WP/18/9

IMF Working Paper

Friend or Foe? Cross-Border Linkages, Contagious Banking Crises, and "Coordinated" Macroprudential Policies

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INTERNATIONAL MONETARY FUND

 WP/18/9

IMF Working Paper

Institute of Capacity Development

Friend or Foe? Cross-Border Linkages, Contagious Banking Crises, and "Coordinated" Macroprudential Policies

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January 2018

Abstract

This paper examines whether the coordinated use of macroprudential policies can help lessen the incidence of banking crises. It is well-known that rapid domestic credit growth and house price growth positively influence the chances of a banking crisis. As well, a crisis in other countries with high trade and financial linkages raises the crisis probability. However, whether such "contagion effects" can operate to reduce crisis probabilities when highly linked countries execute macroprudential policies together has not been fully explored. A dataset documenting countries' use of macroprudential tools suggests that a "coordinated" implementation of macroprudential policies across highly-linked countries can help to stem the risks of widespread banking crises, although this positive effect may take some time to materialize.

JEL Classification Numbers: F36, F42, G21

Keywords: Trade Linkages, Financial Linkages, Financial Crisis, Banking Crisis, Macroprudential Policies

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[1] We would like to thank our IMF colleagues and Hyun Song Shin for helpful discussions and comments.

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I. INTRODUCTION

The holy grail search for reliable precursors of financial crises continues unabated following the global financial crisis. Despite the large literature on contagion and the role of spillovers, the question of how much trade and financial linkages matter quantitatively for the predictability of a financial crisis remains relatively unexplored. More importantly, and despite calls from international bodies for coordinated use of macroprudential policies, there is nearly no empirical evidence that such coordination would help to alleviate the chances of a banking crisis. This paper attempts to fill this gap by first verifying the extent to which trade and financial linkages contribute to the probability of a banking crisis and then by showing that the joint use of macroprudential policies by these partners can indeed lower the incidence of crises.

To begin, the paper examines how the marginal contributions from domestic determinants diminish with the introduction of contagion-type variables, verifying that contagion is an important component of financial crises. Then, as an intermediate step, using a dataset on the use of macroprudential tools, including caps on loan-to-value (LTV) and debt-to-income (DTI) ratios, we examine how real credit growth and real house price growth (two precursors to crises) evolve when these tools are employed. We then connect "coordinated" or simultaneous use of such macroprudential tools across highly-connected partners to the probability of a banking crisis. The result suggests there tends to be a positive role for coordination (although it may take some time to be effective), contributing to ongoing discussions within global policymaking circles about spillovers and leakages of macroprudential policies.

The formal recognition that cross-country financial linkages were important in the spread of crises has its root in the Asian financial crisis in the late 1990s. Following this crisis, a spate of studies showed how investors altered their global portfolio decisions in ways that led to capital flows in excess of what would be justified from domestic economic fundamentals.[2] Hence, even countries with relatively positive economic prospects found themselves subject to rapid and destabilizing capital outflows. Alternatively in a financially integrated world, if a country is hit by a banking crisis, international loan providers to that country could be exposed to credit risks, through which the crisis could spread to banks in other countries. Also, banks could proactively pull funds out of the countries that are considered to have similar characteristics or are closely linked to the crisis country. (See Espinosa-Vega and Solé (2010).) Trade linkages have also been examined as a precursor to crises, but their predictive power has been less strongly linked to banking crises than financial linkages (Van Rijckeghem and Weder, 2001).[3] See, also, IMF (2013) on financial and trade linkages which amplify the effects of financial shocks.

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[2] See Kodres and Pritsker (2002), Yuan (2005), and Baig and Goldfajn (1999).

[3] In this earlier literature, some of these effects were tied to investor perceptions of risk (often measured imprecisely or as a residual effect), rather than actual exposures. In this paper, we leave this latter influence aside and focus on documented linkages.

We use these insights regarding trade and financial linkages to verify their role as early warnings of the probability of future crises. Building on the literature that illustrates the importance of rapid credit growth and house price growth in estimating the likelihood of banking crises, we add variables that measure actual trade and financial linkages. For trade linkages, we use bilateral data from the IMF's Direction of Trade Statistics (DOTS). For financial linkages, we use bilateral data from the Bank of International Settlements (BIS) on cross-border bank claims.

