Financial structure, capital openness and financial crisis

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Abstract:
This paper examines how the financial structure and capital openness of a country have affected the likelihood of financial crisis over the past two decades. By applying a panel probit estimation to a sample of 38 countries, we find the following. 1) An economy with a more market-based financial structure is less likely to experience a currency crisis. 2) More capital openness is associated with a lower probability of a currency crisis. 3) Countries with a more market-based financial structure are also less likely to experience a currency crisis if that structure is coupled with a more open capital account. 4) Unlike what is found for currency crises, neither financial structure nor capital openness has any effect on banking crises.

JEL Classification: G01, G15, G28
Keywords: financial structure, capital openness, currency crisis, banking crisis

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1. Introduction

Several large-scale financial crises have ravaged the world over the past two decades. The first was the Asian financial crisis of 1997, and the second was the global financial crisis of 2008. These financial crises have revealed the vulnerability of economic systems in both developed and developing countries. Many countries have been prone to financial crises both in the past and at present, and some are on the verge of a crisis. Because the determinants and impacts of financial crises vary by the type of crisis and by country, it is critical to identify the determinants of each kind of crisis in various settings. Numerous works have made an effort to investigate this issue from various perspectives.

Two main empirical approaches have been adopted in the relevant literature. The first group of studies focuses on clarifying the determinants of financial crises. For instance, Gourinchas and Obstfeld (2012) analyze the effects of the twenty-first century's first global crisis and suggest that domestic credit expansion and real currency appreciation have been the most robust predictors of financial crises for both developed and developing countries. Davis et al. (2016) estimate a probabilistic model to find the marginal effect of private sector credit growth on the probability of a banking crisis. Davis et al. (2016) introduce an economic model as a system for predicting crisis events that was very popular in the periods following the Tequila and Asian financial crises. Specifically, many researchers have focused on abnormal changes occurring before a crisis event. Sachs et al. (1996) report that overvalued exchange rates and lending booms coupled with low international reserves are necessary conditions for crises. Kaminsky and Reinhart (1999) find that after a prolonged boom accompanied by an overvalued currency, the appreciation of a real exchange rate episode can trigger a crisis.

Several works have also reported that the financial structure, whether bank based, market based or a combination of the two, matters for economic performance. Such studies describe the superiority or inferiority of different financial structures by focusing on their political, legal, and protective aspects, among other factors. One of the most common approaches involves classifying countries' financial systems as either bank- or market-based. For countries such as Germany and Japan, the bank-based financial structure has a positive effect on the economy because it offers advantages in terms of (1) acquiring information about firms to improve capital allocation and corporate governance, (2) managing risk and enhancing investment efficiency and economic growth, and (3) mobilizing capital to achieve economies of scale. On the other hand, in countries such as the US and UK, the market-based financial structure has positive effect on their economies by (1) creating stronger incentives for research firms, (2) enhancing corporate governance by easing takeovers, and (3) facilitating risk management (Levine, 2002). In

the early empirical literature, supporting evidence is provided for both types of financial structures. However, especially in recent years, more studies appear to report the superiority of market-based financial structures over bank-based ones. For example, state-owned banks are associated with less economic growth because they tend to supply credit to fully developed industries rather than to strategic industries, where innovation and opportunities for growth are more feasible (La Porta, et al. 2002). In the post-financial-crisis period, market-based economies exhibit significantly and consistently stronger rebounds than bank-based economies (Beck, et al. 2002). The banking sector played an important role in earlier years of economic growth, but in recent years, the stock market has played an even more important role in economic growth (Lee, 2012). Finally, some works find no merits for either bank- or market-based structures and argue that the overall development of financial systems, i.e., efficient legal systems and efficient capital allocation, is more important (Levine, 2002; Beck and Levine, 2002).

In considering arguments for the role of financial structure on economic development, we believe that it is important to empirically test whether financial structure affects the likelihood of a financial crisis. A number of existing works in the financial crisis literature have focused on the financial vulnerability of developing countries. Some studies have had similar objectives as those of the present work. Frost and Saiki (2014) find that a more open capital account decreases the probability of currency crises. Kim et al. (2013) show that restrictions on the banking sector and entry requirements have decreased the likelihood of banking crisis, while at the same time, capital regulation and government ownership of banks have increased the likelihood of a currency crisis. Ji et al. (2019) find that a more market-based structure can reduce systemic risks facing the banking sector in China.

Following the line of research described above, our main objective is to clarify whether and how financial structure and capital openness affect the likelihood of a financial crisis. We apply binary models, which include financial structure, capital openness and their interaction terms on the right-hand side, to 38 countries for the period of 1996-2016. Our empirical results can be summarized as follows. First, via a panel probit regression, we find that financial structure, capital openness and their interaction term play an important role in reducing the likelihood of a currency crisis but have no effect on banking crises. Second, after adding a set of control variables and changing the regression method, our qualitative results remain almost unchanged. We also find that while they have no effect on currency crises, the likelihood of a banking crisis is susceptible to changes in the VIX index, international reserves and the degree of democratic governance.

Considering these results, this paper primarily focuses on differences in countries'

financial structures. We seek to explain the relationship between financial structures, capital openness and financial crises. To the best of our knowledge, this is the first paper to systematically investigate the impact of long-term financial structure data and interactions between financial structures and both types of financial crisis.

The remainder of this paper is organized as follows. Section 2 presents our data and variables. Section 3 discusses the link between the probability of financial crises and financial structures. Section 4 presents the results of our sensitivity analysis. Section 5 concludes.

2. Data

With this study, we aim to clarify the financial crisis formation process over the long term and for a large sample of countries. Due to the availability of both financial structure and capital openness database, the study period covers 1996 to 2016 for 38 countries; the number of observations made varies with the availability of variables included in the regression.

2.1. Financial crisis

We first use Laeven and Valencia's (2018) financial crisis database[i]. These authors define a banking crisis as an event that satisfies the following two conditions: (1) significant financial distress in the banking system and (2) significant banking policy intervention measures in response to significant losses in the banking system. Significant policy intervention is considered to include at least three of the following six measures: deposit freezes and bank holidays; significant nationalization; bank restructuring costs (3% of GDP); extensive liquidity support (5% of deposits and liabilities to nonresidents); significant bank guarantees; and significant asset purchases (5% of GDP).

The authors define a currency crisis as involving a significant depreciation of the domestic currency against the US dollar. Significant depreciation is defined as meeting two conditions: (1) a depreciation of the currency vis-à-vis the US dollar of at least 30% relative to the previous year and (2) at least a 10% higher rate of depreciation than that observed in the previous year.

A crisis may continue over a number of years, or one crisis (of less than 12 months) may follow after another crisis (of less than 12 months); Laeven and Valencia's (2018) database, however, only contains information denoting whether a crisis is observed in a given year. This limitation makes it difficult to distinguish an ongoing crisis from a new crisis, as multiple years of crisis observations are included in the database, further leading

to econometric endogeneity problems because the macroeconomic explanatory variables used to predict a crisis in the later years of a crisis are themselves affected by the earlier years of the crisis. We follow the convention outlined by Demirgüç-Kunt and Detragiache (2005) and simply omit crisis years following the initial year in our basic analysis. We will handle this problem in section 5 for robustness check.

Figure 1 plots the occurrence of the two types of financial crises, i.e., currency and banking crises, over the past twenty years for 165 countries. As presented in Figure 1, both crises show a two-modal distribution: the occurrence of banking crises is concentrated in approximately 1997 and 2008, whereas currency crises are concentrated in 1998 and in recent years.

For data constraints, our sample includes 38 advanced and emerging countries for the period 1996-2016. Table 1 (a) shows the sampled countries and (b) lists all 21 systemic banking crisis and 17 currency crisis events occurring from 1996-2016, and Table 1 displays the crisis distributions. We find that global banking crisis incidence peaks during the 1997 Asian crisis and with the bankruptcy of Lehman Brothers in 2008, while currency crises are frequent after the after Asian crisis and peak again in 2015.

2.2. Financial structure

For financial structure variables, we use the financial structure database (updated July 2018) developed by Beck et al. (2000, 2009) and Čihák et al. (2012)[ii]. Three variables are related to banking sector activity, and two are related to equity market development. The first four variables are constructed as the ratio of the two-year average of the financial variable to real GDP in the current year. The formula used is as follows:

$$\{(0.5) * [F_t/P_{et} + F_{t-1}/P_{et-1}]\}/[GDP_t/P_{at}]$$

where F_t denotes financial data for period t, GDP_t is nominal GDP in period t, P_{et} is the consumer price index (CPI) of end-of period t, and P_{at} is the annual average CPI for period t.

Private credit by deposit money banks to GDP (prcb): Private credit by deposit money banks to GDP is calculated from the above formula: F_t is credit to the private sector in period t. These variables are drawn from the IFS database of the IMF. IFS indicator codes include FOSAOP, PCPI, and NGDP for F, P, and GDP, respectively.

