' ownership status in the last reporting year. Second, we identify the historical evolution of bank ownership by reading the profile on banks' website, where the changes on ownership are usually documented. We also use the database of *SDC Platinum*, which records both within- and cross-border mergers and acquisitions in banking markets, to distinguish the year when a bank's ownership is changed. If we are still unable to identify banks' ownership status, we resort to various sources such as banks' annual reports, the archives of central banks and the Internet. We follow similar steps to identify domestic government-owned banks, defined as banks with 50% or more of capital owned by government, public institutions or state-owned enterprises.

[24] In addition, the growth rate of bank size and bank corporate governance may also affect banks' efficiency and risk from diversification. Since ROE is a part of Z-score, which is the dependent variable in our regression, we do not include profitability-type variables, such as ROE or income-to-cost ratio, as an independent bank characteristic variable in the estimation.

the variable is relatively higher than its regularity, and vice versa.

The studies on the "risk-taking channel of monetary policy" have suggested that the innovation of central banks' monetary stance can be a significant determinant of bank soundness (Borio and Zhu, 2012). Following Bernanke and Mihov (1998), we construct for each sampled economy a structural vector autoregression (VAR) model with five macro-economic variables, namely, the growth rate of real GDP, the inflation rate, the first order difference of short-term interest rate, the real growth rate of financial credit and the depreciation of exchange rates. We then use the residuals of the interest rate equation to represent the innovations to monetary policy, where a higher (lower) value in this indicator suggests a contractionary (expansionary) policy adjustment. The main source of macroeconomic data is the IMF's *International Financial Statistics*. Moreover, as severe financial distress is commonly witnessed during crisis periods, we include in our estimations a dummy variable for the episodes of banking crisis during our sample period of 2000-2016 in order to control for possible crisis effects in emerging economies. We identified the crisis periods from Leaven and Valencia (2018).

4.6 Financial regulations and the other variables

In response to the scope and extent of financial regulations on banking activities, banks will choose the optimum level of risk-taking in their business operations. The empirical evidence that financial regulatory rules are an important factor affecting the risk of the banking sector has been reported in the literature (e.g., Barth et al. (2004, 2008) and Laeven and Levine (2009)). Our estimation therefore controls for the regulatory strength on four different aspects: the restriction on banks' activity mix (*Activity*), the strictness of regulations on capital adequacy (*Capital*), the authorities owned by supervisory agencies to intervene banks' structure and operation (*Supervisory power*) and the extent to which banks are exposed to private monitoring and public supervision (*Market discipline*). Using the survey data provided by Barth et al. (2004, 2008, 2013) and following the methodology suggested by Barth et al.(2004), we build country-level time-series indices for each of the above four regulatory aspects for each emerging economy in our sample. A higher score in these indices represents more stringent regulations.

The banking market structure may affect the performance of banks given the ongoing debate

whether market concentration or competition induces financial prudence (Boyd and De Nicoló, 2005; Beck et al., 2013). We use the Herfindahl-Hirschman Index (HHI), measured as the sum of the squares of an individual bank's market share in total banking assets, to proxy the overall market structure of host markets. A higher value of HHI indicates that the banking market approaches higher consolidation.

It has been suggested in prior literature that the efficacy of deposit insurance systems can affect the banking sector stability. Deposit insurance may benefit banks by lowering their deposit cost but has been commonly identified as a source of moral hazard in many research papers. Using the data from Demirgüç-Kunt et al. (2013) and following Barth et al. (2004), we construct a composite index to measure the strength of the deposit insurance coverage, by summing up various design features of deposit insurance schemes, such as the coverage limit as a share of GDP per capita, the source of funding, the compulsoriness of membership, and others.

Finally, as La Porta et al. (1998) have argued, institutional environments, including the effectiveness of contract enforcement and the legal protection on creditors, also influence financial development significantly. Following the literature of "law and finance", we include *Rule of law*, as the proxy for the quality of institutions in our regression. We obtain the data of the rule of law index from the World Bank's Worldwide Governance Indicators (Kaufmann et al., 2010).

4.7 Descriptive statistics

We present the definition of our main variables and their descriptive statistics in Table 1. The Z-score of banks in emerging economies is distributed with the mean value at 3.320 and the standard deviation at 1.148. Although not reported, the maximum and the minimum of Z-scores are -4.108 and 7.335, respectively. The relatively wide range of the Z-score and the fairly high standard deviation suggest a notable variation on the riskiness of banks across countries.

The mean level of banks' income diversification is 0.335 across our sampled economies, suggesting that a typical bank in emerging economies earns nearly one third of its net operating income from non-interest generating activities. In contrast, the mean value of the funding diversity is only 0.131 and the median is even lower, implying that banks are still more reliant

on customer deposits than wholesale funding as their major source of financing.[25] However, the overall values of our diversification indicators likely conceal their heterogeneity across countries. In Appendix Table 1, we present the average income and funding diversity of banks in each economy over periods. The share of non-interest income in net operating revenue is found higher in Central and Eastern Europe and Latin America than in Asia, while the proportion of non-deposit funding in total liabilities is notably higher in Latin America than the other two regions. These statistics seemingly suggest greater financial liberalization to allow banks to be engaged in non-traditional activities in Central and Eastern Europe and Latin America but more constraints in Asia.[26] Moreover, we find no persistently rising trend in the diversification of banks. Both Central and Eastern Europe and Asia experienced a decline in banks' non-interest income ratio in the sampled period of 2000-2016, and the relevance of non-deposit funding only increased apparently in Latin America.

Following the procedure that was introduced in Section 4.3, our estimation indicates the mean value of bank efficiency in emerging economies is 0.640.[27] This result is interpreted as that the efficiency of a typical bank is around 64% of that in the bank with the most optimal efficiency. As presented in Appendix Table 2, banks also exhibit regional heterogeneity in efficiency across economies. Banks in Central and Eastern Europe are characterized by the highest efficiency on average, while those in Asia have only the relatively lower efficiency. This regional difference in bank efficiency may be attributed to the disparity of market competition in the above three regions, as suggested by Wu et al. (2019) that the Lerner index is shown the highest in Asian emerging markets, followed by Latin America and Central and Eastern Europe. Although some countries experienced a decline in bank efficiency in the sampled period, there seems to be a rising trend in efficiency as our efficiency indicator overall increases in all three areas.

We also report the pairwise correlation coefficients between the key variables in

[25] The variation in the income and funding diversification is found driven by that between banks rather than within banks over time. The standard deviation of income (funding) diversification between banks is .187 (.169) whereas that within banks is .135 (.102).

[26] Demirgüç-Kunt and Huizinga (2010) document a relatively mild variation of income and funding diversification in commercial banks. However, they use only listed banks in their sample, which may have more stabilized income and funding structure than their peers. Meanwhile, they also find that the non-interest income as a share of total income of banks in developing economies is higher than that in developed economies, while the non-deposit funding as a proportion of total liability is lower in developing countries.

[27] The standard deviation of efficiency between banks is .170 while that within banks is .083.

Appendix Table 3. Both the Pearson correlation coefficient and the Spearman rank correlation coefficient suggest that the Z-score is negatively correlated with their diversification in both income and funding. This fact is consistent with the weak evidence diversification may have a stability-increasing impact found in much previous literature. Bank efficiency is found negatively correlated with their income from non-traditional business but positively correlated with the extent of banks' non-deposit funding, providing only mixed result for our hypothesis that banks' activity diversification may undermine their efficiency. Moreover, we find that, as expected, the Z-score and the efficiency of banks are positively correlated, in line with the works that more efficient banks would have a lower chance of failure. The correlation between income and funding diversification is positive, suggesting that banks with a higher share of non-interest income may also likely expand their funding sources beyond traditional customer deposits. However, the Pearson correlation coefficient between these two diversification indicators is only .038 and the Spearman rank correlation is .105, seemingly indicating only a modest co-movement of these two variables. Our other main variables are only mildly correlated, thus it is less likely to have serious multicollinearity problems when including them into our estimations collectively.

5. Results

5.1 Baseline results

Our baseline empirical results are reported in Table 2. We first estimate eq. (1) by using the income diversification as the only indicator of banks' activity mix (Table 2, column 1). This practice, although not distinguishing a potential conduit that allows for an indirect impact of banks' diversification, detects the overall effect of diversification on the risk of banks. We find that the coefficient on income diversification is .697 but statistically insignificant, implying no supportive evidence for a stability-increasing effect with a higher diversity in banks' income-generating activities.

We next estimate eq. (2) with the aim to examine if diversification tends to affect and hinder the efficiency of banks (Table 2, column 2). Regressing our indicator of bank efficiency on the level of banks' income diversification, we find the coefficient on income diversification is -

0.107, suggesting a negative and significant association between these two variables. This result is consistent with many previous works that find a declining efficiency of banks with an increased proportion of non-interest income. Based on the estimates of eq. (2), we derive the predicted value of efficiency, denoted as *efficiency hat*, and include it as a regressor in our next estimation.

With both the *efficiency hat* and income diversification in our model (eq. 3), this test examines whether diversification would exert an impact on bank stability via efficiency, and meanwhile if there is any extra direct impact from diversification, given the above-mentioned efficiency conduit has been controlled for. We find that, at Table 2, column 3, the coefficient on *efficiency hat* is positive (1.124) and statistically significant, interpreted as an evidence in favor of the efficiency conduit in the diversification-risk nexus, i.e., the lowered efficiency that arises with increased activity mix leads to a lower stability (or put differently, a higher risk) in banks. In addition, the coefficient on the income diversification is found at .798, larger than that when the efficiency conduit is not taken into account, and becomes statistically significant. This finding suggests that there are two competing forces associated with increased income diversification on the soundness of banks. The direct impact of diversification tends to bolster banks' stability, whereas the indirect effect through the efficiency conduit weakens it.[28]

We next replace the indicator of revenue diversification by that of funding diversification. As before, we first examine the effect of funding diversity on the Z-score without considering the potential efficiency conduit, and find no statistically significant result for a stability-increasing force by widening the sources of bank financing (Table 2, column 4). Funding diversification is however found negatively associated with the efficiency of banks (Table 2, column 5), probably due to the higher costs to collect wholesale funding. Having derived the predicted value of efficiency, *efficiency hat*, based on the above estimation, and include it in our next regression, we find analogous result to that when using income diversification as the proxy of bank diversification. The coefficient on *efficiency hat* is positive and statistically significant,

[28] We check the *overall* effect of income diversification based on the estimates at Table 2, column 2 and 3. The indirect impact of diversification on the Z-score of banks is calculated as $-0.107 \times 1.124 \approx -0.120$. As the direct impact of diversification is shown as 0.798, its overall impact is -0.120 + 0.798 = 0.678, very close to the result, 0.697, suggested in Table 2 column 1.

again suggesting that the diversified sources of bank funding mitigate their efficiency, which in consequence leads to a higher riskiness. The positive coefficient on funding diversification turns to be statistically significant after the efficiency conduit has been controlled for (Table 2, column 6).[29]

As the income diversification of banks is positively correlated with their funding diversification, it is possible that the variation of one indicator, at least partially, reflects the change in the other, thus likely causing biased estimates when these two diversification indicators are included in our model separately. In order to check if our results still hold by considering banks' activity mix on their income and funding side simultaneously, we include both the indicators of income and funding diversification in our model. As presented in Table 2, column 7, without considering the efficiency conduit, the coefficients on the income and funding diversification still fail to yield significant evidence that banks' risk tends to decrease with the diversity of their earning and funding sources. When using bank efficiency as the dependent variable, we find again some adverse effects of business diversification, that is, the coefficients on both income and funding diversification are still negative and statistically significant (Table 2, column 8). Having added the predicted value of efficiency into our next estimation, we find our results are still similar to before (Table 2, column 9). The coefficient on *efficiency hat* is positive and significant, again providing a supportive evidence for the efficiency channel that links diversification and risk indirectly. The direct impact of both income and funding diversification now becomes significantly positive, in line with the results when they are estimated separately.[30] More specifically, given the estimation results as shown in columns 8-9 of Table 2, where both the indicators of income and funding diversification are included, the direct impact of 1 percent increase in income diversification is shown to be 0.863 percent increase in bank stability (or the inverse of bank risk), while the indirect impact of income diversification through the efficiency conduit is -.096×1.061 ≈ -.101 percent, and that of funding diversification is -.142×1.061 ≈ -.150 percent. Accordingly, the overall impact of income diversification on the bank stability is -.101+.863

[29] The indirect impact of funding diversification on the Z-score, based on the estimation of Table 2, columns 5 and 6, is -.191×.966 ≈ -.184, and the overall impact is -.184 +.964 = .780. This result is highly close to the estimate (.762) based on Table 2, column 4.