Our regression results confirm that a banking crisis in major partner countries increases the domestic crisis probability even after controlling for domestic determinants, such as real credit growth and real house price growth.[4] Table 1 (based on Table 3's specification (2) to be discussed later) illustrates that crises are contagious—the crisis probability increases substantially if at least one partner country is in crisis.[5] Moreover, and perhaps more importantly, the size of this contagion effect appears disproportionately larger when the country's own vulnerabilities are relatively high. That is, a top-10 trade partner that is in crisis raises the crisis probability of its partner country at a median level of real credit growth (0.9 percent per year) and real house price growth (1.8 percent) from 1 percent to 14 percent. If the domestic economy is in the top 5th percentile of the distribution of the credit growth (9.2 percent) and real house price growth (19.6 percent), then the impact from a trade partner's crisis is even greater—going from about a 2-percent to an 18-percent crisis probability. With financial linkages, the increases are also large.

Table 1. Probability of a Banking Crisis according to Partner Crises
(A) Trade Linkages

Lagged credit growth and real house price growth (percent)	Number of top-10 trade partner countries that were in crisis in the last year	Crisis probability (percent)
Median (0.9 and 1.8)	Zero	1.4
	At least one	13.9
Top 5 percent (9.2 and 19.6)	Zero	1.9
	At least one	18.4

[4] We also used the credit-to-GDP gap, which is measured as the difference between the credit-to-GDP ratio and a trend estimated using a one-sided Hodrick-Prescott filter as recommended by the Basel Committee on Banking Supervision for the construction of a countercyclical capital buffer. The main results are not substantially affected.

[5] For the results on trade partners, we use annual data in a panel logit model (across 120 countries from 1970 to 2014) where 2014 is the last year for which the crisis is available. For the results on financial linkages, we use the BIS consolidated banking data for 20 reporting countries and 128 counterparty countries from 1983 to 2014. See Appendix 1 for more detail on the data.

Table 1: Probability of a Banking Crisis according to Partner Crises (Continued)
(B) Financial Linkages

Lagged credit growth and real house price growth (percent)	Number of top-10 credit recipient countries that were in crisis in the last year	Crisis probability (percent)
Median (0.9 and 1.8)	Zero	0.1
	At least one	14.2
Top 5 percent (9.2 and 19.6)	Zero	0.1
	At least one	16.4

In addition to quantifying the magnitude of the impact of partner crises, this paper's main contribution is to show the potential usefulness of coordinated macroprudential policies. To date, most of the literature on macroprudential policies focuses on the effectiveness on *domestic* objectives, such as (i) increasing the resilience of the domestic financial system to aggregate shocks by building and releasing buffers, (ii) containing the build-up of domestic systemic vulnerabilities, for example, by reducing procyclical feedback between credit and asset prices, and (iii) controlling structural vulnerabilities within the domestic financial system that arise through interlinkages of individual intermediaries. See, for example, IMF-FSB-BIS (2016). This paper aims to understand whether containing the build-up of vulnerabilities in *partner* countries (through their use of macroprudential tools) can improve resilience domestically.

The result that contagion effects are sizable is an important intermediate step to provide for a role for coordinated macroprudential policies across highly-linked countries to stem the risks of widespread banking crises. The notion is that if macroprudential policies used in country A reduce the crisis probability in country A, then this reduction will lower the probability of crisis in a partner country B. Our results suggest that tightening in partner countries can lower real credit growth and real house price growth (at least in some specifications of the model). Beyond dampening these intermediate targets of macroprudential policies, we also find evidence that tightening in partner countries affects the probability of a banking crisis even after controlling for credit growth and real house price growth. Interestingly, the timing of effects can sometimes differ (depending on the specification) whereby a tightening in partner countries may initially increase the crisis probability, but later reduce it. As discussed below, country A's tightening decision could be the result of more vulnerable global financial conditions, which may continue to affect country B's crisis probability in the short run. Alternatively, country A's banks could replace their lower lending in country A by lending more in country B (sometimes referred to as a "spillover" or "leakage" of macroprudential policies).

The paper is organized as follows. We first summarize how the paper fits within the related literature on banking crisis, contagion, and the effectiveness of macroprudential policies, in Section II. Then we discuss the data for the variables used in the model in Section III. Details

about the data are in Appendix I. Section IV provides the main results without the use of macroprudential tools. Section V connects the macroprudential tools first with the precursors of crises—namely credit growth and house price growth—and then directly connects the crisis probabilities to partners' use of macroprudential policies. The final section concludes with some guidance for financial stability policymakers and some ideas for future investigations.