Stock market capitalization to GDP (smcap): This variable is the ratio of the value of listed shares to real GDP. F is stock market capitalization. The original data are drawn from the World Federation of Exchanges and Standard and Poor's Emerging Market Database.

Stock market total value traded to GDP (smtrd): F is total shares traded on the stock

market exchange to GDP (World Federation of Exchanges and Standard and Poor's Emerging Market Database).

Bank overhead costs to total assets (overhead): This last variable does not use the above formula. It denotes the accounting value of a bank's overhead costs as a share of its total assets. The original data are taken from the Bankscope and Orbis Bank Focus databases.

Following the methodology proposed by Levine (2002), we construct three indicators that proxy for finance *size*, *activity*, and *efficiency*. They are defined as follows. Finance *size* is the logarithm of the ratio of stock market capitalization to private credit. *Activity* is the logarithm of the ratio of the stock market's total value traded to private credit. *Efficiency* is the logarithm of the ratio of the stock market's total value traded times overhead costs[iii]. For financial structure (*FS*), i.e., the main variable used in our study, we use the first principal component of the *size* and *activity* indicator variables following Allen et al (2018). We also use the first principal component of *size*, *activity* and *efficiency* as an alternative financial structure index (*FS_alt*), and we use this alternative index for a robustness check of our main results in Section 5.

Financial structure is concerned with the development of domestic financial institutions and markets. The degree to which external factors may affect currency crises and banking crises depends on how open and accessible financial markets are to foreign investors. To address this external channel, we include capital account openness (*KAO*) as an explanatory variable in the crisis regression. This variable is Chinn and Ito's (2008) capital account openness index. *KAO* is based the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.

2.3. Other control variables

In addition to financial structure and capital openness, we consider other explanatory variables that have been shown to have a significant influence on financial crises in previous studies. These include the reserve to GDP, inflation, political factors and the volatility of global financial markets. We review our financial crisis analysis of these potentially important variables based on a bivariate-dependent variable panel regression in this paper.

Reserves to GDP (RES): This variable is defined as total official reserves excluding gold to GDP. As an indicator of international liquidity, a shortage of foreign reserves can become an immediate cause of a currency crisis. As Catao and Milsei-Ferretti（2014) and Frost and Saiki (2014) have confirmed, we expect this variable to have a negative effect

on currency crises.

Inflation (INF): The theoretical effect of inflation is ambiguous from both positive and negative points of view. On one hand, inflation has negative effects by increasing the opportunity cost of holding money; on the other hand, inflation reduces the real value of debt and unemployment. Some previous studies identify a negative impact of inflation on economic growth, leading to an increase in the likelihood of a banking crisis (Kaminsky and Reinhart, 1999). Conversely, some studies find no evidence of inflation affecting banking crisis (Guerineau and Leon, 2019).

Polity (POL): Data for this variable are taken from the POLITY IV dataset. The variable is computed by subtracting the institutionalized autocracy score from the institutionalized democracy score. We use the extended version of the POLITY variable to facilitate our use of the POLITY regime measure in our time-series analyses. We expect a country with a lower polity score to be more likely to fall into financial crisis.

VIX: As a proxy variable expressing global uncertainty, we include a theoretical expectation of stock market volatility in the near-future VIX index. VIX has been confirmed to be negatively correlated with the likelihood of a banking crisis (Cesa-Bianchi, 2019).

2.4 Summary Statistics

Table 2 provides descriptive statistics for the independent variables. Of the variables related to financial structure, Activity and Efficiency show higher variability than Size. FS, an index representing financial structure, shows less variation than Activity and Efficiency, whereas the Alternative financial structure index (*FS_alt*) shows more volatility.

The unconditional correlations between these variables are presented in Table 3. The correlations between Size and Activity and Efficiency are valued at nearly 0.4, whereas activity and efficiency have a strong correlation of over 0.9. Similarly, correlations between Financial structure and Size and Activity are valued at nearly 0.45. As expected, the correlation between Financial structure (*FS*) and Alternative financial structure (*FS_alt*) is high at approximately 0.95. We use *FS_alt* as an alternative proxy variable to Financial structure. Notably, there seems to be no relationship between the capital openness and financial structure variables. As a preliminary check to determine whether there is any relationship between our key financial variables and the prosperity of countries, we also compute correlations between GDP per capita and the financial variables. From the results, we confirm a strong correlation between capital openness and GDP per capita and a comparatively weaker correlation between activity and efficiency

and GDP per capita, but there appears to be no correlation between GDP per capita and the two financial structure indices. From these results, we assume that financial structure is not only a proxy of economic growth (since, in general, a more developed country may have a larger financial market) but also related to other factors.

3. Methodology

Using a single method is limited to focusing on only one variable's threshold and ignores the information provided by other variables. In this sense, the binary response models can make the best possible use of information provided by all explanatory variables (Demirgüç-Kunt and Detragiache, 2005). We use a binary response models for panel data approach in this study[iv]. To investigate the relationship between financial structure and capital openness with respect to financial crises, we estimate the following panel OLS regression equation (1) as a base model:

$$Pr(Crisis_{it} = 1) = \alpha_0 + \alpha_1 FS_{it} + \alpha_2 KAO_{it} + \alpha_3 FS_{it} \times KAO_{it} + \varepsilon_{it} \qquad (1)$$

where $Crisis_{it}$ is a dummy variable of one when a banking or currency crisis event occurs in country i and in year t and zero otherwise. FS_{it} is a country's financial structure defined as an index indicating whether a country is bank- or market-based where a higher value of this index means that a country is more oriented toward a market-based economy. KAO_{it} is the value of the Chinn-Ito capital openness index. The Chinn-Ito index is based on binary dummy variables that the IMF classifies as restrictions on cross-border financial transactions.

The effect of capital openness on financial crises may depend on the financial structure. We expect the effect of capital openness to be stronger in a more market-based economy. Because the interaction between financial structure and capital openness may have an important effect on the occurrence of a financial crisis, we also evaluate the influence of the interaction term $FS_{it} \times KAO_{it}$ on financial crises. This interaction term can be problematic because both financial structure and capital openness variables can take both positive and negative values, so that interaction term indicates positive for case (i) financial structure and capital openness are both positive, and case (ii) financial structure and capital openness are both negative. We will address this problem in section 5 with two alternative methods; however, the qualitative results remain almost unchanged.

As financial shocks are transmitted to both banking and currency crises quickly, we assume that using the current year's explanatory variables is appropriate. If the

explanatory variables are lagged by one year, the true correlation between the crisis and macroeconomic variables may be distorted[v]. Thus, we use year t on the right-hand side of the regression model for year t. This approach is commonly used in studies in the literature (Gourinchas and Obstfeld, 2012; Davis et al, 2016). However, we are also concerned with endogeneity problems where independent variables are influenced by the crisis itself. Our dataset includes 38 sample countries with 20 having experienced banking crisis events and 12 having experienced currency crisis events. We expect including both crisis and noncrisis countries to control for the reverse causality of crisis to independent variables and to mitigate bias in our regression results.

$$Pr(Crisis_{it} = 1) = \alpha_0 + \alpha_1 FS_{it} + \alpha_2 KAO_{it} + \alpha_3 FS_{it} \times KAO_{it} + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \qquad (2)$$

Finally, we add a vector of control variables as in equation (2) to check the robustness of the results of our key variables, i.e., financial structure and capital openness. $\boldsymbol{X_{it}}$ is a vector that includes the inflation rate, official reserves, the current account and the CBOE volatility index (VIX), i.e., a popular measure of the stock market's expected volatility.

4. Empirical results

In this section, we empirically investigate whether financial structure and capital openness affect the likelihood of the two types of financial crises by estimating the regression equations presented in the previous section. As emphasized by Cameron and Miller (2015), failure to control for within-cluster error correlation can misleadingly lead to small standard errors, and thus consequently narrow confidence intervals. Our regression models group sample countries into clusters, with errors uncorrelated across clusters but correlated within cluster (cluster-robust standard errors). The primary results are based on the panel probit model[vi]. Column (i) and (ii) of Table 4 report results for the estimated coefficient and for the marginal effects of regression equation (1).

The results for currency crisis listed in column (ii) show that capital openness, financial structure and their interaction are significant, which means that the more market-based the financial system is and the more open capital accounts are, the less likely a country is to fall into a currency crisis. Our result of capital openness being associated with a lower probability of a currency crisis is consistent with the findings of Frost and Saiki (2014), and the combined effects of capital openness within the financial structure, including both level and interaction term effects, can be strengthened nearly twofold. Our finding of financial structure and capital openness working in the same direction in preventing

financial crises corroborates the empirical work of Dal Bianco et al. (2017), according to whom capital openness helps mitigate the negative impact of an external shock but is conditional on the level of financial development.