[30] The overall impacts are still close to the estimates when the efficiency conduit is not considered in the estimation (see Table 2, column 7), but higher than those when the income/funding diversification is included in our model separately.

= 0.762 percent increase and that of funding diversification is -.150+.960 = .810 percent increase in bank stability. (See Figure 2)

To summarize, our results provide consistent evidence for a trade-off between the positive and negative forces associated with diversification on banks' stability. Although the risk of banks tends to decrease directly when banks can engage in fee-creating services and wholesale funding, their deteriorated efficiency offsets the beneficial impact and causes an ambiguous aggregate outcome on the stability of banks.

There are other interesting results with respect to the risk implications of other variables. We find that, after having controlled for the effects of efficiency, banks' stability is positively associated with their liquidity, in line with Cornett et al. (2011) that more sufficient liquid assets may reduce the probability of bank failure. Consistent with Iannotta et al. (2013), state-owned banks are seemingly characterized by higher riskiness than their foreign and domestic private-owned counterparts, as the coefficient on the dummy *state* is negative and significant in some of our regressions. There is some strong evidence that the stability of banks is pro-cyclical, i.e., it tends to strengthen (weaken) as the real GDP growth rate is deviated above (below) its long-term regularity. Meanwhile, the risk of banks is significantly deteriorated in the episodes of banking crisis. We also find that financial regulations may affect bank stability significantly. More stringent regulations on capital adequacy tend to secure lower bank vulnerability, while excessive supervisory power is seemingly only counterproductive. Finally, there is also some evidence suggesting bank risk is lower in countries with a stronger rule of law.

5.2 Robustness tests

In this section, we conduct a series of robustness tests to assess if our results are consistent when using alternative indicators of bank diversification, efficiency and risk. First, following Stiroh and Rumble (2006), Sanya and Wolfe (2011) and many others, we break down the net operating income into net interest income and non-interest income, and then construct our indicators of banks' diversification on the earning side in a Herfindahl Hirschmann Index (HHI) fashion:

$$Income\ diversification\_HHI_{ijt} = \left(\frac{Net\ interest\ income}{Net\ operating\ income}\right)_{ijt}^{2} + \left(\frac{Non\text{-}interest\ income}{Net\ operating\ income}\right)_{ijt}^{2} \quad (9)$$

where this index would be equal to 0.5 if there is a complete diversification between these two sources of income for a bank, and approach to 1 if the bank's income relies completely on only one type of activity. Different from our initial proxy of revenue diversification, which suggests the share of non-interest income within the earnings of banks, this alternative indicator reflects the dispersion of a bank's income between their interest income and non-interest income.

Analogously, we separate banks' total liabilities into customer deposits and the non-deposit liabilities, and then compute an alternative indicator for funding diversity as:

$$Funding\ diversification\_HHI_{ijt} = \left(\frac{Deposits}{Total\ liabilities}\right)_{ijt}^{2} + \left(\frac{Non\text{-}deposit\ funding}{Total\ liabilities}\right)_{ijt}^{2} \quad (10)$$

We replace these two alternative indicators for income and funding diversification into our model and present the results in Table 3. When using the Z-score as the dependent variable and not considering the efficiency conduit, the coefficients on income and funding diversification are found negative, suggesting the stability of banks may increase with a greater dispersion of banks' income or funding between different sources, but the coefficients are all statistically insignificant, no matter whether they are included in our estimation separately or jointly (Table 3, columns 1, 4 and 7). In the efficiency equation, we find that these two diversification indicators enter our regression significantly, and the coefficients suggest banks' efficiency tends to decrease with a higher level of income/funding diversification (Table 3, columns 2, 5 and 8). After having taken the efficiency conduit into consideration, we still find efficiency is significantly and positively related to the Z-score of banks, lending consistent evidence that diversification can increase the risk of banks by reducing their efficiency. In addition, the coefficients on income and funding diversification turn to be statistically significant, implying there is a direct beneficial impact of diversification but is offset by the negative effect aroused by lowered efficiency (Table 3, columns 3, 6 and 9).

We next adopt different proxies of efficiency and replace our initial efficiency indicator. Like before, we still include only the indicator of income and funding diversification separately in our regression and then jointly. The results are reported in Table 4, and for brevity, we present

only the estimates for eqs. (2) and (3) since those of eq. (1) are not affected by using alternative measures of efficiency. We first re-estimate the inefficiency item in eq. (8), u_{ijt}, which is an exponential function of $u_i \cdot exp(\varpi t)$, by assuming u_i is truncated-normal distributed, other than following a half-normal distribution. As presented in Panel A of Table 4, we find consistent outcomes as our baseline results: Both the coefficients on income and funding diversification are negative and statistically significant when efficiency is the dependent variable. The coefficient on *efficiency hat*, the fitted value of efficiency by the last estimation, is found positive as the Z-score is the dependent variable, and meanwhile the positive coefficient on income diversification is statistically significant and that on funding diversifi-cation is significant in one regression and only marginally not in the other case.

We then experiment replacing our indicator of cost efficiency by that of revenue and profit efficiency.[31] We alternatively estimate eq. (7) by substituting the dependent variable, total cost, by banks' total revenue. As shown in the Panel B of Table 4, this practice does not alter our results qualitatively. We still find that increased income and funding diversification hinders the revenue efficiency of banks, implying that expanded areas of activities not only add the costs of banks, but also impede them to create the optimal amount of revenue given the volumes of their services and the input prices. Moreover, regressing the Z-score on the *efficiency hat* and the income and funding diversification, we find that the coefficients on *efficiency hat* remain positive although their statistical significance is weakened, while those on the diversification indicators are all significantly positive.

We additionally use the indicator of banks' profit efficiency, which is computed by replacing the total costs of banks with their profitability and re-estimating eq. (7). Like our earlier experiments, we still find consistent results (Table 4, Panel C). There is a negative association between the income/funding diversification and the profit efficiency of banks, interpreted as that banks' profits are deviated below their hypothetically optimal level, probably because of the unfavorable effects of diversification on their cost and revenue. *Efficiency hat* is found positively and significantly related to the Z-score and the coefficients on both income and

[31] We find the correlations between our three efficiency indicators are positive and not excessively high. The correlation between cost efficiency and revenue efficiency (profit efficiency) is .476 (.576).

funding diversity are positive, either statistically significant or only marginally not.

We next experiment using a series of different risk proxies to replace the Z-score of banks. The results are reported in Table 5. We only present the estimates for eqs. (1) and (3) since the estimations of eq. (2) are not affected by the substitution of alternative risk indicators. First, as the Z-score of individual banks may not reflect their relative riskiness in comparison to their counterparts in the banking sector, we define the *excessive risk* of bank *i* in country *j* in each year *t* as below:

$$excessive\ risk_{ijt} = \frac{Z_{ijt} - \bar{Z}_{ijt}}{\max(Z_{ijt}) - \min(Z_{ijt})} \quad \text{for } j = 1, 2, \ldots J \text{ and } t = 1, 2, \ldots T \qquad (11)$$

where $\bar{Z}_{ijt}$ denotes the average Z-score for banks in each economy *j* in year *t*, and max(Z_{ijt}) and min(Z_{ijt}) represent the maximum and the minimum of Z-scores in country *j* in year *t*. A higher reading of this indicator is interpreted as a greater stability (or say, lower risk) of the bank in excess of the average stability of banks in their own country. This indicator allows for the comparison of the relative riskiness of banks across countries. As presented by the Panel A in Table 5, we find that the results after replacing the Z-score with this excessive risk indicator are overall consistent with our baseline findings. The coefficient on *efficiency hat* is still positive and statistically significant, suggesting an operating efficiency conduit even though the riskiness of banks is measured in this relative manner. Having controlled for the efficiency conduit, the direct impact of income and funding diversification is shown positive and significant.

We also experiment using another two commonly used variables to measure bank risk, namely, the non-performing loans as a share of gross loans and the ratio of loan loss provisions to gross loans. The former is an *ex post* measure of risk, while the latter an *ex ante* measure of risk. Despite this difference, higher values in both proxies suggest higher risk, or say, lower stability in banks. The results based on non-performing loans and loan loss provisions are still in line with our benchmark results. *Efficiency hat* is found negatively associated with these two risk indicators, suggesting banks' non-performing loans and loan loss provisions will increase if their efficiency decreases with expanded diversification. The extra direct effect of both income

and funding diversification is still found beneficial to the risk of banks, as the coefficients on these two diversification proxies are negative and statistically significant in most cases when the efficiency channel is considered (Table 5, Panel B and C).