II. LITERATURE REVIEW

Our paper is related to the literature on crisis prediction, contagion and spillovers, and the effectiveness of macroprudential policies. Early work on crisis prediction followed the Mexican crisis of 1994 and then grew with the onset of the Asian crisis in the late 1990s.[6] Indeed, this crisis spawned a large literature on the use of domestic economic variables to predict currency crises in emerging economies, but also began to explore financial fundamentals and some measures of cross-country contagion (including their linkages to advanced economies). Both trade and financial linkages were examined, with most findings indicating that financial linkages were relatively more important.[7] For the most part, these models focused on balance of payments crises (current account reversals) and currency crises in emerging market countries.

Crisis prediction models have also examined banking crises, again starting from a domestic context and predominately using domestic banking sector variables.[8] More recently, the banking crisis literature and the balance of payments crisis literature have both begun to incorporate various measures of interconnectedness, ranging from (direct) common creditors to more statistical measures of interconnectedness. Some cases, such as Minoiu, et al. (2014), use both actual connections alongside statistical techniques to measure the strength of potential contagion.[9]

Our paper attempts to link banking crisis prediction models with actual measures of interconnectedness (see Figure 1). It takes as a starting point the now-common approach using real credit growth and real house price growth. We follow Arregui, et al. (2013) in which a panel logit model is estimated for 30 countries from 1970 to 2010. Their results suggest that

[6] Examples of this early literature include: Berg and Pattillo (1999), Goldfajn and Valdés (1998), Goldstein et al (2000), IMF (1998), and Kaminsky, et al. (1998).

[7] See Eichengreen et al (1996), Glick and Rose (1999), Van Rijckeghem and Weder (2001), Forbes (2001), and Caramazza, Ricci and Salgado (2004) for examples.

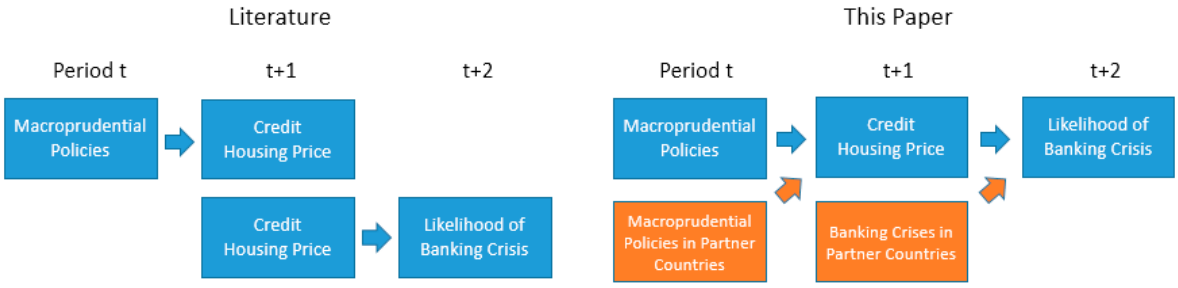
[8] See Demirgüç-Kunt and Detragiache (1998) for one of the earlier papers in this strain.

[9] See Carmazza, Ricci and Salgado (2004) for an example of a common creditor/debtor approach and Minoiu, et al. (2014) for the use of network-based financial connectedness measures and principle components to assess the strength of these connections on banking crises.

(continued…)

the interaction between high credit growth and rapid real house price growth is more important whenever the change in credit-to-GDP ratio is above a 3 percent threshold. They find that rapid credit growth combined with a housing boom is more dangerous than either alone. We add other domestic banking sector variables and the extent to which important trade and financial partner countries are also embroiled in a banking crisis.[10]

Figure 1. Illustrated Goal of This Paper



This paper is also related to the fast-growing literature of spillovers, both the negative spillovers of crises, but more recently, and the possibility of spillovers resulting from macroprudential policies themselves.

On crisis spillovers, our paper is mostly aligned with papers that use actual data on interlinkages, rather than those relying on market data and implicit interlinkages. For instance, network models, such as Espinosa-Vega and Solé (2010), typically consider spillovers based on actual bilateral exposures.[11] Their paper utilizes the BIS banking data to simulate the transmission of a country's banking system "failure" to other countries' banking systems as a result of an explicit (predetermined) interbank credit or funding shock.