However, there appears to be no association between financial structure and banking crises. Additionally, echoing the results reported in Davis et al (2016), we confirm that capital openness has no effect on banking crises.

Next, we add a set of control variables to the model[vii] as in regression equation (2), and columns (iii) and (iv) of Table 4 report the estimated results. Both the signs of the coefficients and the statistical significance of the key variables, i.e., *FS* and *KAO*, remain unchanged. From column (iii) of Table 4, we find that Polity, the VIX index and Reserves to GDP have statistically significant impacts on banking crises. More precisely, a higher VIX index is associated with an increased probability of a banking crisis, and conversely, a higher reserve rate and polity score can reduce the probability of a banking crisis. For the currency crisis results listed in column (iv), in contrast to financial structure and capital openness, a higher inflation rate is associated with a higher probability of a currency crisis. From these results, it is clear that banking crises are influenced by the polity score, VIX index and reserve rate but are not affected by financial structure or capital openness, whereas currency crises are greatly affected by financial structure.

More specifically, to clarify the effect of capital openness and financial structure to currency crisis. Based on the results of column (iv) of Table 4, we plot the marginal effect of capital openness conditional on financial structure and the marginal effect of financial structure conditional on capital openness separately. Figure 2 show that both capital openness and financial structure have a negative marginal effect to currency crisis in almost case. But for an extremely banking based financial system (under -2.7) and low capital openness (under -1.8), the marginal effect may work in opposite direction.

From the results of our basic and extended models, we can draw the following two conclusions. First, a more market-based financial system in a country is more likely to prevent a currency crisis but does not affect the probability of banking crises. Second, a more open capital account strengthens the negative relationship between market-based financial systems and currency crises. For a country with a market-based financial system, a more open capital account further reduces the probability of a currency crisis. Laeven et al. (2016) provide some supporting evidence based on a perspective that differs from ours. The authors argue that systemic risk grows with bank size and is inversely related to bank capital and that this effect exists above and beyond the effect of bank size and capital on independent bank risk. Our empirical results demonstrate that more reliance on market-based finance can mitigate the vulnerability of economic systems in both

developed and developing countries. Moreover, Langfield and Pagano (2016) argue that the over expansion of the banking sector is not only associated with more systemic risk but also with less economic growth. With the development of the world's economies over the last few decades, both bank- and market-based financial sectors have become larger. However, economic yield sensitivity to bank development has also decreased, while its sensitivity to market development has increased (Demirgüç-Kunt et al, 2013). Overall, we expect both developed and developing countries to focus on a more developed market-based financial sector in the future, which will benefit economic growth and stability.

From the results of our basic and modified models, we can draw the following conclusions. First, countries with a lower probability of experiencing currency crises are more likely to have a market-based system, but a weaker relation to banking crises is found. Second, capital account openness is associated with this relationship. For a market-based country with more open capital accounts, the probability is further reduced. Laeven et al. (2016) provide further proof of this trend from the opposite perspective. The authors argue that systemic risk grows with bank size and is inversely related to bank capital and that this effect exists above and beyond the effect of bank size and capital on independent bank risk. We believe that a relatively more active market sector can mitigate the vulnerability of economic systems in both developed and developing countries. Simultaneously, an overexpansion of the banking sector is associated with more systemic risk and less economic growth (Langfield and Pagano, 2016). With the development of the world's economies, both bank and market sectors have been become more developed. However, the sensitivity of economic yields to bank development has also decreased, while their sensitivity to market development has increased (Demirgüç-Kunt et al, 2013). Overall, we expect a more developed market sector to be more important in the future in terms of both economic growth and stability.

5. Robustness Check

Our main results show that a more market-oriented financial structure can strengthen vulnerable currencies and that a more open capital account can magnify this effect. After adding a set of control variables to our base model, these results do not change. In this section, we further check the robustness of our results in the following four respects. First, we use a different transformation of our binary dependent variable by implementing the logistic panel method instead of the probit method used in the above section. Second, as mentioned in section 3, interaction term can be problematic because both financial structure and capital openness variables can take both positive and negative values. We

will suggest two alternative approaches to this problem. Third, we also consider an alternative financial structure. The current financial structure index is based on two of three underlying variables, namely, size and activity. We also construct another financial structure index based on all three underlying variables, including efficiency. The estimated result is broadly similar to the results shown in Section 4. Fourth, we consider an alternative econometric estimation model, i.e., the fixed-effect logistic model with cluster-robust standard errors. We introduce one caveat in applying this estimation model to our sample countries: we include countries that did not experience a crisis during the sample period. For these countries, the dependent variable is completely explained by the country dummy, and therefore, the data are automatically removed from the regression process. Fifth, to avoid the possibility of macroeconomic explanatory variables being affected by the crisis itself, we adopt a two-year window to exclude the years after the crisis. We thus also re-estimate the random effect model for the subsample of countries experiencing a financial crisis and compare the result of the fixed-effect logistic model to that of the random effect model for the same countries. Finally, we adopt the receiver operating characteristic (ROC) curve to test the predictive capacities of our models.

Logistic panel model

We obtain almost the same result from the logistic method for our basic and extended models, presenting the same coefficient sign and statistical significance and similar marginal effects. From columns (i) and (iii) of Table 5 for banking crises, we find that the coefficients of Polity and Reserves are negative and statistically significant, and the coefficients of VIX are positive and statistically significant. Financial structure is statistically significant only in the extended model, echoing the results of the probit estimates. Columns (ii) and (iv) show that financial structure and capital openness remain as important factors related to decreasing changes in a currency crisis.

Alternative interaction term

The interaction term between financial structure and capital openness variables can be problematic because both variables can take both positive and negative values, so that interaction term indicates positive for case (i) financial structure and capital openness are both positive, and case (ii) financial structure and capital openness are both negative. In this sub-section, we will suggest two alternative approaches to this problem.

Firstly, we distinguish the case in which both financial structure and capital openness are negative from other cases in which at least one of two variables are positive. Appendix figure A1 plots the distribution of banking and currency crisis, which the vertical axis

represents financial structure and the horizontal axis represents capital openness. Interestingly, in the case financial structure and capital openness both have positive values, no currency crisis event has been observed. Appendix table A1 shows the result of basic and extended models. From columns (ii) of basic model, we find that after decomposing interaction terms to two separate indexes, the coefficients of both indexes are negative and statistically significant. For $FS_{it} \times KAO_{it}(1,2,4)$, it means the synergy effect of financial structure and capital openness remain as important factors related to decreasing the chance of currency crisis. On the other hand, negative significant coefficient of $FS_{it} \times KAO_{it}(3)$ means, for countries with banking based financial system and low capital openness, the synergy effect may work in opposite direction. However, this result is not robust because we cannot find significant effect in column (iv) of extended model,

Secondly, we use the capital openness index modified to [0,1] interval, instead of the original index with the range including both positive and negative values. In Table A2 we find results almost consistent with the main results, only difference appears in statistically insignificant coefficient for financial structure in a currency crisis regression. From these robustness check, we find financial structure is important factor via interacting with capital openness in explaining currency crisis.

Alternative financial structure index

Table A3 in the appendix provides the estimated results for an alternative financial structure index, which uses the first principal component of the efficiency variable and two variables used in the other financial structure index. Echoing the results of the currency crisis model, we obtain statistically significant coefficients for financial structure and capital openness; however, their interaction term is no longer statistically significant. We attribute this result to the problems with the efficiency calculation method mentioned in Section 2 (see footnote iii). Alternatively, the interaction effect of the two variables may be not as intuitive as their direct effect on financial crisis[viii].

Omitting countries without crisis experience

After removing countries not experiencing a crisis in the sampled period from the set of originally sampled countries, the results of the fixed-effect logistic regression based on the extended model with control variables are reported in Table A4 in the appendix. To make our comparison meaningful, we re-estimate random-effect logistic regressions for the reduced sample and present the results in Table A4. Even after limiting the number of sample countries, the results of the fixed effect and random models are similar to the estimated results for the full sample. From these results, we can confirm that the

likelihood of a currency crisis is mainly affected by financial structure and capital openness, including their interaction term. In addition, the inflation rate still has a positive effect on currency crisis probability.

The results also show that in our model, the likelihood of a banking crisis is mainly affected by polity, the VIX index and Reserves to GDP. We also confirm that banking crisis likelihood is independent of financial structures and capital openness levels. Although we found a statistically significant negative effect of financial structure on banking crises from our extended model with control variables for the full sample of countries, from Tables A1 and A2 in the appendix, we suspect that the effect may not be robust.

Window regression

Laeven and Valencia's (2018) financial crisis database only identify the crisis occurrence year although crisis may continue over a number of years. To avoid the possibility of macroeconomic explanatory variables being affected by the crisis itself in the earlier years, we adopt a two-year window to exclude the years after the crisis. we re-estimate probit robust regressions for the reduced sample and present the results in Table A5. Columns (ii) and (iv) show for currency crisis that the results are similar to the estimated results for the full sample. On the other hand, from columns (i) and (iii), we find the coefficients of VIX are positive and statistically significant, but the coefficients of Polity and Reserves are no longer significant.