Finally, different from using accounting data to build the risk indicators such as the Z-score, we follow Merton (1974) to construct the distance to default of banks based on market data and use it as our proxy of bank risk. We compute this Merton's distance-to-default indicator such that a higher value indicates a farther distance to default, or put differently, a higher level of stability.[32] Because most of banks in emerging economies are not listed in stock markets, the number of banks that are used in our regressions decreases considerably. Nevertheless, as reported in Panel D in Table 5, we find our results are qualitatively consistent. There is a significantly positive relationship between *efficiency hat* and Merton's distance to default, indicating that a lowered efficiency with banks' diversification would increase the likelihood of bank default. Meanwhile, as the efficiency channel is controlled for, the coefficients on income and funding diversification, which hint the direct impact of banks' activity mix, are still found positive, either statistically significant or only marginally not.[33]

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[32] To be more specific, the distance to default (DD) is computed as:

$$DD = \frac{\ln(\frac{V}{F}) + (\mu - 0.5\sigma_V^2)T}{\sigma_V\sqrt{T}}$$

where V is the current bank value, F is the face value of the bank's debt, μ is the expected return of bank assets and σ_V the volatility of the bank's assets. T is the forecast horizon. V and σ_V are estimated using the following two equations, as they are not observable. The first one is the call option pricing formula by Merton (1974):

$$E = VN(d_1) - e^{-rT}FN(d_2)$$

where E is the equity of the bank, r is the risk-free interest rate and N is the cumulative density function of the standard normal distribution. d_1 and d_2 are defined as below, respectively:

$$d_1 = \frac{\ln(\frac{V}{F}) + (r + 0.5\sigma_V^2)T}{\sigma_V\sqrt{T}} \quad \text{and} \quad d_2 = d_1 - \sigma_V\sqrt{T}$$

The second equation is the volatilities of firms' assets to equity using Ito's formula:

$$\sigma_E = (\frac{V}{F})N(d_1)\sigma_V$$

We measure F by using the total liabilities of the bank. The expected return of assets μ is gauged by one-year lagged ROA of the bank. The forecast horizon T is set at 1 as a common practice. The risk-free interest rate r is proxied by the money market rate. Equity value E is measured as the number of shares outstanding times daily stock price. The data of banks' number of shares and stock price are from the *Bloomberg* database. We use the iterative procedure described in Bharath and Shumway (2008) to calculate the value of the monthly DD for each bank and then convert them into yearly data by taking a simple average of the monthly DD value.

[33] Although not reported, we also construct the naïve distance to default, proposed by Bharath and Shumway (2008), as a simpler alternative of Merton's distance to default. The results are still consistent with our baseline findings.

To summarize, our experiments with various alternative diversification, efficiency and risk indicators generally reveal an operating efficiency conduit that offsets the direct stability-increasing impact of diversification.

5.3 Diversification, efficiency and the components of Z-scores

In order to better understand how diversification affects the risk of banks, with the efficiency conduit considered, we use the three components of the Z-score, i.e., the return on assets (ROA), the ratio of equity over assets, and the standard deviation of ROA, as the dependent variable in our estimation of eqs. (1) and (3). These three components are interpreted as the measures of banks' profitability, leverage risk and portfolio risk, respectively. The results are present in Table 6.

We find that the indirect effect of diversification on bank stability, via the efficiency conduit, is more conspicuous on the ROA and the volatility of ROA in banks. Put differently, the efficiency conduit offsets the beneficial impact of business diversification mainly through its effect on the profitability and portfolio risk of banks, but not significantly on their leverage risk. When using ROA as the dependent variable (Table 6, Panel A), the coefficient on *efficiency hat* is positive and statistically significant, implying that banks' profitability tends to decline when diversification dampens their operating efficiency. Meanwhile, both income and funding diversification yield an extra positive impact on ROA, suggesting that there is a direct beneficial effect by banks' activity diversification, but it is counteracted by the adverse effect through lowered efficiency. We find analogous results on banks' portfolio risk. The standard deviation of banks' return ($\sigma(ROA)$) is negatively associated with *efficiency hat*, which indicates an increased volatility in banks' return amid lower efficiency. As the efficiency channel has been controlled for, a higher level of business diversification on both the income and funding of banks tends to reduce the volatility of bank return (Table 6, Panel C). However, we find no significant evidence that efficiency would affect the equity-to-assets ratio of banks, although the sign of the coefficient on *efficiency hat* suggests a likely negative association between these two terms. The extra direct impact of diversification on banks' equity-to-assets ratio is not significant either (Table 6, Panel B).

5.4 M&A and failed bank cases

Our sample covers 1403 banks, of which 252 banks were merged or experienced bankruptcy (including liquidation). The proportion of those banks out of total number of banks is 18% (252/1403). We reestimated the diversification-efficiency-bank risk nexus equations after removing these banks from our sample.[34] The estimation results are reported in Table 7.

We find that our main results are not qualitatively changed. In particular we still detect that efficiency can play a negative conduit that transmits the impact of diversification on bank risk. However, the favorable direct effect of diversification dominates the unfavorable indirect effect via (in)efficiency channel, resulting in the total effect of bank-stability-inducing diversification activities by banks. We provide the results without bankrupt or merged banks below.

6. The heterogeneous diversification-risk nexus

In this section, we mainly focus on the investigation whether the diversification-risk nexus in banks is heterogeneous. In particular, we examine whether the offsetting effect of diversification on bank stability via efficiency varies across a number of bank characteristics, namely the size, market power and ownership of banks, and in the meantime whether the direct impact of diversification also differs across these bank characteristics. We revise our eqs. (2) and (3) as the following:

$$\begin{aligned} Efficiency_{ijt} = {} & \beta \cdot Diversification_{ijt-1} + \zeta \cdot Diversification_{ijt-1} \times X_{ijt-1} \\ & + \rho_2 \cdot Bankchar_{ijt-1} + \sigma_2 \cdot Macro_{jt} + \lambda_2 \cdot Regu_{jt} + \phi_2 \cdot Others_{jt} + f_i + \varepsilon_{ijt} \end{aligned} \tag{12}$$

$$\begin{aligned} Risk_{ijt} = {} & \delta \cdot \hat{Efficiency}_{ijt} + \eta \cdot Diversification_{ijt-1} + \gamma \cdot Diversification_{ijt-1} \times X_{ijt-1} \\ & + \rho_3 \cdot Bankchar_{ijt-1} + \sigma_3 \cdot Macro_{jt} + \lambda_3 \cdot Regu_{jt} + \phi_3 \cdot Others_{jt} + f_i + \varepsilon_{ijt} \end{aligned} \tag{13}$$

where the interactive term between diversification and bank characteristics X is included in our model. The interactive term, *Diversification* × X, in eq. (12), would suggest if the impact of diversification on efficiency would alter, given the difference on banks' characteristic X, and in eq. (13) it indicates if the direct impact of diversification on bank risk would vary with this characteristic, after the heterogeneous efficiency conduit has been controlled for.

[34] We thank the anonymous referee for this suggestion.

6.1 Bank size

We first examine if the relationship between diversification and risk, including the efficiency conduit that links these two variables, would alter with the size of banks. As presumed conventionally, large banks may better exploit the economies of scale and yield higher cost efficiency as their financial production increases (Hunter and Timme, 1986; De Young and Roland 2001). Moreover, large banks may be equipped with advanced technologies, more sophisticated risk-control skills and/or richer human capital, which allow them to better manage the risk associated with non-traditional business (Cerasi and Daltung, 2000; Chiorazzo et al., 2008). Smaller banks, in contrast, are commonly less transparent and lack the adequate expertise to manage more diversified business lines, which likely induce them to be more inclined to take riskier projects (De Jonghe et al., 2015).

We construct a dummy variable, *Dummy*(*size*), which is equal to 1 (0) if the size of a bank is above the median value of our sample distribution, and then interact it with our indicators of income and funding diversification, respectively. As before, we first include these two interactive terms separately and then jointly. The results are reported in Table 8.

When regressing efficiency on the diversification indicators and their interactive terms with *Dummy*(*size*), we find that the coefficients on the stand-alone terms of diversification are still negative and statistically significant as our earlier findings, no matter that these two measures of diversification are included in our estimation separately or collectively. The interactive terms, *income diversification*$\times$*Dummy*(*size*) and *funding diversification*$\times$*Dummy*(*size*), are found both positive and significant in all cases (Table 8, columns 1, 3 and 5). These results suggest that, although more diverse activity mix reduces the efficiency of banks in general, this "diseconomies of diversification" is more conspicuous in smaller banks. Probably due to the offsetting strength from the economies of scale, the efficiency of large banks is less hindered with the expansion of their business areas.

With the Z-score as the dependent variable and *efficiency hat*, diversification, and the interactive terms of diversification with *Dummy*(*size*) added into our regressors, we find that, the coefficients on *efficiency hat* are still positive and significant (Table 8, columns 2, 4 and 6).

These results indicate not only an operating efficiency conduit that links diversification and risk, but also that the effects of diversification on efficiency would be converted into heterogeneous risk impacts across bank sizes. For income diversification, its direct effect on bank stability is significantly positive, and we find no evidence that this direct effect may vary across banks with a large or small size. For funding diversification, however, its direct beneficial impact on bank stability is seemingly more pronounced in larger banks.

Overall, our results imply that larger banks benefit more from business diversification. On one side, the effect of both income and funding diversification on efficiency is significantly dampened in banks with greater assets, thus weakening the countervailing force of the efficiency conduit on bank stability. On the other side, although the income diversifi-cation does not have heterogeneous direct effects across bank assets, the direct impact of funding diversification is more conspicuous in larger banks, thus leading to greater stability-increasing outcomes when these larger banks increasingly expand their business into non-traditional areas.[35]

6.2 Market power

As banks may be exposed to higher risk when they expand business into areas where they face greater competition (Acharya et al., 2006), we are interested to examine in this subsection if banks' market power plays any role in their nexus of diversification and risk. The adverse impact of diversification on bank stability might be moderated if banks' market power allows them to have greater advantages in competition. A dominant market status may also reduce banks' incremental costs when they shift to non-deposit funding (Bertay et al., 2013), thus likely reducing their efficiency by a lesser extent than their counterparts. Moreover, banks with greater market share may face tighter prudential supervision and regulatory constraints due to their systemic importance within banking sectors (Khan et al., 2017), which likely limit the "dark side" of bank diversification. Analogous to before, we construct a dummy, *Dummy*(*market*

[35] A number of other works have documented that the effect of diversification on banks' risk or performance may vary with their size. Stiroh (2004b) find that income diversification affects the risk-adjusted performance of community banks negatively, which generally have much lower assets, and positively in the case of other types of banks. Chiorazzo et al. (2008) detect a positive relationship between non-interest income and banks' Sharpe ratio, and find that this relationship is more pronounced for larger banks. De Jonghe et al. (2015) find that non-interest income only reduces the systemic risk exposure of large banks.

power), which is equal to 1 (0) when the indicator of market power is above the median of its distribution.[36] We next compute the interactive terms of income and funding diversification with this dummy, and include them into our estimations. The results are reported in Table 9.

We first detect how the impact of income and funding diversification on efficiency varies with the market power of banks. We find that market power may shield banks' efficiency from being undermined with their diversification, but the result is only significant with funding diversification. To be more specific, when using efficiency as the dependent variable, the coefficients on income diversification is still negative and significant as before, but those on their interactive term with *Dummy*(*market power*) have only mixed sign and are insignificant, lending no evidence that the impact of income diversification on efficiency may differ across banks with higher/lower market power. In contrast, we find the coefficients on funding diversification are significantly negative while those on its interaction with *Dummy*(*market power*) are significantly positive (Table 9, columns 1, 3 and 5). These findings indicate a greater heterogeneity on efficiency with banks' market power when funding diversification increases, but no evident heterogeneous efficiency effects with income diversification.

As we regress the Z-score on *efficiency hat*, diversification and the interaction of diversification with *Dummy*(*market power*), we still find positive coefficients on *efficiency hat*, which is perceived as the evidence for operating efficiency conduit (Table 9, columns 2, 4 and 6). Although income diversification does not lead to statistically different effects on efficiency, the notably different impact by funding diversity across banks' market power would be transmitted via the efficiency conduit and translate into a more (less) conspicuous offsetting strength in banks with lower (higher) market power.