The effectivenss of domestic macroprudential policies on domestic financial sector indicators and domestic crisis probabilities has been studied in Buch and Goldberg (2017), Akinci and Olmstead-Rumsey (2015), Arregui, et al. (2013), and IMF (2014). However, a smaller number of studies focused on the impact of *foreign* macroprudential policies. As regards the growing literature on unintended consequences (such as leakages, spillovers, or evasion) of

[10] Claessens, Tong and Zuccardi (2012) studies how bank and trade linkages affected the responses of stock valuations of non-financial firms to the euro-area crisis. They find the financially constrained firms in creditor countries exposed to peripheral euro countries were more substantially affected by shocks. Trade linkages also played a role. Our paper's focus is to consider country-level crisis probabilities rather than firm-level stock valuations, providing implications on macroprudential policies. Grant (2016) proposes a theoretical model to understand the transmission through which a crisis in trade or financial partners affects the performance of the domestic economy.

[11] See also Hattori and Suba (2007) and Minoiu, et al. (2015, 2016) for an examination of network-based measures across countries' banking systems.

macroprudential policies on other economies, our paper supports some (but not all) of the work done to date. Most of this literature examines the impact of macroprudential policies on (bank-issued) credit growth in domestic and foreign countries, but not on the probability of a banking crisis. See Kang et al. (2017) for several methods to examine such spillovers. For example, Cerutti, Claessens and Laeven (2017) examine what happens to country B when country A tightens and finds that, in some cases, international banks re-position their market shares by decreasing lending in country A but increasing it in country B. This channel suggests that country A's macroprudential tightening could have a "loosening" impact on country B—particularly when country A is a more open economy. Work encompassed by Buch and Goldberg (2017) across a number of countries so far suggests the empirical size of this "spillover" channel to credit growth depends on a number of factors: for instance, balance sheet conditions of banks, such as the amount of capital, and their business models as well as the type of macroprudential policy employed. Our paper's results generally suggest that negative spillovers are offset by the overall positive externalities at macro level – Country A's crisis probability decreases, which benefits Country B. However, when (domestic) non-deposit funding is included as a control variable in our logit model, the results initially show an increase in the crisis probability within one year, but a diminution the following year.

III. THE DATA

The extant literature on banking crises uses various definitions of a crisis. We adopt the Laeven and Valencia (2014) definition under which a (systemic) banking crisis is defined in reference to a large number of defaults in corporate and financial sectors with great overall difficulties repaying contracts. The crisis can be accompanied by bank runs, losses in the banking system, bank liquidations, and significant banking policy interventions. Applying this definition results in an annual binary banking crisis variable, $Y_{i,t}$, where 1 signifies a crisis in country *i* in year *t*. Only the initial year of the crisis is marked as a value of 1 and all directly subsequent years are excluded from the analysis although a given country can experience more than one banking crisis as long as they recover from an earlier one.[12] These data for 120 countries from 1970 to 2014 comprise our dependent variable.

Important variables include credit growth and house price growth. To proxy for the former variable, we use the change in credit-to-GDP ratio defined as private sector credit divided by nominal GDP, where the former is obtained from the IMF's International Financial Statistics (IFS) and the latter from the IMF's World Economic Outlook database. To proxy for the latter, we obtain the real house price data from the IMF Real Estate Markets Module and compute the growth rate. Importantly, the credit data incorporate non-bank forms of credit (if observations are available) since credit growth outside the banking system is often the catalyst for a banking crisis.

[12] For instance, if a country experienced only one crisis from 2008 to 2010, then the dummy variable takes the value of one in 2008, but the years 2009 and 2010 are marked as "not available." All years except 2008 through 2010 are marked as zero. Laeven and Valencia (2012) truncate the duration of crises at five years.

The construction of the linkage variables are meant to capture trade linkages (reflecting aggregate demand effects) and financial linkages (reflecting credit supply channels). The bilateral trade data are extracted from the IMF's Direction of Trade Statistics (DOTS), which provide bilateral trade (both imports and exports) in U.S. dollars. We use the sum of imports and exports to identify top ten trade partners.[13]

For financial linkages, we identify top-10 loan recipients for a given country[14], capturing credit risks, using bilateral claims from the BIS consolidated banking statistics.[15] There are several measures on financial linkages provided by the BIS. We use the immediate counterparty basis, as opposed to the ultimate risk basis. Using the immediate counterparty basis, a loan from, say, Credit Suisse's subsidiary in London to a Unicredit's subsidiary in London would be viewed as a loan from Switzerland to the United Kingdom. In the ultimate risk basis, where all the loans are consolidated on the parent's balance sheet, this loan would be viewed as a loan from Switzerland to Italy. Both types of data consolidate the exposures of the lenders' foreign offices (i.e., subsidiaries and branches) into the lenders' head office, but they treat the borrowers' location differently. See Appendix I for more detail. In using the immediate counterparty basis, we construct net total claims for all banks for 20 reporting countries (with 128 counterparty countries) in the BIS database.