Receiver operating characteristic curve

To test the predictive capacities of binary classifier models, the receiver operating characteristic curve (ROC) has been applied in many previous studies. This approach has been widely used in laboratory medicine in recent years. It is also used to test financial crisis predictive ability in Davis et al. (2016) and many previous studies. The ROC curve is created by plotting the true positive rate against the false positive rate. If the area under the ROC curve is 1, the model makes a perfect prediction. If the area under the ROC curve is less than 0.5, the model is considered to have no predictive ability because it predicts outcomes worse than random chance. The closer the ROC curve is to the upper left corner, the higher the overall accuracy of the test. The ROC curve results are presented in Figure 3.

We plot the ROC curves for our basic and modified models using the logistic panel method[ix]. The top two panels are based on the basic model with panels A and B pertaining to banking and currency crises, respectively. For banking crises, the area under the ROC

curve is valued at approximately 0.58, indicating that the model has a nearly 58% chance of providing the correct signal. It is thus difficult to determine whether the model can predict a banking crisis occurrence. However, for currency crises, we obtain a ROC curve with an area of nearly 0.85 even without the interaction term between financial structure and capital openness, which is not shown in Figure 3. After including the interaction term in the model, the ROC curve moves upward to approximately 0.87. It is thus clear that our model performs well in the prediction of currency crises.

The ROC curves plotted based on our extended model are reported in panels C and D. Note that we removed one country (Lebanon) from the sample due to data restrictions. For banking crises, the area under the ROC curve rises to approximately 0.86. We confirm again the important roles of polity, the VIX index and reserves in predicting banking crises. For currency crises, the area under the ROC curve rises to approximately 0.90, and the inclusion of the inflation rate may have contributed to an increase in the predictive power. In summary, we believe that financial structure and capital openness in the basic model best predict currency crises, whereas polity, the VIX index, and reserves are more important in predicting banking crises.

5. Conclusion

In this paper, we investigated the effect of financial structure and capital openness on the occurrence of two types of financial crisis: banking crises and currency crises. Our main results are summarized by the following four points. First, financial structure plays an important role in reducing the probability of a currency crisis. An economy with a more market-based structure is less likely to experience a currency crisis. Second, capital openness is also an important factor in the occurrence of a currency crisis. Higher capital openness is associated with a lower probability of a currency crisis. Third, capital openness can increase the effect of financial structure on a currency crisis. This means that a country with a more market-based structure is more likely to enjoy a more stable economy in terms of reducing a sudden drop in the value of its currency by maintaining a more open capital account. Fourth, in contrast to what is found for currency crises, both financial structure and capital openness have no effect on banking crises.

These results have important two policy implications. First, as many studies have also shown (Gourinchas and Obstfeld, 2012 and Kim et al, 2013, among others), it is important to associate different types of crisis with different sets of macroeconomic conditions, especially for recent years. Restrictions on bank activities and entry requirements can lower the likelihood of a banking crisis. On the other hand, financial agency supervisory

power can reduce the probability of a currency crisis. In particular, the banking sector has come to play a much larger role, and its growth has led to the accumulation of debt in credit and assets, which has increased the probability of a banking crisis (Reinhart and Rogoff, 2008). At the same time, financial market development can stabilize the foreign exchange market and mitigate information asymmetry, through which currency crisis likelihood can be reduced (Kim et al, 2013). Our analysis also confirms completely different sets of determinants of banking and currency crises. Second, developing countries must work simultaneously to foster the development of domestic financial markets and to open their capital accounts. Currently, a large set of capital controls tend to exist especially in countries in which domestic financial markets are relatively undeveloped and are more bank oriented. Frost and Saiki (2014) also point out that a closed capital account does not provide a country sufficient capacity to build a more robust financial market. In contrast, a country with a more developed and open financial market can mitigate currency sensitivity to external shocks.

This paper's main purpose is to distinguish the response of different types of crisis to different sets of macro variables. As heighted by Kaminsky and Reinhart (1999), there is also interesting to analysis the effect of capital openness and financial structure to twin crises in future studies. Moreover, capital openness is also known as a constituent of the impossible trinity of international finance. In a seminal work on trilemma configurations, Aizenman et al. (2010) suggest that a crisis spurs a comprehensive reevaluation of international macroeconomic policies and of the international financial architecture. Policy makers will have to face constraints on choices posed by such a trilemma. In contrast, both the present work and Forst and Saiki (2014) confirm that more capital open markets can lower the probability of a crisis. We believe that clarifying the direction of causality between financial crisis and trilemma policies will be an interesting challenge for future studies.

References:

Allard, J., and Blavy, R., 2011. Market Phoenixes and Banking Ducks Are Recoveries Faster in Market-Based Financial Systems? *IMF Working Paper* 11/213.

Allen, F., Bartiloro, L., Gu, X., and Kowalewski, O., 2018. Does economic structure determine financial structure? *Journal of International Economics* 114, 389-409.

Allen, F., Gu, X., and Kowalewski, O., 2012. Financial crisis, structure and reform. *Journal of Banking & Finance* 36, 2960-2973.

Aizenman, J., Chinn, MD., and Ito, H., 2010. The emerging global financial architecture: Tracing and evaluating new patterns of the trilemma configuration. *Journal of International Money and Finance* 29, 615-641.

Beck, T., Demirgüç-Kunt, A., and Levine, R., 2000. A New Database on Financial Development and Structure. *World Bank Economic Review* 14, 597–605

Beck, T., Demirgüç-Kunt, A., and Levine, R., 2009. Financial Institutions and Markets across Countries and over Time: Data and Analysis. *World Bank Policy Research Working Paper* 4943.

Beck, T., and Levine, R., 2002. Industry growth and capital allocation: does having a market- or bank-based system matter? *Journal of Financial Economics* 64, 147-180.

Cameron, A.C., and Miller, D.L., 2015. A Practitioner's Guide to Cluster-Robust Inference. *Journal of Human Resources* 50(2), 317-372.

Catao, L.A.V., and Milsei-Ferretti, G.M., 2014. External liabilities and crises. *Journal of International Economics* 94. 18-32.

Cesa-Bianchi, A., Martin, F.E., and Thwaites, G., 2019. Foreign booms, domestic busts: The global dimension of banking crises. *Journal of Financial Intermediation* 37, 56-74.

Chinn, M.D., and Ito, H., 2008. A new measure of financial openness. *Journal of Comparative Policy Analysis* 10, 309-322.

Čihák, M., Demirgüç-Kunt, A., Feyen, E., and Levine, R., 2012 Benchmarking Financial Development around the World, *World Bank Policy Research Working Paper* 6175.

Dal Bianco, S., Amini, C., and Signorelli, M., 2017. The Impact of the Global Financial Crisis and the Role of External and Internal Factors in Emerging Economies. *Emerging Market Finance and Trade* 53, 229-249.

Davis, J.S., Mack, A., Phoa, W., and Vandenabeele, A., 2016. Credit booms, banking crises, and the current account. *Journal of international Money and Finance* 60, 360-377.

Demirgüç-Kunt, A., and Detragiache, E., 2005. Cross-country empirical studies of systemic banking distress: a survey. *IMF Working Paper* 05/96.

Demirgüç-Kunt, A., Feyen, E., and Levine R., 2013. The Evolving Importance of Banks and Securities Markets. *World Economic Review* 27, 476-490.

Forst, J., and Saiki, A., 2014. Early warning for currency crises: What is the role of financial openness? *Review of International Economics* 22(1), 722-743.

Greene, W.H., Econometric analysis. Pearson Education Limited 2012.

Gourinchas, P.O., and Obstfeld, M., 2012. Stories of the Twentieth Century for the Twenty-First. *American Economic Journal: Macroeconomics* 4(1), 226-265.

Guerineau, S., and Leon, F., 2019. Information sharing, credit booms and financial stability: Do developing economies differ from advanced countries? *Journal of Financial Stability* 40, 64-76.

Ji, G., Kim, DS., and Ahn, K., 2019. Financial Structure and Systemic Risk of Banks: Evidence from Chinese Reform. *Sustainability* 11, 3721.

Kaminsky, G.L., and Reinhart, CM., 1999. The twin crises: The causes of banking and balance-of-payments problems. *America Economic Review* 89, 473-500.

Kim, T., Koo, B., and Park, M., 2013. Role of financial regulation and innovation in the financial crisis. *Journal of Financial Stability* 9, 662-672.

Laeven, L., Ratnovski, L., and Tong, H., 2016. Bank size, capital, and systemic risk: Some International evidence. *Journal of Banking & Finance* 69, 25-34.