Moreover, with respect to the direct impact of diversification, the coefficients on income diversification is insignificantly positive, while those on its interactive term with *Dummy*(*market power*) are positive and highly significant. This result implies that the banks with greater market power tend to yield a higher direct beneficial impact on their stability relative to their counterparts with lower market power. In comparison, we find that the

[36] We checked if there is a significant overlap for the banks with a larger size and the banks with a greater market power. The correlation coefficient between *Dummy(size)* and *Dummy(market power)* is only 0.380, suggesting an adequate discrepancy between these two groups of banks.

coefficients on funding diversification are significantly positive while those on the interactive term are significantly opposite, suggesting that the direct beneficial effects from funding diversification are more pronounced in banks with lower market power (Table 9, columns 2, 4 and 6). As noticed, in both of the regressions using efficiency and the Z-score as the dependent variable, the size of the coefficients on funding diversification and its interaction with *Dummy*(*market power*) is very close to each other, implying that the banks with greater market power are shielded from the direct impact of funding diversification.

To summarize, in this section, we find that greater market power allows banks to reap more diversification gains, in particular, the stability of banks benefits directly from their income diversification, and indirectly from their funding diversification.[37]

6.3 Foreign and state ownership

Lastly, we investigate if the nexus of diversification and risk diverges across banks' ownership status. How banks' ownership influences the impacts of diversification on their risk is theoretically ambiguous. Foreign banks likely benefit from diversification owing to their richer experience in innovative fee-based services, but they also face some problems that may result in fewer diversification gains, including greater information difficulties in markets that are different from their home countries (Chen et al., 2017), and/or the internal governance problems that they have to rely on the directions from parent banks other than their own independent decisions (Curi et al., 2015). In addition, although traditionally perceived as more risky than other types of banks, state-owned banks may likely outperform their peers on efficiency if the implicit government guarantee saves on costs in raising non-deposit funding, or if they have the privilege to earn profits from some government-sponsored programs (Bhattacharyya et al., 1997).[38] Hence, how ownership might affect the risk implications of diversification is still an empirical question to answer.

[37] Similar to our results, Khan et al. (2015) find that banks tend to take higher risk when they are more reliant on customer deposit but this adverse effect is significantly buffered when they have more important market status, probably because they are more closely overseen by financial regulators. Nguyen et al. (2012) also find that revenue diversification in South Asian banks tends to strengthen their stability, but this effect is more conspicuous in banks with greater market power.

[38] For example, Bhattacharyya et al. (1997) find that state-owned banks exhibit higher efficiency than private banks in India, likely attributed to the support of government and/or the public confidence with respect to safety of deposits. They also note that state-owned banks are more likely to be selected for government borrowing programs and hence earn rich fee-based income.

We group our sampled banks into three types, i.e., foreign banks, domestically state-owned banks and domestically private banks, and accordingly we use the dummy *foreign* to denote foreign banks and *state* to represent domestically state-owned banks. These two dummy variables are analogously interacted with the indicators of income and funding diversification and added into our estimations. The results are presented in Table 10.

We find that, when regressing efficiency on the proxies of diversification and their interactive terms with banks' ownership status, the coefficients on the stand-alone terms of income diversification and funding diversification are negative and statistically significant, in line with our benchmark findings. These results suggest that the diversity of banks' activities would lower the efficiency in domestically private banks. The coefficients on the interactive terms of *state* with both the income/funding diversification are found significantly positive, implying that the efficiency of state-owned banks is less reduced, or even increased, with the expansion of their earning and financing sources. However, as to the coefficients on the interaction of *foreign* with diversification, we find no statistically significant results overall, except *funding diversification* × *foreign* in only one case (Table 10, columns 1, 3 and 5). These findings are interpreted as the evidence in favor of impeded effects of diversification on efficiency in domestic state-own banks, whereas there seems no significant disparity on the diversification-efficiency linkage for foreign banks.

We next examine the direct effect of diversification on bank risk, with the efficiency conduit controlled for, and find that income diversification still exerts a direct beneficial impact for domestic private banks, but there are only some marginally insignificant evidence that funding diversification would also directly benefit the stability of domestic private banks. The coefficients on the interactive terms *state* and income/funding diversifications are negative but statistically insignificant, while those on *foreign* and both diversification indicators are negative and significant in all regressions (Table 10, columns 2, 4 and 6).

Overall, our results suggest that, relative to their private counterparts, domestic state-owned banks are likely more benefited from business diversification, because their efficiency are less reduced with expanded activity mix and thus they are exposed to a less adverse indirect impact via the efficiency conduit. In contrast, foreign banks are seemingly affected by diversification

only unfavorably, as there is no adequate evidence that the efficiency conduit is mitigated thanks to their foreign ownership and diversification only yields a more conspicuously adverse direct impact on their stability.[39]

6.4 A summary of bank heterogeneity of diversification effects on bank risk

This subsection provides a summary of direct, indirect and total effects of diversification—income diversification and funding diversification—on bank stability (or the inverse of bank risk) for different types of banks.[40] The summary effects are reported in Table 11.

Bank diversification, both from the income side and funding side, are shown to increase bank stability (or decrease bank risk) significantly. These favorable effects of diversification on bank risk are achieved by large direct effects, which are partially offset by unfavorable indirect effects caused by the inefficiency channel of the implementation of bank diversification. This pattern of the diversification-bank risk nexus is confirmed well for income diversification by small banks, banks with low market power and domestic privately-owned banks. Evidence on the negative or small positive effects of indirect effects of both income diversification and funding diversification on bank stability through the efficiency channel are also provided in Table 10. Interestingly, in contrast to privately-owned domestic banks and state-owned banks, foreign banks are shown not to be benefitted from bank diversification activities, as discussed in Sec. 6.3.[41]

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[39] We compare our results with some related works. As with our results, Pennathur et al. (2012) find that the relevance of non-interest income is negatively associated with the volatility of profitability for state-owned banks in India, while the result is opposite for foreign banks. Curi et al. (2015), using the data from Luxembourg, record a negative association between efficiency and income/funding diversification of foreign owned banks. In contrast, Berger et al. (2010b) find that the diseconomies of diversification, evidenced by higher costs and lower profits with the extent of bank diversification, are mitigated in banks with foreign ownership in China. Saghi-Zedek (2016) uses the sample of banks in 17 developed European countries and the result reveals diseconomies of diversification when banks are state owned.

[40] For overall banks and benchmark characteristics banks (i.e., small, low market powered and domestic private-owned banks), direct effects are estimated by the coefficient on *Diversification*, η, in eq. (3); indirect effects are estimated by the product of the coefficients on *Diversification*, β, in eq. (2) and *Efficiency hat*, δ, in eq. (3), which is $\beta\delta$; and total effects are estimated as $\eta + \beta\delta$. This system is illustrated in Figure 2. For other non-benchmark banks (large, high market powered and foreign/state-owned banks), direct effects are estimated by $\eta + \gamma$, where γ is the coefficient on the interaction term for non-benchmark characteristics banks from eq. (13); indirect effects are estimated by $(\beta + \zeta) \times \delta$, where ζ is the coefficient on the interaction term for non-benchmark characteristics banks from eq. (12); and total effects are estimated by $(\eta + \gamma) + (\beta + \zeta) \times \delta$. The levels of statistical significance are determined most conservatively, meaning that the estimated effects are considered statically significant only when all estimated coefficients comprising each of direct, indirect and total effects are statistically significant.

[41] Further specific analyses on the time-related heterogeneity of the 'diversification-bank risk' nexus will be left for our future research.

7. Conclusions

How diversification affects the stability of banks is still an inconclusive question. In spite of a rich size of works that assess the overall relationship between diversification and bank risk, only a few disentangle the direct and the indirect impact of diversification by investigating the potential conduits that may transmit the impacts of diversification to risk. In this paper, we hypothesize that efficiency is likely such a conduit, which leads to a negative impact on the stability of banks as efficiency likely decreases with the diversity of banks' business and counteracts the direct beneficial impact of diversification.

Using the bank-level data from more than 1400 commercial banks in 39 emerging economies in Central and Eastern Europe, Latin America and Asia during the period of 2000-2016, we find consistent evidence that, the diversification of banks on their revenue and funding sources are negatively associated with the efficiency of banks, suggesting a detrimental impact of activity diversity on efficiency. With the efficiency conduit considered and controlled for, there is an overall stability-increasing (and risk-reducing) effect of expanded business diversification. Our results are robust when we use alternative indicators for diversification, efficiency and risk. We also extend our research into the heterogeneity of the diversification-bank risk nexus, including the composition of their direct and indirect linkages, and find that this diversification-bank risk association varies across banks' size, market power and bank ownership.

Our findings may shed some light on the underlying pros and cons of banks' diversification in many emerging economies. While increased activity diversification of income and funding sources could exert some favorable effects on the stability of banks, there is an offsetting force arising from lowered bank efficiency when banks are engaged in the business beyond their traditional areas. Thus, the overall benefits from bank diversification rely on the trade-off of the two competing forces. As many prior studies and this one suggest the diversification of income and funding sources alone cannot guarantee a bolstered financial stability. As the structural reforms in emerging economies proceeds, which allow for higher financial liberalization and increased participation in various financial services, it is critically important for financial regulators to have a better understanding on both the "bright side" and the "dark

side" of banks' business diversity. The efforts to neutralize the undesired effects of activity mix are recommended as an indispensable condition for maximized diversification benefits on financial stability.