For both the trade and financial linkage data, we examine the top-10 trade partners and top 10 loan recipients for country *i* and count how many of them are experiencing a banking crisis at year *t*. This variable is then used to measure the extent to which contagion across borders could influence the probability of a crisis in country *i*. Not surprisingly, the correlation between the two contagion measures is high, most likely because international banks are well-known for following their domestic corporate customers abroad and hence top trade partners are more likely to be financial partners and vice versa. Table 2 below aptly demonstrates this point during crisis times.

IV. Influence of Crises Experienced in Trade Partners and Loan Recipients

We estimate a pooled logit model of the form:

$$(1)\ \Pr\left(y_{i,t} = 1 \middle| x_{i,t-h}, z_{i,t-h}\right) = \Phi(\alpha_i + x_{i,t-h}\theta + z_{i,t-h}\beta)$$

[13] Since the major trading partners do not change frequently, we identify top ten partners every five years.

[14] As for trade linkage data, loan recipients are also identified at five year intervals.

[15] See McGuire and Wooldridge (2005) for more discussions on the uses of new BIS consolidated banking data.

where, $y_{i,t}$ is the crisis dummy variable for country *i* at year *t*, $x_{i,t-h}$ is a vector of independent variables for country *i* at year *t-h* where *h* is the number of lags; $z_{i,t-h}$ is a vector of the measure of contagion for country *i* at year *t-h*; and α, β, and θ are (vectors of) parameters to

Table 2. Numbers of Trade Partners and Loan Recipients Experiencing a Banking Crisis

		Number of loan recipients experiencing a banking crisis								
		0	1	2	3	4	5	6	7	**Total**
Number of trade partners experiencing a banking crisis	0	371	32	5	-	-	-	-	-	**408**
	1	27	15	4	1	-	-	-	-	**47**
	2	3	5	14	2	-	-	-	-	**24**
	3	1	-	1	-	-	1	-	-	**3**
	4	-	-	-	-	1	-	-	-	**1**
	5	-	-	-	-	-	1	1	-	**2**
	6	-	-	1	-	1	1	3	1	**7**
	7	-	-	-	-	-	1	2	-	**3**
Total		**402**	**52**	**25**	**3**	**2**	**4**	**6**	**1**	**495**

Sources: IMF Direction of Trade Statistics, BIS Consolidated Banking data, and financial crises identified in Laven and Valencia (2014). Annual data, 1970-2014.

be estimated. Also, Φ refers to the cumulative probability density of the logistic distribution. In order to obtain crisis probabilities, the following transformation (which represents the logistic probability distribution) is used:

$$(2)\ \widehat{\Pr}\left(y_{i,t}=1\middle|x_{i,t-h},z_{i,t-h}\right)=\frac{\exp(\alpha_i+x_{i,t-h}\theta+z_{i,t-h}\beta)}{1+\exp(\alpha_i+x_{i,t-h}\theta+z_{i,t-h}\beta)}.$$

Our baseline model follows Arregui, et al. (2013) by including the lagged change in credit-to-GDP ratio, i.e., $\Delta(\text{Credit/GDP})_{t-1}$, and the lagged real house price growth, i.e., $\Delta(\log(\text{Real House Price}))_{t-1}$. Other explanatory variables, such as lagged capital adequacy ratio, non-performing loans as a ratio of total loans, and the rate of return on assets are also considered as robustness checks.[16] We then add a new "contagion" variable measuring the number of top-10 trade or financial partners experiencing a crisis, lagged one year. We perform both a logit estimation with and without fixed effects. The fixed effects model will attempt to purge the results of country-specific characteristics. These characteristics include institutional or legal ones that make one country more likely to experience a banking crisis than another.

[16] The capital adequacy ratio, the non-performing loans ratio, and the return on assets are financial sector indicators used in advanced economies and emerging market economies in the IMF-FSB Early Warning Exercise (IMF (2010)). See also Papi, Presbitero and Zazzaro (2015) for an overview of determinants of banking crises. The M2-to-foreign-exchange-reserves ratio is also widely considered as a determinant (especially in emerging economies), but including it as an additional explanatory variable would lose a large number of observations without changing the main results substantially.