Laeven, L., and Valencia, F., 2018. Systemic banking crises revisited. *IMF Working Paper* 18/206.

Langfield, S., and Pagano, M., 2016. Bank bias in Europe: effects on systemic risk and growth. *Economic Policy* 31, 51-106.

La Porta, R., Lopez-de-Silanes, F., and Shleifer, A., 2002. Government ownership of banks. *Journal of Finance* 57, 265-301.

Lee, BS., 2012. Bank-based and market-based financial systems: Time-series evidence. *Pacific-basin finance journal* 20, 173-197.

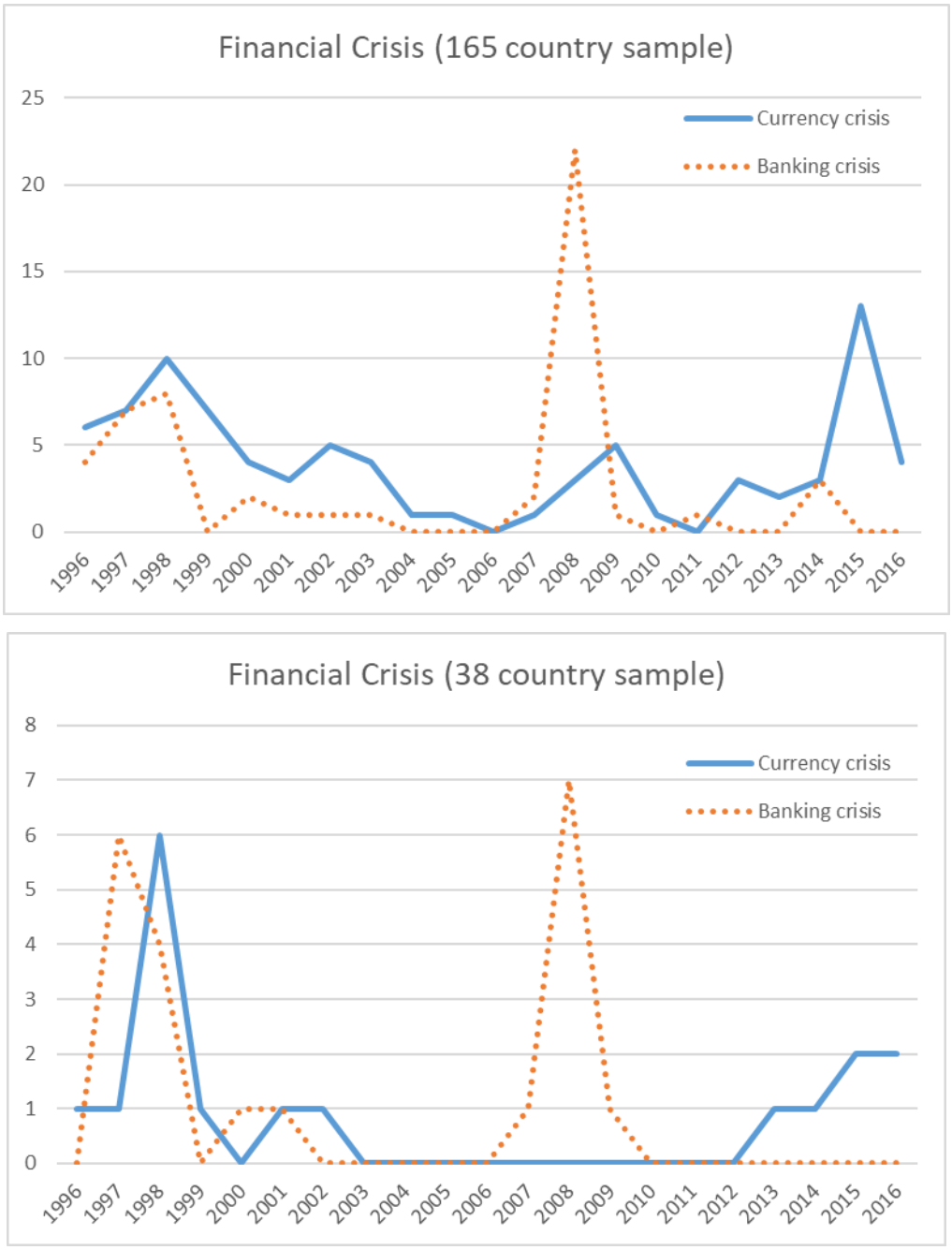
Levine, R., 2002. Bank-Based or Market-Based Financial Systems: Which Is Better? *Journal of Financial Intermediation* 11, 398-428.

Reinhart, CM., and Rogoff, KS., 2008. Is the 2007 US sub-prime financial crisis so different? An international historical comparison. American Economic Review 98, 339-344.

Sachs, J., Tornell, A., and Velasco, A., 1996 Financial crises in emerging markets: the lessons from 1995. *Brookings papers on economic activity* 1, 147-215.

Wooldridge, J.M., Econometric Analysis of Cross Section and Panel Data, 2nd ed. Cambridge, MA: MIT Press 2010.

Figure 1 Distributions of the two types of financial crisis for 1996 to 2016



Source: IMF Laeven and Valencia Database

Table 1 Sampled countries and financial crisis events

(a)

Argentina	Hungary	Mauritius	Singapore
Australia	India	Mexico	Slovenia
Brazil	Indonesia	Morocco	South Africa
Chile	Ireland	Nigeria	Spain
China	Israel	Norway	Switzerland
Colombia	Japan	Pakistan	Thailand
Croatia	Jordan	Peru	Turkey
Egypt, Arab Rep.	Korea, Rep.	Philippines	United States
Germany	Lebanon	Poland	
Greece	Malaysia	Russian	

(b)

Banking crisis		Currency crisis	
Argentina (2001)	Korea (1997)	Argentina (2002, 2013)	Thailand (1998)
China (1998)	Malaysia (1997)	Brazil (1999, 2015)	Turkey (1996, 2001)
Colombia (1998)	Philippines (1997)	Egypt (2016)	
Croatia (1998)	Russian (1998, 2008)	Indonesia (1998)	
Germany (2008)	Slovenia (2008)	Korea (1998)	
Greece (2008)	Spain (2008)	Malaysia (1998)	
Hungary (2008)	Switzerland (2009)	Nigeria (1997, 2016)	
Indonesia (1997)	Thailand (1997)	Philippines (1998)	
Ireland (2008)	Turkey (2000)	Russian (1998, 2014)	
Japan (1997)	United States (2007)	South Africa (2015)	

Source: IMF Laeven and Valencia Database

Table 2 Descriptive Statistics

	Obs.	Mean	S.Dev	Min	Max	Median
Size	798	-0.13	0.69	-2.46	1.64	-0.14
Activity	798	-1.23	1.31	-5.17	1.64	-1.03
Efficiency	798	3.55	1.45	-0.61	7.94	3.72
Financial structure (FS)	798	0.00	1.26	-3.74	3.36	0.02
FS_alt	798	0.00	1.51	-4.50	3.93	0.07
Capital openness	798	0.73	1.43	-1.91	2.36	1.07
Inflation rate (%)	798	5.82	9.69	-5.99	143.69	3.67
Reserves to GDP	798	0.19	0.18	0.00	0.99	0.15
Polity	789	6.27	5.10	-7.00	10.00	8.00
VIX	798	20.73	5.80	12.81	32.69	21.98

Source: IMF International Financial Statistics, World Development Indicators, Financial Structure Database, Polity IV Project, CBOE Volatility Index, and author's own calculations.

Table 3 Correlations between the variables

	Size	*Activity*	*Efficiency*	*Financial structure*	*Aggregate*	*Capital openness*	*Inflation rate*	*Reserves to GDP*	*Currnet account*	*VIX index*	*GDP per capital*
Size	1.000										
Activity	0.450	1.000									
Efficiency	0.371	0.899	1.000								
Financial structure (FS)	0.491	0.462	0.382	1.000							
FS_alt	0.445	0.492	0.398	0.949	1.000						
Capital openness	-0.089	0.019	0.062	0.041	0.074	1.000					
Inflation rate	0.124	0.041	-0.027	0.017	0.004	-0.325	1.000				
Reserves to GDP	0.158	0.078	0.102	0.107	0.107	0.092	-0.142	1.000			
Polity	-0.008	-0.032	0.025	0.001	-0.004	0.280	-0.057	-0.397	1.000		
VIX index	-0.058	0.089	0.075	0.058	0.092	-0.009	0.053	-0.038	-0.002	1.000	
GDP per capital	-0.111	0.189	0.211	-0.011	0.011	0.596	-0.262	0.034	0.339	-0.064	1.000