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Table 1. Main variables and the descriptive statistics

Variable	Definition	Source	Mean	Median	Std. dev.	1st percentile	99th percentile
Bank risk							
Z	Natural logarithm of Z-scores, i.e., ln [1+ (ROA_{ijt}+ EA_{ijt}) /$\sigma(ROA)_{ijt}$], where *ROA* denotes return on assets, *EA* the equity as a share of total assets, and σ(*ROA*) the 3-year rolling-over standard deviation of ROA. A higher value in the Z-score suggests a greater stability, or put differently, a higher risk-taking level of banks.	Bankscope and authors' own calculation	3.320	3.371	1.148	.482	5.817
Business diversification							
Income diversification	Non-interest income as a share of net interest income plus non-interest operating income.	Bankscope and authors' own calculation	.335	.306	.211	0	.948
Funding diversification	Non-deposit liability as a share of total liability.	Bankscope and authors' own calculation	.131	.066	.179	0	.956
Efficiency							
Efficiency	Efficiency index based on the estimates of a trans-log cost function of banks, employing the stochastic frontier approach suggested by Wang and Ho (2010). The estimated inefficiency item in the error term is converted by following Battese and Coelli (1988) such that the efficiency indicator is ranged in (0,1) and a higher value implies a higher level of bank efficiency.	Bankscope and authors' own calculation	.640	.653	.180	.155	.986
Bank characteristics							
Size	Natural logarithm of bank assets in millions of US dollar.	Bankscope and authors' own calculation	6.999	6.926	2.234	2.233	12.432
Market power	Bank assets as a share of the aggregate assets in banking sector.	Bankscope and authors' own calculation	.032	.007	.062	.000	.292
Liquidity	The ratio of liquid assets to total assets.	Bankscope and authors' own calculation	.267	.218	.193	.009	.909
Foreign	A dummy which is equal to 1 if more than 50% of the bank capital is owned by foreign banks, individuals, firms or organizations.	Authors' own collection	.424	0	.494	0	1
State	A dummy which is equal to 1 if more than 50% of the bank capital is owned by domestic government or state-owned enterprises.	Authors' own collection	.116	0	.320	0	1
Age	Natural logarithm of banks' operational years.	Bankscope and authors' own calculation	3.023	2.944	.949	.693	4.948

Macroeconomic condition							
GDP per capita	Natural logarithm of GDP per capita in thousands of US dollar	International Financial Statistics and authors' own calculation	1.546	1.605	.963	-.805	3.652
GDP growth rate	The cyclical part in Hodrick-Prescott filtered real GDP growth rate (%). A higher value suggests a greater deviation from the regularity of GDP growth rate.	International Financial Statistics and authors' own calculation	.032	.168	2.749	-10.756	6.153
Inflation	The cyclical part in Hodrick-Prescott filtered inflation rate (%). A higher value indicates a greater deviation from the regularity of inflation.	International Financial Statistics and authors' own calculation	1.305	-.154	10.371	-13.028	50.984
Monetary policy	The residual of the interest rate equation in a five-variable VAR model inspired by Bernanke and Mihov (1998). A positive/negative value is interpreted as a contractionary/expansionary monetary policy.	International Financial Statistics and authors' own calculation	-.145	-.034	4.454	-10.260	13.153
Crises	A dummy equal to 1 for the periods of banking crisis in a sampled country, 0 for other periods.	Laeven and Valencia (2018)	.077	0	.267	0	1
Financial regulation							
Activity mix	Index of activity regulatory stringency. A higher score suggests more stringent regulations on the scope of banks' business operation.	Barth et al. (2004 , 2008, 2013)	7.341	7	2.199	3	12
Capital adequacy	Index of capital regulatory stringency. A higher score suggests more stringent regulations on banks' overall and initial capital.	Barth et al. (2004 , 2008, 2013)	6.848	7	2.183	3	10
Supervisory power	Index of supervisory power. The score in this index is higher when supervisory agencies are authorized more oversight power.	Barth et al. (2004 , 2008, 2013)	11.752	11.85	1.801	7.5	16
Market discipline	Index of the private monitor strength. A higher value denotes a higher private monitoring force.		8.333	8	1.293	5	11
Others							
Market structure	Herfindahl-Hirschman Index, defined as the sum of the squared shares of bank assets to total banking sector assets within a given country in a year.	Bankscope and authors' own calculation	.119	.104	.061	.048	.313
Deposit insurance	A composite index to reflect the strength of deposit insurance schemes.	Demirgüç-Kunt et al., (2013) and authors' own calculation	6.700	6.5	4.227	0	16.1
Rule of law	The Rule of Law sub-index in World Bank's Worldwide Governance Indicators (WGI).	World Bank's WGI	-.156	-.353	.680	-1.617	1.613

Notes: This table summarizes the description of main variables and the source of data. More details of the variables are provided in Section 3. Meanwhile, this table also presents the major descriptive statistics, including the mean, median, standard deviation and the 1st and the 99th percentile of the variables.

Table 2. Diversification, efficiency and bank risk

Dependent variable:									
Z and efficiency	**Income diversification**			**Funding diversification**			**Income & funding diversification**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	Z	***efficiency***	***Z***	***Z***	***efficiency***	***Z***	***Z***	***efficiency***	***Z***
Income diversification	.697 (.232)	-.107*** (.000)	.798** (.016)				.710 (.238)	-.096* (.066)	.863*** (.007)
Funding diversification				.762 (.310)	-.191** (.018)	.964* (.091)	.726 (.327)	-.142* (.080)	.960* (.087)
Efficiency hat			1.124* (.062)			.966** (.041)			1.061** (.042)
Bank characteristics									
Size	-.088 (.181)	.007 (.285)	.061 (.259)	.039 (.552)	.011 (.161)	.045 (.407)	-.039 (.565)	.004 (.558)	.033 (.526)
Market power	-.519 (.836)	-.157 (.596)	.129 (.936)	-.577 (.835)	-.186 (.621)	.308 (.837)	-.294 (.898)	-.136 (.557)	.604 (.623)
Liquidity	.594 (.261)	-.008 (.873)	1.420*** (.001)	.943 (.147)	.006 (.939)	1.470*** (.001)	.734 (.152)	.002 (.961)	1.446*** (.001)
Foreign	.035 (.841)	.017 (.105)	-.004 (.969)	-.119 (.471)	.023** (.042)	-.216** (.039)	-.167 (.188)	.014 (.184)	-.085 (.395)
State	-.241 (.552)	.017 (.578)	-.326 (.124)	-.613* (.081)	.032 (.398)	-.266 (.154)	-.594* (.068)	.002 (.916)	-.377* (.079)
Age	.149** (.015)	-.003 (.694)	.070 (.206)	.081 (.184)	-.004 (.689)	.032 (.528)	.114* (.090)	.000 (.955)	.081 (.115)
Macroeconomic condition									
GDP per capita	.190* (.099)	.013 (.231)	.028 (.792)	.122 (.246)	.013 (.337)	.041 (.696)	.190* (.072)	.016 (.111)	.058 (.574)
GDP growth rate	.023*** (.000)	.001 (.111)	.022*** (.000)	.022*** (.000)	.000 (.181)	.019*** (.000)	.023*** (.000)	.000 (.128)	.021*** (.000)
Inflation	-.002 (.261)	.000 (.692)	-.003** (.047)	-.001 (.560)	.000 (.842)	-.002 (.194)	-.002 (.216)	.000 (.632)	-.004** (.021)
Monetary policy	.001 (.565)	-.000 (.120)	.003 (.397)	.001 (.781)	-.000 (.443)	.003 (.226)	.001 (.569)	-.000 (.141)	.002 (.480)
Crises	-.248*** (.000)	-.010* (.079)	-.224*** (.002)	-.210*** (.001)	-.011* (.059)	-.218*** (.004)	-.232*** (.001)	-.007 (.181)	-.215*** (.004)
Financial regulation									
Activity mix	.008 (.391)	.001 (.162)	.004 (.707)	.001 (.925)	.001 (.111)	-.003 (.749)	.001 (.834)	.001 (.125)	.002 (.804)
Capital adequacy	.020** (.018)	-.002*** (.002)	.030** (.014)	.021*** (.005)	-.002*** (.005)	.032*** (.009)	.023*** (.008)	-.002*** (.000)	.036*** (.006)
Supervisory power	-.005 (.711)	.000 (.538)	-.031* (.051)	-.002 (.866)	.000 (.856)	-.023 (.154)	-.008 (.580)	.000 (.634)	-.033** (.044)
Market discipline	.005 (.789)	-.001 (.232)	.026 (.175)	.013 (.560)	-.001 (.415)	.012 (.530)	.015 (.423)	-.001 (.298)	.028 (.147)
Others									
Market structure	1.299* (.058)	.050 (.461)	.725 (.330)	1.657** (.022)	.066 (.371)	.487 (.496)	1.229* (.100)	.046 (.466)	.993 (.161)
Deposit insurance	-.014* (.088)	-.000 (.504)	-.009 (.238)	-.012* (.069)	-.000 (.284)	-.007 (.359)	-.015* (.077)	-.000 (.727)	-.011 (.151)
Rule of law	.141 (.129)	-.009 (.208)	.185* (.051)	.145 (.152)	-.008 (.357)	.148 (.139)	.175* (.061)	-.011 (.135)	.211** (.039)
Lagged dependent variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	11402 (1403)	9023 (1273)	8103 (1182)	11943 (1418)	9328 (1285)	8358 (1195)	11390 (1402)	9023 (1273)	8103 (1182)
AR(1)/AR(2)	.016/.357	.000/.891	.000/.239	.000/.897	.000/.969	.000/.436	.012/.314	.000/.833	.000/.108
Hansen J	.130	.298	.139	.142	.147	.283	.117	.145	.236

Notes: This table reports the results how banks' business diversification, including income and funding diversification, affects their risk, with efficiency as a conduit. The dependent variable in regression is the *Z-score* in columns (1), (3), (4), (6), (7) and (9), and the efficiency indicator in the other columns. *Z-score* is defined as the return on assets (ROA) plus the equity-to-assets

ratio, divided by the 3-year rolling over standard deviation of ROA. The *efficiency* of banks is based on a trans-log cost function which is estimated by employing the stochastic frontier approach. *Efficiency hat* denotes the predicted value of efficiency based on the estimation of Eq. (2) and is used as the indicator of efficiency in Eq. (3). *Income diversification* is measured as the non-interest income as a share of net interest revenue plus other operating income, while *funding diversification* as the ratio of non-deposit liability over total liability. The other controlled variables include: *Size*, which is the natural logarithm of bank assets in millions of dollars. *Market power* is the bank asset as a share of the aggregated banking assets in each country. *Liquidity* is captured as the ratio of liquid assets to total assets. *Foreign* is a dummy, which is equal to 1 for foreign-owned banks, while *State* is the dummy for domestically state-owned banks. *Age* is constructed as the natural logarithm of banks' operational years. *GDP per capita* is the logarithm of GDP per head in terms of US dollar. *GDP growth rate* is Hodrick-Prescott filtered real GDP growth rate. *Inflation* is Hodrick-Prescott filtered inflation rate. *Monetary policy* is proxied by using the residual of the interest rate equation in a five-variable VAR model, following Bernanke and Mihov (1998). *Crises* is a dummy variable that indicates the banking crisis episodes in sampled economies. For financial regulation indicators, *Activity mix*, *capital adequacy*, *supervisory power* and *market discipline* measure the regulatory stringency on banks' activity mix, capital adequacy, the authority of supervisory officials and the strength of market discipline, respectively. *Market structure* is the Herfindahl-Hirschman Index of banks' market share in sampled economies. *Deposit insurance* is a composite index representing the strength of the deposit insurance coverage. *Rule of law* is the rule of law index from the World Bank's Worldwide Governance Indicators. We also include lagged dependent variable and year dummies as regressors in our model. The estimation is conducted by employing the system generalized method of moments (GMM). *AR(1)/AR(2)* reports the *p*-value for the Arellano-Bond test for first- and second-order autocorrelation in the first-differenced errors. *Hansen J* presents the *p*-value of the Hansen J test for overidentifying restrictions. The *p*-value of estimates in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 3. Robustness tests: Alternative indicators of diversification

Dependent variable: *Z* and efficiency	**Income diversification**			**Funding diversification**			**Income & funding diversification**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	Z	***efficiency***	***Z***	***Z***	***efficiency***	***Z***	***Z***	***efficiency***	***Z***
Income diversification_ HHI	-.622 (.396)	.111** (.043)	-.839* (.071)				-.689 (.223)	.098* (.093)	-.822* (.087)
Funding diversification_ HHI				-.893 (.144)	.125** (.014)	-.980 (.140)	-.852 (.173)	.097* (.060)	-1.019* (.089)
Efficiency hat			1.343** (.015)			1.038** (.037)			1.254** (.035)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	11402 (1403)	9023 (1273)	8103 (1102)	11943 (1418)	9328 (1285)	8358 (1195)	11390 (1402)	9023 (1273)	8103 (1102)
AR(1)/AR(2)	.000/.119	.000/.864	.000/.232	.000/.961	.000/.893	.000/.308	.000/.245	.000/.832	.000/.127
Hansen J	.259	.219	.158	.117	.153	.126	.112	.240	.120

Notes: This table reports the results when we use alternative diversification indicators that are constructed on the Herfindahl-Hirschman Index approach. The dependent variable in regression is the *Z*-score in columns (1), (3), (4), (6), (7) and (9), and the efficiency indicator in the other columns. The income diversification indicator in this test is built as (net interest income/total income)^2+(non-interest income/total income)^2, while the funding diversification indicator as (deposit/total liability)^2+(non-deposit liability/total liability)^2. A lower value in both indicators suggests more diversified revenue and funding sources. All other regressors in the baseline model are also controlled for. *p-value* in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 4. Robustness tests: Alternative efficiency indicators

Panel A: Alternative estimate of cost efficiency						
Dependent variable						
	Income diversification		**Funding diversification**		**Income & funding diversification**	
	(1)	(2)	(3)	(4)	(5)	(6)
	Efficiency	***Z***	***Efficiency***	***Z***	***Efficiency***	***Z***
Income diversification	-.105*** (.000)	.803** (.019)			-.102* (.055)	.803** (.017)
Funding diversification			-.221** (.013)	.978* (.089)	-.146* (.093)	.948 (.105)
Efficiency hat		1.071* (.086)		1.122** (.050)		1.022* (.090)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	8995 (1271)	8078 (1182)	9328 (1285)	8358 (1195)	8995 (1271)	8078 (1182)
AR(1)/AR(2)	.000/.979	.000/.229	.000/.978	.000/.644	.000/.894	.000/.150
Hansen J	.371	.173	.163	.111	.173	.148
Panel B: Revenue efficiency						
Dependent variable						
	(1)	(2)	(3)	(4)	(5)	(6)
	Efficiency	***Z***	***Efficiency***	***Z***	***Efficiency***	***Z***
Income diversification	-.103* (.059)	.835* (.055)			-.072** （.040）	.705* (.058)
Funding diversification			-.094*** (.001)	.946* (.062)	-.093* （.082）	1.042* (.062)
Efficiency hat		1.237 (.271)		1.143* (.088)		1.047 (.219)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	9052 (1249)	8182 (1168)	9328 (1258)	8429 (1177)	9052 （1249）	8182 (1168)
AR(1)/AR(2)	.000/.305	.000/.963	.000/.415	.000/.379	.000/.200	.000/.103
Hansen J	.105	.123	.271	.114	.173	.134
Panel C: Profit efficiency						
Dependent variable						
	(1)	(2)	(3)	(4)	(5)	(6)
	Efficiency	***Z***	***Efficiency***	***Z***	***Efficiency***	***Z***
Income diversification	-.091** (.041)	.837 (.108)			-.054** (.026)	.752* (.062)
Funding diversification			-.178*** (.004)	1.070** (.023)	-.102** (.042)	1.101* (.073)
Efficiency hat		1.706** (.021)		1.352** (.040)		1.287* (.096)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	7603 (1171)	7310 (1127)	7786 (1178)	7488 (1133)	7603 (1171)	7310 (1127)
AR(1)/AR(2)	.000/ .979	.001/.150	.000/ .298	.000/.127	.000/.961	.000/.228
Hansen J	.214	.181	.258	.126	.133	.129

Notes: This table reports the results of robustness tests when we replace the efficiency indicator by some alternatives. The dependent variable is bank efficiency in columns (1), (3) and (5) and the *Z*-score in columns (2), (4) and (6) in each panel. In Panel A, the indicator of cost efficiency is re-estimated by adopting the assumption of truncated normal distribution, other than half normal distribution. In Panel B, cost efficiency is replaced by using revenue efficiency, while in Panel C by using profit efficiency. All other regressors in the baseline model are also controlled for. For the purpose of brevity, we only report the results for Eqs. (2) and (3). *p*-value in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 5. Robustness tests: Alternative risk indicators

	Income diversification		Funding diversification		Income & funding diversification	
Panel A						
Dependent variable: ***Excessive risk-taking***						
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	.144* (.051)	.223** (.036)			.121 (.118)	.190** (.043)
Funding diversification			.201* (.091)	.328** (.022)	.220 (.227)	.260* (.089)
Efficiency hat		.531*** (.003)		.382*** (.007)		.412** (.019)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11402	8103	11943	8358	11390	8103
(banks)	(1403)	(1182)	(1418)	(1195)	(1402)	(1182)
AR(1)/AR(2)	.000/.351	.000/.110	.004/.384	.000/.173	.000/.461	.000/.122
Hansen J	.116	.111	.106	.545	.124	.393
Panel B						
Dependent variable: ***Non-performing loans***						
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	-3.273 (.160)	-4.270** (.021)			-2.548 (.184)	-3.689* (.070)
Funding diversification			-4.952 (.156)	-6.155* (.073)	-4.555 (.121)	-6.278* (.083)
Efficiency hat		-7.114* (.069)		-6.580** (.030)		-6.128* (.073)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9572	7281	10028	7522	9560	7281
(banks)	(1302)	(1136)	(1331)	(1152)	(1305)	(1136)
AR(1)/AR(2)	.000/.262	.000/.365	.000/.537	.000/.531	.000/.268	.000/.432
Hansen J	.121	.323	.218	.154	.144	.125
Panel C						
Dependent variable**:** ***Loan loss provision***						
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	-1.141 (.207)	-1.634** (.046)			-1.623* (.066)	-1.849** (.030)
Funding diversification			-1.369 (.367)	-2.091 (.123)	-1.497 (.243)	-1.735 (.211)
Efficiency hat		-4.490*** (.008)		-3.802*** (.009)		-3.230*** (.008)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11527	8108	12080	8378	11506	8108
(banks)	(1471)	(1244)	(1483)	(1255)	(1470)	(1244)
AR(1)/AR(2)	.000/.949	.000/.514	.000/.209	.000/.957	.000/.558	.000/.444
Hansen J	.117	.132	.142	.156	.152	.302
Panel D						
Dependent variable**:** ***Merton's distance-to-default***						
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	1.104 (.191)	1.350 (.136)			.991 (.288)	1.649** (.037)
Funding diversification			1.284 (.268)	2.045 (.130)	1.191 (.460)	1.668 (.249)
Efficiency hat		2.753** (.020)		2.576** (.042)		2.177 (.128)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2360	1887	2396	1912	2356	1887
(banks)	(243)	(232)	(244)	(233)	(243)	(232)
AR(1)/AR(2)	.000/.182	.000/.664	.000/.139	.000/.921	.000/.223	.000/.924
Hansen J	.237	.691	.440	.619	.205	.725

Notes: This table reports the results of robustness tests when we replace the indicator of bank risk by some other proxies. In Panel A, we use the banks' excessive risk-taking, defined as $(Z_{ijt} - \overline{Z}_{ijt}) / [\max(Z_{ijt}) - \min(Z_{ijt})]$, as the dependent variable. In Panel B, our dependent variable is replaced by non-performing loans as a share of gross loans, while in Panel C by the ratio of loan loss provision to gross loans. In Panel D, we follow Merton (1974) by estimating the value of distance-to-default of banks, where a higher reading represents a lower probability of bank failure. All other regressors in the baseline model are also controlled for. For the purpose of brevity, we only report the results for Eqs. (1) and (3). *p*-value in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 6. Diversification, efficiency and the components of Z-scores

Panel A						
Dependent variable: ***ROA***						
	Income diversification		**Funding diversification**		**Income & funding diversification**	
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	1.097 (.288)	1.360* (.075)			1.162 (.138)	1.344** (.039)
Funding diversification			1.463 (.264)	1.872** (.029)	1.357 (.111)	1.739* (.063)
Efficiency hat		2.259* (.082)		2.645** （.014）		2.385** (.024)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	13858 (1608)	9422 (1295)	14563 (1616)	9739 (1309)	13820 (1603)	9422 (1295)
AR(1)/AR(2)	.000/.734	.000/.740	.000/.586	.000/.956	.000/.480	.000/.830
Hansen J	.245	.122	.130	.180	.112	.134
Panel B						
Dependent variable: ***Equity-to-assets ratio***						
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	.973 (.599)	.857 (.588)			.946 (.628)	.819 (.533)
Funding diversification			.952 (.641)	.667 (.824)	1.018 (.665)	.677 (.770)
Efficiency hat		-1.841 (.541)		-2.047 (.446)		-1.897 (.416)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	14005 (1609)	9540 (1307)	14864 (1629)	9884 (1320)	13978 (1605)	9540 (1307)
AR(1)/AR(2)	.000/.740	.000/.538	.000/.374	.004/.157	.000/.756	.000/.852
Hansen J	.119	.178	.123	.157	.164	.140
Panel C						
Dependent variable**: *σ(ROA)***						
	(1)	(2)	(3)	(4)	(5)	(6)
Income diversification	-.614 (.143)	-.768* (.073)			-.608 (.310)	-.647** (.044)
Funding diversification			-.807 (.339)	-1.085* (.085)	-.895 (.169)	-1.048* (.070)
Efficiency hat		-1.101 (.184)		-1.291** （.031）		-1.108* (.090)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	11727 (1423)	8256 (1194)	12323 (1438)	8536 (1207)	11704 (1421)	8256 (1194)
AR(1)/AR(2)	.000/.989	.000/.871	.000/.610	.000/.511	.007/.177	.000/.515
Hansen J	.333	.118	.110	.159	.110	.356

Notes: This table reports the impact of diversification on the three components of *Z*-scores, with efficiency as the conduit. The dependent variable is ROA, equity-to-assets ratio and the standard deviation of ROA (*σ(ROA)*) in Panel A, B and C, respectively. All other regressors in the baseline model are also controlled for. For the purpose of brevity, we only report the results for Eqs. (1) and (3). *p*-value in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 7. Estimation results of the "diversification-risk" nexus using the sample excluding M&A and failed (ceased) bank cases

Dependent variable: *Z* and efficiency	**Income diversification**			**Funding diversification**			**Income & funding diversification**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	Z	***efficienc***	***Z***	***Z***	***efficienc***	***Z***	***Z***	***efficienc***	***Z***
Income	1.167*	-.122***	.728**				1.342**	-.103*	.768**
Funding				.715	-.149*	1.610**	.524	-.113	1.211**
Efficiency			1.063*			.994**			.959*
Observations (banks)	10360	8256	7425	10849	8520	7646	10348	8256	7425
AR(1)/AR(2)	.027/.32	.000/.86	.000/.19	.000/.88	.000/.97	.000/.74	.000/.35	.000/.82	.000/.22
Hansen J	.164	.367	.115	.034	.132	.462	.220	.096	.284

Notes: This table reports the estimation results for the diversification-efficiency-bank risk nexus using our sample which does not include M&A and failed bank cases. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 8. The heterogeneity of "diversification-risk" nexus across bank size