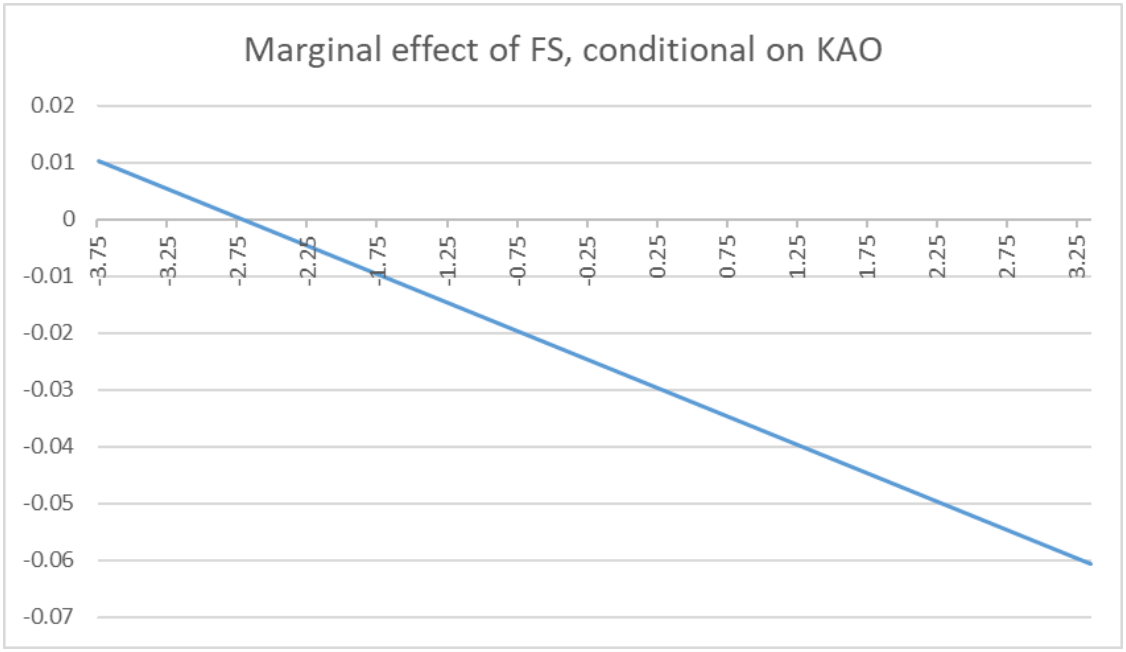
Note: Correlations are calculated for the full sample period of 1996-2016.

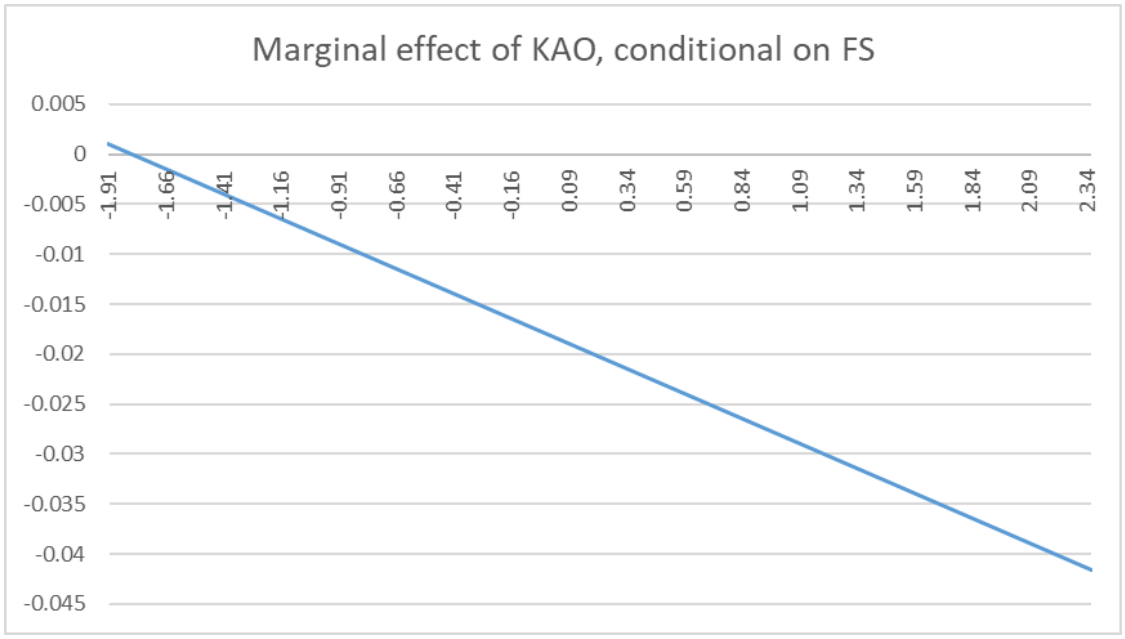
Table 4 Random-effect probit model panel robust estimates for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.122	-0.495 ***	-0.194 *	-0.463 ***
	(0.083)	(0.152)	(0.100)	(0.151)
KAO	0.017	-0.806 ***	0.031	-0.679 ***
	(0.067)	(0.260)	(0.088)	(0.253)
FS*KAO	0.022	-0.276 **	0.022	-0.242 **
	(0.052)	(0.120)	(0.060)	(0.119)
POL			-0.043 *	0.001
			(0.023)	(0.024)
VIX			0.109 ***	0.009
			(0.024)	(0.024)
RES			-4.578 ***	0.012
			(1.541)	(1253)
INF			0.004	0.017 ***
			(0.008)	(0.006)
Marginal effect				
FS	-0.007	-0.021 ***	-0.010 *	-0.018 ***
	(0.005)	(0.007)	(0.005)	(0.007)
KAO	0.001	-0.033 ***	0.002	-0.027 **
	(0.004)	(0.012)	(0.004)	(0.011)
FS*KAO	0.001	-0.011 **	0.001	-0.010 *
	(0.003)	(0.005)	(0.003)	(0.005)
POL			-0.002 *	0.000
			(0.001)	(0.001)
VIX			0.006 ***	0.000
			(0.001)	(0.001)
RES			-0.232 ***	0.000
			(0.084)	(0.050)
INF			0.000	0.001 ***
			(0.000)	(0.000)
Cons	-1.971 ***	-2.596 ***	-3.782 ***	-2.860 ***
	(0.111)	(0.338)	(0.637)	(0.650)
Obs.	798	798	777	777
Log pseudo-Likelihood	-95.971	-64.230	-75.031	-60.092

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

Figure 2 Marginal effect of capital openness and financial structure to currency crisis





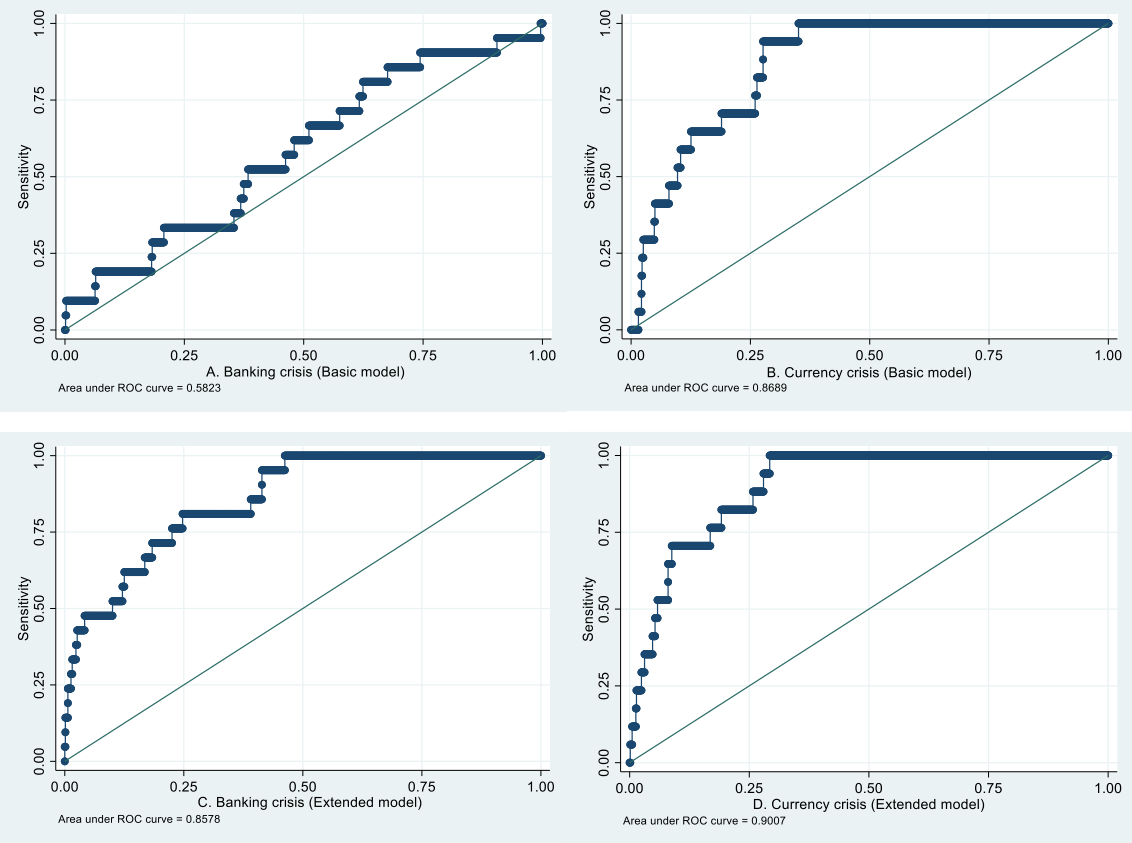
Note: Based on the results of column (iv) of Table 4

Table 5 Random-effect logistic model panel robust estimates for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.310	-1.055 ***	-0.494 **	-1.005 ***
	(0.204)	(0.299)	(0.232)	(0.302)
KAO	0.050	-1.712 ***	0.087	-1.488 ***
	(0.165)	(0.513)	(0.187)	(0.517)
FS*KAO	0.064	-0.563 **	0.096	-0.505 **
	(0.126)	(0.228)	(0.130)	(0.227)
POL			-0.109 **	0.000
			(0.050)	(0.052)
VIX			0.242 ***	0.021
			(0.053)	(0.052)
RES			-10.518 ***	0.464
			(3.542)	(2.708)
INF			0.006	0.029 **
			(0.017)	(0.011)
Marginal effect				
FS	-0.008	-0.021 ***	-0.012 **	-0.019 ***
	(0.005)	(0.007)	(0.006)	(0.007)
KAO	0.001	-0.033 ***	0.002	-0.028 **
	(0.004)	(0.012)	(0.004)	(0.011)
FS*KAO	0.002	-0.011 **	0.002	-0.010 **
	(0.003)	(0.005)	(0.003)	(0.005)
POL			-0.003 **	0.000
			(0.001)	(0.001)
VIX			0.006 ***	0.000
			(0.002)	(0.001)
RES			-0.251 ***	0.009
			(0.092)	(0.051)
INF			0.000	0.001 **
			(0.000)	(0.000)
Cons	-3.710 ***	-5.027 ***	-7.721 ***	-5.666 ***
	(0.275)	(0.690)	(1.462)	(1.421)
Obs.	798	798	777	777
Log pseudo-Likelihood	-95.897	-64.640	-74.672	-61.068

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

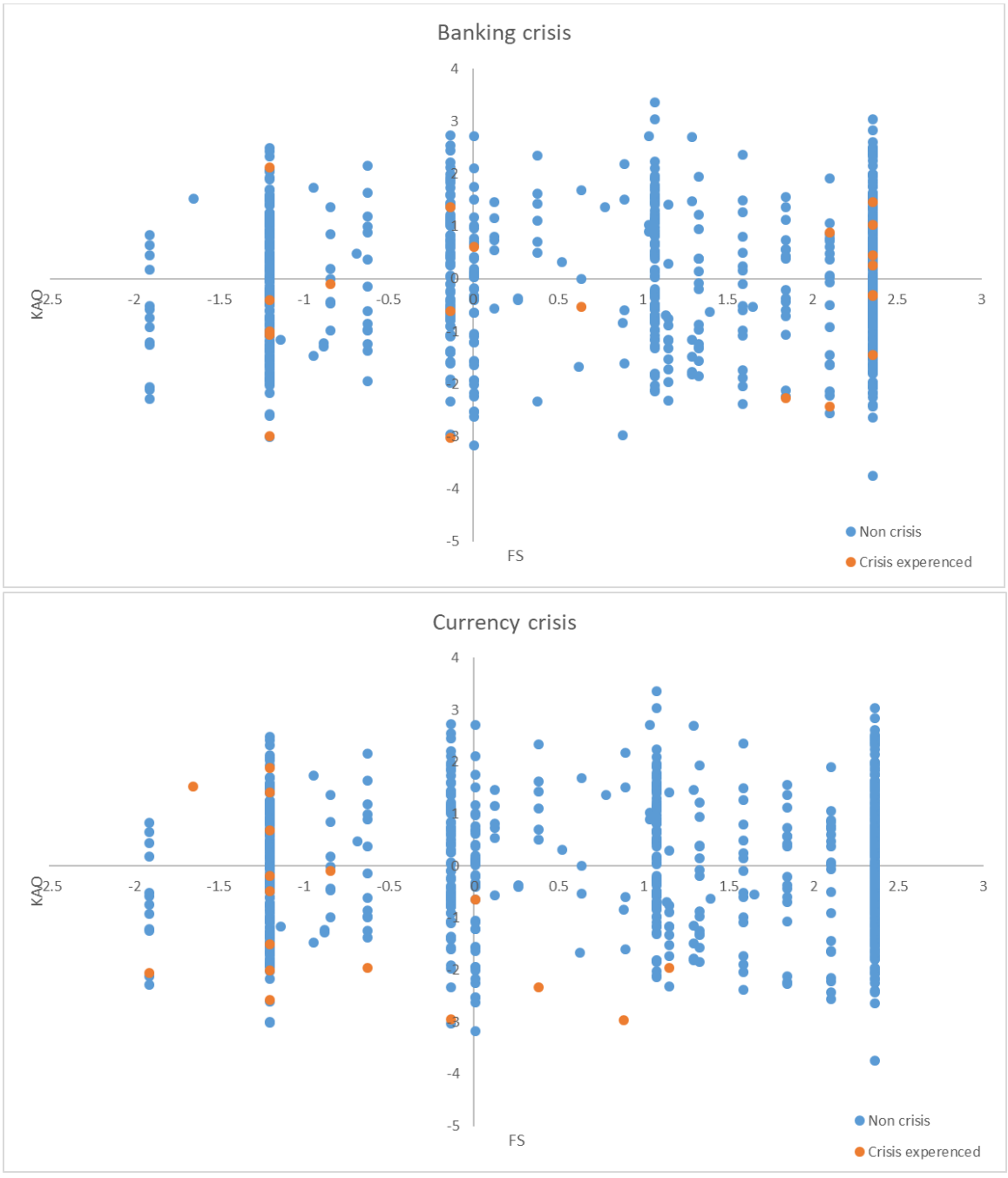
Figure 3 Receiver operating characteristics (ROC) curves



Note: Points located above the diagonal represent good prediction results, and points positioned below the line represent poor prediction results. The best possible prediction method would yield a line that crosses the point in the upper left corner.

Appendix

Figure A1



Note: The vertical axis represents financial structure and the horizontal axis represents capital openness.

Table A1 Two dummy interaction term random-effect logistic panel robust estimates for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.072	-0.494 ***	-0.173	-0.442 ***
	(0.114)	(0.169)	(0.164)	(0.156)
KAO	0.038	-0.806 ***	0.053	-0.661 ***
	(0.074)	(0.214)	(0.100)	(0.242)
FS*KAO(1,2.4)	-0.012	-0.278 **	0.024	-0.254 **
	(0.109)	(0.118)	(0.139)	(0.128)
FS*KAO(3)	(0.137)	-0.272 *	0.080	-0.198
	(0.173)	(0.161)	(0.216)	(0.151)
POL			-0.044 *	0.000
			(0.024)	(0.023)
VIX			0.109 ***	0.010
			(0.024)	(0.016)
RES			-4.550 ***	0.048
			(1.298)	(0.833)
INF			0.005	0.017 ***
			(0.004)	(0.004)
Marginal effect				
FS	-0.004	-0.020 ***	-0.009	-0.017 ***
	(0.007)	(0.008)	(0.008)	(0.007)
KAO	0.002	-0.033 ***	0.003	-0.026 ***
	(0.004)	(0.011)	(0.005)	(0.009)
FS*KAO(1,2.4)	-0.001	-0.011 **	0.001	-0.010 **
	(0.007)	(0.005)	(0.007)	(0.005)
FS*KAO(3)	0.008	-0.011 *	0.004	-0.008
	(0.010)	(0.007)	(0.011)	(0.006)
POL			-0.002 *	0.000
			(0.001)	(0.001)
VIX			0.006 ***	0.000
			(0.001)	(0.001)
RES			-0.231 ***	0.002
			(0.066)	(0.033)
INF			0.000	0.001 ***
			(0.000)	(0.000)
Cons	-2.020 ***	-2.598 ***	-3.801	-2.897 ***
	(0.135)	(0.311)	(0.618)	(0.692)
Obs.	798	798	777	777
Log pseudo-Likelihood	-95.787	-64.233	-74.961	-60.068