Dependent variable: Z and efficiency	Income diversification		Funding diversification		Income & funding diversification	
	(1)	(2)	(3)	(4)	(5)	(6)
	Efficiency	***Z***	***Efficiency***	***Z***	***Efficiency***	***Z***
Income diversification	-.117***	.900**			-.123***	.816**
	(.002)	(.011)			(.004)	(.030)
Funding diversification			-.318***	-.611	-.266***	-.456
			(.004)	(.319)	(.000)	(.502)
Income diversification × Dummy (size)	.061**	-.370			.054*	-.294
	(.022)	(.295)			(.067)	(.445)
Funding diversification × Dummy (size)			.271***	1.462**	.201***	1.451*
			(.008)	(.049)	(.008)	(.076)
Efficiency hat		1.138**		.995*		1.011*
		(.033)		(.061)		(.054)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9023	8103	9328	8358	9023	8103
(banks)	(1273)	(1182)	(1285)	(1195)	(1273)	(1182)
AR(1)/AR(2)	.000/.959	.000/.142	.000/.949	.000/.758	.000/.971	.000/.435
Hansen J	.313	.111	.330	.221	.278	.206

Notes: This table reports the impact of bank size on the bank "diversification-risk" nexus. The dependent variable is bank efficiency in columns (1), (3) and (5) and the *Z*-score in columns (2), (4) and (6), respectively. We add the interactive term of income and funding diversification with the dummy variable, *Dummy*(*size*), which is equal to 1 (0) if bank size is higher (lower) than the median of its distribution. All other regressors in the baseline model are also controlled for. For the purpose of brevity, we only report the results for Eqs (2) and (3). *p*-value in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 9. The heterogeneity of "diversification-risk" nexus across banks' market power

Dependent variable: Z and efficiency	Income diversification		Funding diversification		Income & funding diversification	
	(1)	(2)	(3)	(4)	(5)	(6)
	Efficiency	***Z***	***Efficiency***	***Z***	***Efficiency***	***Z***
Income diversification	-.098* (.069)	.441 (.249)			-.084** (.040)	.323 (.399)
Funding diversification			-.238** (.019)	1.614*** (.010)	-.150** (.012)	1.681*** (.010)
Income diversification × Dummy (market power)	.015 (.754)	.958*** (.008)			-.020 (.609)	1.084*** (.006)
Funding diversification × Dummy (market power)			.230** (.029)	-1.667* (.068)	.182*** (.005)	-1.759* (.064)
Efficiency hat		1.163* (.053)		1.128** (.034)		1.156* (.058)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	9023 (1273)	8103 (1182)	9328 (1285)	8358 (1195)	9023 (1273)	8103 (1182)
AR(1)/AR(2)	.000/.903	.000/.216	.000/.863	.000/.457	.000/.806	.000/.158
Hansen J	.157	.123	.119	.440	.218	.324

Notes: This table reports the impact of banks' market power on the "diversification-risk" nexus. The dependent variable is bank efficiency in columns (1), (3) and (5) and the *Z*-score in columns (2), (4) and (6), respectively. We add the interactive term of income and funding diversification with the dummy variable, *Dummy*(*market power*), which is equal to 1 (0) if the indicator of market power of banks is higher (lower) than the median of its distribution. All other regressors in the baseline model are also controlled for. For the purpose of brevity, we only report the results for Eqs. (2) and (3). *p*-value in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 10. The heterogeneity of "diversification-risk" nexus across bank ownership

Dependent variable: Z and efficiency	Income diversification		Funding diversification		Income & funding diversification	
	(1)	(2)	(3)	(4)	(5)	(6)
	Efficiency	***Z***	***Efficiency***	***Z***	***Efficiency***	***Z***
Income diversification	-.090** (.030)	1.036** (.044)			-.101** (.017)	.998** (.046)
Funding diversification			-.278* (.069)	1.960 (.131)	-.276** (.042)	1.718 (.219)
Income diversification × Foreign	.038 (.487)	-1.090* (.096)			.040 (.445)	-1.161* (.053)
Funding diversification × Foreign			.181 (.280)	-2.939** (.030)	.233* (.091)	-2.744* (.054)
Income diversification × State	.133** (.048)	-.944 (.295)			.140* (.053)	-.869 (.378)
Funding diversification × State			.314* (.083)	-1.241 (.510)	.281* (.088)	-1.099 (.586)
Efficiency hat		1.232* (.056)		1.188** (.027)		1.093** (.041)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (banks)	9023 (1273)	8103 (1182)	9328 (1285)	8358 (1195)	9023 (1273)	8103 (1182)
AR(1)/AR(2)	.000/.902	.000/.482	.000/.872	.000/.255	.000/.755	.000/.413
Hansen J	.289	.136	.227	.109	.201	.120

Notes: This table reports the impact of ownership on the "diversification-risk" nexus. The dependent variable is bank efficiency in columns (1), (3) and (5) and the *Z*-score in columns (2), (4) and (6), respectively. We add the interactive term of income and funding diversification with the dummy variable *foreign* that indicates banks' foreign ownership. The income and funding diversification are also interacted with the dummy variable *state* that indicates domestic banks' state ownership. All other regressors in the baseline model are also controlled for. For the purpose of brevity, we only report the results for Eqs. (2) and (3). *p*-value in parentheses. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Table 11. Direct, indirect and total effects of diversification on bank risk: Bank heterogeneity

Bank type		Income diversification			Funding diversification		
		Direct effects	Indirect effects	Total effects	Direct effects	Indirect effects	Total effects
Overall[1)]		**0.863*** **	**-0.101***	**0.762***	**0.960***	**-0.151***	**0.809***
Types of banks							
Size[2)]	Large banks	0.522	-0.070*	0.452	0.995	-0.066*	0.929
	Small banks	**0.816** **	**-0.124***	**0.692***	-0.456	-0.269*	-0.725
Market power[3)]	High level	-0.078*	-0.120	-0.198	1.407	0.037*	1.444
	Low level	**1.681*** **	**-0.097***	**1.584***	0.323	-1.006*	-0.683
Bank ownership[4)]	Private domestic	**0.998** **	**-0.110** **	**0.888** **	1.718	-0.302**	1.416
	Foreign-owned	-0.163*	-0.067	-0.230	-1.026	-0.047*	-1.073
	State-owned	0.129	0.043*	0.172	0.619	0.005*	0.624

Notes: [1)] from Table 2; [2)] from Table 7; [3)] from Table 8; [4)] from Table 9. For overall banks and benchmark characteristics banks (i.e., small, low market powered and domestic private-owned banks), direct effects are estimated by the coefficient on *Diversification*, η, in eq. (3); indirect effects are estimated by the product of the coefficients on *Diversification*, β, in eq. (2) and *Efficiency hat*, δ, in eq. (3), which is $\beta\delta$; and total effects are estimated as $\eta + \beta\delta$. This system is illustrated in Figure 2. For other non-benchmark banks (large, high market powered and foreign/state-owned banks), direct effects are estimated by $\eta + \gamma$, where γ is the coefficient on the interaction term for non-benchmark characteristics banks from eq. (13); indirect effects are estimated by $(\beta + \zeta) \times \delta$, where ζ is the coefficient on the interaction term for non-benchmark characteristics banks from eq. (12); and total effects are estimated by $(\eta + \gamma) + (\beta + \zeta) \times \delta$. The levels of statistical significance are determined most conservatively, meaning that the estimated effects are considered statically significant only when all estimated coefficients comprising each of direct, indirect and total effects are statistically significant. ***, ** and * denotes the significance level on 1%, 5% and 10%, respectively.

Figure 1. Research design for the estimation of the direct and indirect effects of diversification on bank risk

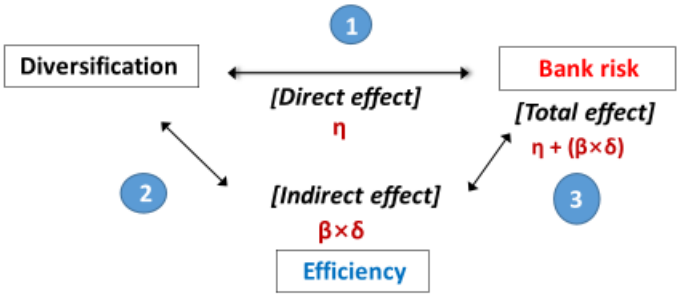
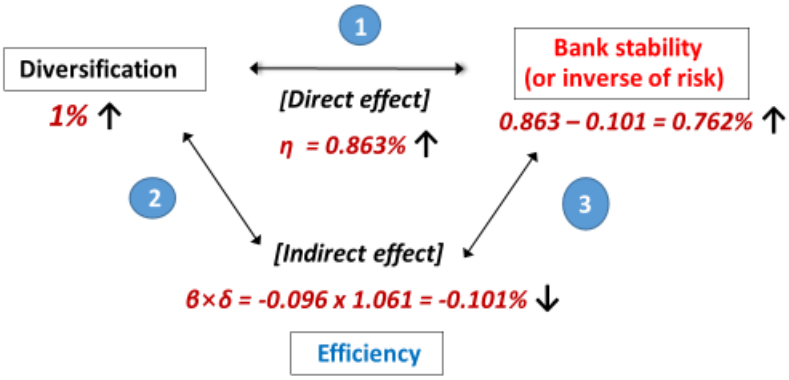


Figure 2. The quantitative assessment for the effects of the income diversification case on bank risk



Appendix Table 1. Banks' income and funding diversification in emerging economies

	Income diversification				Funding diversification			
	2000 - 04	2005 - 10	2011 - 16	All-years average	2000 - 04	2005 - 10	2011 - 16	All-years average
Eastern and Central Europe								
Albania		.235	.186	.202		.022	.023	.023
Belarus	.454	.501	.483	.483	.105	.094	.103	.100
Bosnia & Herzegovina	.526	.394	.360	.418	.129	.081	.082	.095
Bulgaria	.388	.292	.384	.353	.104	.224	.242	.194
Croatia	.339	.313	.308	.320	.111	.123	.077	.104
Czech	.408	.313	.289	.336	.140	.123	.136	.133
Estonia	.403	.317	.390	.368	.138	.187	.061	.125
Hungary	.373	.409	.480	.421	.106	.109	.101	.105
Latvia	.477	.402	.565	.478	.052	.069	.117	.079
Lithuania	.480	.386	.446	.432	.055	.081	.084	.074
Macedonia	.413	.323	.289	.337	.072	.111	.128	.107
Moldova	.476	.458	.419	.449	.097	.091	.093	.093
Poland	.439	.384	.342	.387	.102	.104	.109	.105
Romania	.367	.378	.365	.370	.053	.127	.085	.090
Serbia	.606	.534	.467	.529	.128	.120	.121	.123
Slovakia	.366	.332	.272	.325	.057	.137	.085	.096
Slovenia	.412	.349	.374	.377	.102	.132	.079	.106
Ukraine	.449	.335	.391	.379	.075	.103	.135	.118
Regional average	.430	.372	.384	.391	.096	.113	.116	.110
Latin America								
Argentina	.564	.563	.466	.529	.107	.119	.203	.143
Bolivia	.408	.453	.326	.388	.057	.054	.067	.060
Brazil	.233	.252	.297	.261	.302	.323	.390	.340
Chile	.326	.377	.373	.359	.155	.224	.246	.208
Colombia	.607	.421	.339	.457	.102	.117	.141	.119
Mexico	.377	.391	.444	.412	.194	.289	.282	.264
Paraguay	.454	.517	.417	.461	.061	.060	.137	.088
Peru	.294	.251	.220	.248	.105	.188	.242	.193
Uruguay	.431	.450	.547	.470	.042	.037	.063	.047
Venezuela	.249	.304	.330	.291	.082	.078	.094	.084
Regional average	.367	.380	.372	.373	.166	.198	.250	.206
Asia								
China		.156	.204	.185		.049	.052	.051
Hong Kong, SAR	.307	.348	.389	.348	.090	.103	.133	.109
India	.388	.302	.267	.316	.083	.087	.124	.099
Indonesia	.254	.207	.180	.205	.140	.093	.096	.106
Korea	.289	.202	.182	.224	.150	.206	.192	.183
Malaysia	.286	.352	.332	.325	.088	.119	.159	.125
Pakistan	.308	.269	.287	.286	.055	.089	.112	.089
Philippines	.365	.322	.311	.331	.076	.162	.171	.148
Singapore	.322	.428	.463	.403	.048	.129	.130	.103
Thailand	.319	.203	.283	.264	.083	.091	.111	.097
Vietnam	.275	.255	.210	.239	.071	.081	.063	.071
Regional average	.297	.244	.242	.255	.090	.091	.098	.094

Notes: This table reports the income diversification, measured as non-interest income/(net interest income + non-interest income) and the funding diversification, proxied by non-deposit liability/total liability. For brevity, we report the average income and funding diversification in each sampled country in the period of 2000-2004, 2005-2010 and 2011-2016, respectively, and then the all-year average level.

Appendix Table 2. Banks' efficiency in emerging economies

	2000 - 04	2005 - 10	2011 - 16	All-years average
Eastern and Central Europe				
Albania		.577	.554	.564
Belarus	.648	.716	.677	.686
Bosnia & Herzegovina		.734	.772	.756
Bulgaria	.640	.739	.741	.709
Croatia	.723	.766	.741	.746
Czech	.431	.561	.573	.521
Estonia	.628	.705	.619	.653
Hungary	.640	.668	.645	.652
Latvia	.472	.590	.516	.534
Lithuania	.581	.684	.669	.650
Macedonia	.725	.758	.723	.737
Moldova	.808	.808	.775	.795
Poland	.586	.634	.683	.633
Romania	.617	.703	.711	.681
Serbia	.675	.754	.760	.745
Slovakia	.536	.649	.689	.635
Slovenia	.681	.787	.798	.760
Ukraine	.624	.719	.740	.712
Regional average	.611	.702	.703	.681
Latin America				
Argentina	.576	.557	.648	.611
Bolivia	.625	.557	.645	.612
Brazil	.613	.669	.687	.657
Chile	.746	.778	.789	.772
Colombia	.681	.710	.770	.715
Mexico	.623	.547	.494	.543
Paraguay	.636	.573	.690	.631
Peru	.713	.729	.761	.738
Uruguay	.533	.455	.610	.535
Venezuela	.462	.486	.457	.469
Regional average	.614	.626	.658	.634
Asia				
China		.632	.557	.585
Hong Kong, SAR	.642	.635	.676	.654
India	.463	.571	.613	.551
Indonesia	.564	.639	.722	.661
Korea	.616	.695	.729	.704
Malaysia	.618	.564	.570	.583
Pakistan		.667	.551	.593
Philippines	.548	.546	.555	.550
Singapore	.585	.614	.687	.621
Thailand	.622	.707	.706	.687
Vietnam	.666	.617	.606	.619
Regional average	.563	.618	.618	.607

Notes: This table presents the estimated bank efficiency across emerging economies in the period of 2000-2016. Efficiency is estimated based on a trans-log cost function by employing the stochastic frontier approach suggested by Wang and Ho (2010). A higher reading indicates a higher efficiency of banks. For brevity, we report the average efficiency in each sampled country in the period of 2000-2004, 2005-2010 and 2011-2016 respectively, and then the all-year average level.

Appendix Table 3. Pairwise correlation

	Z	Efficiency	Income diversification	Funding diversification	Size	Market share	Liquidity	Foreign	State	Age	GDP per capita	GDP growth rate	Inflation	Monetary policy	Crises	Activity mix	Capital adequacy	Supervisory power	Market discipline	HHI	Deposit insurance	Rule of law
Z	.	**.053**	**-.166**	**-.030**	**.230**	**-.026**	**-.041**	**-.073**	-.008	**.072**	**.023**	**-.033**	.006	-.011	**-.132**	**.091**	**.123**	-.004	**.108**	**-.077**	**.148**	**.057**
Efficiency	**.073**	.	**-.096**	**.245**	**-.137**	**.074**	**-.224**	**.167**	**-.177**	**-.069**	**.127**	**.019**	**.020**	.015	**.077**	**-.149**	-.005	**.148**	**-.070**	**.162**	**-.053**	**.035**
Income	**-.170**	**-.131**	.	**.105**	**-.160**	**.257**	**.165**	**.115**	**-.075**	**.029**	**.069**	**.042**	-.005	**.040**	**.115**	**-.141**	**-.232**	**-.148**	**-.213**	**.175**	**-.041**	**.102**
Funding	**-.059**	**.207**	**.038**	.	**.117**	**.148**	**-.073**	**.101**	.013	**.166**	**.086**	.011	**.043**	.003	-.013	**-.107**	**.171**	**.049**	.001	**.065**	**.115**	**.093**
Size	**.193**	**-.090**	**-.173**	**-.059**	.	**.386**	**-.237**	**-.076**	**.192**	**.349**	**.138**	**-.033**	**-.022**	**.031**	**-.103**	**.221**	**.157**	**-.034**	**.238**	**-.187**	**.080**	**.166**
Market share	**.039**	**.037**	**.060**	**-.064**	**.393**	.	**-.078**	**.116**	**.062**	**.336**	**.030**	**.056**	-.003	**-.026**	**.034**	**-.108**	**-.220**	**.047**	**-.252**	**.266**	-.011	**.132**
Liquidity	**-.055**	**-.330**	**.179**	.006	**-.261**	**-.064**	.	**.107**	**-.114**	**-.217**	**.164**	**.047**	**.070**	**-.046**	**-.047**	**-.134**	**-.132**	**.069**	**-.137**	**.243**	**-.068**	**-.071**
Foreign	**-.091**	**.124**	**.090**	**.108**	**-.058**	**.044**	**.119**	.	**-.331**	**-.145**	**.223**	**.028**	-.004	-.003	**.025**	**-.169**	**-.112**	**.053**	**-.128**	**.210**	**-.064**	**.159**
State	-.009	**-.130**	**-.053**	.009	**.225**	**.116**	**-.068**	**-.314**	.	**.251**	**-.188**	**-.017**	-.009	**-.022**	**-.052**	**.120**	**.107**	**-.113**	**.095**	**-.181**	**.107**	-.013
Age	**.064**	**-.053**	**.060**	-.011	**.370**	**.260**	**-.156**	**-.091**	**.219**	.	**-.042**	.004	**-.066**	**-.043**	**-.048**	**-.046**	**-.033**	**-.030**	**.060**	**-.069**	**.235**	**.065**
GDP per capita	**.031**	**.109**	**.047**	**.112**	**.191**	**.056**	**.063**	**.247**	**-.146**	**.066**	.	**.077**	-.010	**.079**	-.016	**-.239**	**-.193**	**.117**	**-.150**	**.505**	**-.158**	**.464**
GDP growth rate	**.027**	-.011	**.016**	-.005	**-.033**	-.003	**.030**	**-.021**	-.006	**-.013**	**.023**	.	**-.085**	**.044**	**-.029**	**-.026**	**-.163**	.011	**-.076**	**.038**	**-.021**	-.007
Inflation	**-.084**	.003	.010	**.070**	**-.084**	**-.020**	**.057**	**-.012**	**-.015**	**-.035**	**-.110**	**-.089**	.	**.049**	-.008	**-.030**	**.038**	**.070**	**.043**	-.001	**-.027**	**.031**
Monetary policy	.002	**.020**	**.013**	.007	-.001	-.008	-.004	.006	-.008	-.010	-.001	**-.122**	**-.045**	.	**.104**	.011	.011	**-.084**	**-.101**	**.049**	**-.132**	**.063**
Crises	**-.147**	**.046**	**.083**	**-.024**	**-.146**	**-.030**	-.007	.003	**-.029**	**-.052**	**-.076**	**-.173**	-.004	**.150**	.	**-.198**	**.084**	**-.041**	**-.090**	**-.030**	**-.147**	**-.033**
Activity mix	**.063**	**-.113**	**-.114**	**-.186**	**.212**	-.009	**-.097**	**-.146**	**.152**	**-.057**	**-.274**	**.051**	**-.048**	**-.020**	**-.183**	.	**.147**	**.069**	**.368**	**-.347**	-.001	**-.116**
Capital adequacy	**.125**	**.045**	**-.158**	**-.126**	**.127**	**-.085**	**-.114**	**-.099**	**.077**	**-.026**	**-.137**	**-.102**	**.014**	**.024**	**.118**	**.106**	.	**.065**	**.259**	**-.453**	**-.018**	**-.200**
Supervisory power	**-.037**	**.068**	**-.127**	**.073**	**-.016**	**.031**	**.078**	**.038**	**-.059**	**-.039**	**-.034**	**.052**	**.044**	**-.033**	**-.076**	**.096**	**.029**	.	**.210**	**.082**	**-.044**	**-.025**
Market discipline	**.058**	**-.048**	**-.153**	.007	**.232**	**-.117**	**-.066**	**-.071**	**.089**	**.044**	**-.031**	-.003	**.041**	**-.028**	**-.043**	**.273**	**.125**	**.158**	.	**-.348**	**.116**	**-.120**
HHI	**-.029**	**.052**	**.080**	**.023**	**-.059**	**.265**	**.148**	**.188**	**-.085**	-.006	**.339**	.011	**-.035**	**.026**	**-.086**	**-.252**	**-.281**	**.067**	**-.139**	.	**-.230**	**.290**
Deposit insurance	**.033**	**-.016**	.009	**.111**	**.014**	-.008	**-.036**	**.011**	**.024**	**.168**	-.001	.008	**-.019**	**-.060**	**-.052**	**-.114**	**-.106**	**.088**	**-.037**	**-.104**	.	**-.026**
Rule of law	**.075**	**.046**	**.035**	.011	**.223**	**.115**	.007	**.234**	**-.053**	**.137**	**.561**	-.000	**-.058**	**.027**	**-.048**	**-.170**	**-.142**	**-.052**	**.087**	**.398**	**-.052**	.

Notes: This table reports the pairwise correlation of main variables, with the Pearson correlation coefficients in the region below the diagonal and Spearman's rank correlation coefficients above the diagonal. The figures in bold form denote the correlation coefficients with the significance level lower than 10%.