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is

capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

Table A2 [0,1] capital openness random-effect logistic panel robust estimates for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.164	0.032	0.119	-0.001
	(0.196)	(0.140)	(0.526)	(0.152)
KAO[0,1]	0.017	-0.806 ***	-0.408	-0.679 **
	(0.062)	(0.226)	(0.544)	(0.267)
FS*KAO[0,1]	0.096	-1.178 **	-0.130	-1.032 **
	(0.259)	(0.466)	(0.776)	(0.496)
POL			-0.305 **	0.001
			(0.138)	(0.023)
VIX			0.283 ***	0.009
			(0.067)	(0.016)
RES			-30.346 ***	0.012
			(8.007)	(0.828)
INF			-0.019	0.017 ***
			(0.028)	(0.004)
Marginal effect				
FS	-0.010	0.001	0.013	0.000
	(0.012)	(0.006)	(0.056)	(0.014)
KAO[0,1]	0.001	-0.033 ***	-0.043	-0.027 ***
	(0.004)	(0.011)	(0.058)	(0.010)
FS*KAO[0,1]	0.006	-0.049 **	-0.014	-0.041 **
	(0.016)	(0.021)	(0.082)	(0.019)
POL			-0.032 **	0.000
			(0.015)	(0.001)
VIX			0.030 ***	0.000
			(0.007)	(0.001)
RES			-3.222 ***	0.000
			(0.404)	(0.033)
INF			-0.002	0.001 ***
			(0.003)	(0.000)
Cons	-1.971 ***	-2.596	-3.782 *	-2.860 ***
	(0.106)	(0.311)	(2.260)	(0.682)
Obs.	798	798	777	777
Log pseudo-Likelihood	-95.971	-64.230	-75.031	-60.092

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations

(1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

Table A3 Random-effect logistic model panel robust estimates of banking and currency crises by alternative financial structure calculation

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS_alt	-0.145	-0.552 ***	-0.286	-0.549 **
	(0.166)	(0.209)	(0.191)	(0.218)
KAO	0.032	-1.168 ***	0.072	-0.979 **
	(0.159)	(0.389)	(0.185)	(0.391)
AG*KAO	0.034	-0.223	0.026	-0.216
	(0.103)	(0.171)	(0.107)	(0.172)
POL			-0.103 **	-0.015
			(0.049)	(0.051)
VIX			0.234 ***	0.024
			(0.052)	(0.051)
RES			-10.162 ***	-0.075
			(3.428)	(2.600)
INF			0.005	0.031 ***
			(0.017)	(0.012)
Marginal effect				
FS_alt	-0.004	-0.011 **	-0.007	-0.011 **
	(0.004)	(0.005)	(0.005)	(0.005)
KAO	0.001	-0.023 **	0.002	-0.019 **
	(0.004)	(0.009)	(0.004)	(0.009)
FS*KAO	0.001	-0.004	0.001	-0.004
	(0.003)	(0.004)	(0.003)	(0.003)
POL			-0.002 **	0.000
			(0.001)	(0.001)
VIX			0.006 ***	0.000
			(0.002)	(0.001)
RES			-0.244 ***	-0.001
			(0.090)	(0.050)
INF			0.000	0.001 **
			(0.000)	(0.000)
Cons	-3.657 ***	-4.339 ***	-7.484 ***	-5.003 ***
	(0.261)	(0.508)	(1.430)	(1.316)
Obs.	798	798	777	777
Log pseudo-Likelihood	-96.720	-68.758	-75.821	-64.670

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels,

respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one if a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

Table A4 Logistic model robust estimates of banking and currency crises (omitting countries without crisis experience)

Dep Var	Banking crisis		Currency crisis	
	Random effect	Fixed effect	Random effect	Fixed effect
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.311	0.061	-1.386 ***	-1.489 **
	(0.314)	(0.312)	(0.402)	(0.610)
KAO	-0.186	-0.408	-1.869 ***	-1.994 **
	(0.190)	(0.492)	(0.680)	(0.972)
FS*KAO	0.026	-0.031	-0.917 ***	-1.156 **
	(0.149)	(0.167)	(0.333)	(0.528)
POL	-0.135 ***	-0.305 ***	-0.005	0.087
	(0.048)	(0.084)	(0.040)	(0.100)
VIX	0.252 ***	0.283 ***	0.025	0.019
	(0.053)	(0.065)	(0.034)	(0.032)
RES	-10.853 ***	-30.346 **	-0.741	-0.610
	(3.604)	(13.822)	(1.966)	(4.203)
INF	-0.006	-0.019	0.013 *	0.013
	(0.009)	(0.027)	(0.007)	(0.008)
Marginal effect				
FS	-0.012	0.006	-0.075 ***	-0.137 ***
	(0.013)	(0.033)	(0.020)	(0.034)
KAO	-0.007	-0.043	-0.101 ***	-0.184 ***
	(0.007)	(0.049)	(0.034)	(0.038)
FS*KAO	0.001	-0.003	-0.049 ***	-0.107 ***
	(0.006)	(0.018)	(0.016)	(0.039)
POL	-0.005 ***	-0.032 ***	0.000	0.008
	(0.002)	(0.011)	(0.002)	(0.006)
VIX	0.010 ***	0.030 ***	0.001	0.002
	(0.002)	(0.009)	(0.002)	(0.003)
RES	-0.432 ***	-3.222 ***	-0.040	-0.056
	(0.121)	(0.708)	(0.107)	(0.417)
INF	0.000	-0.002	0.001 **	0.001
	(0.000)	(0.003)	(0.000)	(0.001)
Cons	-6.699 ***		-5.031	
	(1.633)		(1.193)	
Obs.	420	420	252	252
Log pseudo-Likelihood	-60.881	-32.648	-48.352	-34.793

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one if a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

Table A5 Random-effect probit model robust estimates of window regression for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.133	-0.533 ***	-0.243	-0.485 ***
	(1.342)	(0.158)	(0.158)	(0.144)
KAO	0.018	-0.914 ***	0.056	-0.699 ***
	(0.211)	(0.252)	(0.107)	(0.253)
FS*KAO	0.022	-0.308 ***	0.014	-0.248 **
	(0.636)	(0.118)	(0.076)	(0.106)
POL			-0.046	0.002
			(0.052)	(0.022)
VIX			0.124 **	0.008
			(0.052)	(0.017)
RES			-5.210	0.407
			(3.789)	(0.886)
INF			0.007	0.041 ***
			(0.006)	(0.007)
Marginal effect				
FS	-0.008	-0.022 ***	-0.012	-0.018 ***
	(0.074)	(0.008)	(0.008)	(0.006)
KAO	0.001	-0.038 ***	0.003	-0.026 **
	(0.012)	(0.013)	(0.005)	(0.010)
FS*KAO	0.001	-0.013 **	0.001	-0.009 **
	(0.038)	(0.006)	(0.004)	(0.004)
POL			-0.002	0.000
			(0.003)	(0.001)
VIX			0.006	0.000
			(0.004)	(0.001)
RES			-0.268	0.015
			(0.207)	(0.032)
INF			0.000	0.001 ***
			(0.000)	(0.000)
Cons	-1.947	-2.719 ***	-4.063 ***	-3.143
	(7.655)	(0.354)	(0.939)	(0.677)
Obs.	756	772	735	751
Log pseudo-Likelihood	-94.629	-62.672	-70.966	-53.552

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 2.

[i] https://www.imf.org/en/Publications/WP/Issues/2018/09/14/Systemic-Banking-Crises-Revisited-46232

[ii] https://www.worldbank.org/en/publication/gfdr/data/financial-structure-database

[iii] As Levine (2002) also points out, the calculation of efficiency may cause problems. Instead of our efficiency index, Kim et al (2013) and Allen et al (2018) consider the ratio of value traded to overall costs of the bank sector as relative efficiency because the total value traded may reflect the efficiency of market, and conversely, overhead costs reflect banking sector inefficiency. However, the application of market efficiency to bank efficiency will introduce considerable bias. It is more reasonable to consider a higher value as denoting a more market-based financial structure. Consequently, for the calculation of efficiency, we use the original methodology given by Levine (2002).

[iv] Specific methodological econometric issues of panel binary regression can be found in Greene (2012) and Wooldridge (2010).

[v] Considering the endogenous problem, that macro variables can also be affected by the crisis event. We have also checked the effect of financial structure and capital openness in year $t-1$ to financial crisis in year t. The qualitative results remain unchanged, but the synergy effect becomes less clear.

[vi] Since regular specification tests applied in a linear model, such as the Hausman test, cannot be directly applied in a binary dependent variable model, we estimated all pooled, random and fixed effect models. Because it can estimate partial effects for the specific countries in which we are interested, we present the results of the random effect model as our main results. The qualitative results remain unchanged for two other specifications and the corresponding results are available upon request.

[vii] Due to missing polity data for Lebanon, we needed to decrease the size of our country sample from 38 to 37 countries.

[viii] We applied our two financial structure calculation to pooled, random and fix effect models; the qualitative results remained almost unchanged. To conserve space, we only show the FS_alt random effect results to facilitate a direct comparison.

[ix] We also plotted the figure using the logistic panel method and obtained nearly identical results.