Table 3 shows the results of the estimation with the trade and banking contagion variables. In the pooled regression (Part (A)), without the additional contagion variable, credit growth (as measued by the change in credit-to-GDP ratio) is statistically significant at 5 percent level while the lagged real house price growth is insignificant (model (1)). Adding the dummy variable indicating any of top-10 trade partner countries experiencing a crisis at *t-1* shows that this variable is highly significant (at the 1 percent level) (model (2)). When the model is run with fixed effects to account for country specific factors (Part (B)), the coefficient on the trade contagion variable remains highly significant. Similarly, the banking contagion variable is highly significant when added to the model with credit growth and house price growth (model (3), both Parts (A) and (B)).[17] Indeed, in this case the dangers of (own country's) high credit growth are even more apparent as the coefficient increases in value and is even more statistically precise.[18] While we should expect that a credit boom might well be accompanied by cross-border banking inflows, the fact that each variable remains significant in this case suggests that they are independently predictive.

We also introduce an interactive term in addition to the baseline explanatory variables (models (4) and (5)). To be specific, this interactive term is a dummy variable that is 1 if *any* of the top-10 partner countries is experiencing a banking crisis at *t-1* and 0 otherwise, multiplied by each of the two baseline explanatory variables, real credit growth and real house price growth. For trade partners (model (4)), the estimation result suggests that the coefficients for the two new explanatory variables are highly significant in the pooled regression and significant for the interactive credit variable in the fixed effects model.[19] This suggests that having rapid domestic credit growth and house price growth when trade partner countries are in crisis is much more likely to precipitate a crisis than if the overheating credit and housing markets are purely domestic events. For loan recipients (model (5)), the interactive term between credit growth and the dummy variable is large and highly significant. On the other hand, the interactive term between house price growth and the dummy variable is not statistically significant, possibly because credit growth overwhelms any effect that house price growth may have.

The results so far mostly hold when control variables—capital adequacy ratio, return on assets, and nonperforming loans ratio—are added (models (1') -(5')). In addition, applying the country

[17] Due to data availability, the number of observations is lower than in the previous analysis (see Appendix I for the countries with data).

[18] Minoiu (2015) find similar results when at least one neighboring country (as measured using network-based concepts) is experiencing a banking crisis.

[19] Although the house price growth is marginally significant (and the "wrong" sign) in models (4) and (5), this is potentially due to the confounding effect of the interactive term.

(continued…)

fixed effect (Part (B)) does not change the main contagion result (although models (3') and (5') do not have enough variation in the data to estimate the model).[20,21]

Figure 2 illustrates the probability (in percent) of experiencing a crisis using the coefficient estimates from Table 3A (model (4) in the pooled regression). The figure is constructed for various levels of real credit growth and real house price growth when only domestic real credit and house price growth are considered (Table 3A model (1)) and comparing it to when at least one top-10 trading partner is in a banking crisis.[22] Overall, the probabilities of a domestic crisis (the left-hand figure) are all fairly low (less than 6 percent per year) and depend on both the change in the credit-to-GDP ratio and real house price growth. By contrast, once the extent of banking crises in one of the ten most highly connected trade partners is taken into account, the highest probability rises to around 26 percent. Moreover, the probability rises non-linearly. In other words, when trade partners are in crisis, the overall level of the crisis probability increases, and in addition, the marginal impact of the explanatory variables becomes larger.

[20] For models (3') and (5'), there is no crisis episode when the contagion dummy variable is zero, so the slope for the dummy cannot be estimated.

[21] In Appendix II, Table B1 includes a year-2008 dummy variable as an additional explanatory variable (Parts (A) and (B)). This variable is statistically significant at 1 percent level in most specifications while the two contagion variables mostly lose their statistical significance. Moreover, the real house price growth coefficient often has the "wrong" sign, likely due to the overwhelming influence of the crisis year. This implies that a large number of contagion episodes occurred during the global financial crisis. The importance of this latest crisis should be taken in light of the growing interconnectedness across economies over time.

[23] Some of the tools may be not be used expressly to limit *excesses* of real credit and house price growth as we do not know whether they were deployed for this purpose, but do appear to be aimed at these two areas of known vulnerability.

Table 3. Panel Logit Estimation Impact on Crises Experienced in Trade Partners and Loan Recipients on Domestic Crisis Probabilities

Dependent variable: Dummy indicating a banking crisis.
(A) Pooled Regression

	(1)	(2)	(3)	(4)	(5)	(1')	(2')	(3')	(4')	(5')
(Dummy, at least one top-10 trade partner in crisis)$_{t-1}$		2.432***					3.524***			
		(0.363)					(0.651)			
(Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$			5.544***							
			(1.816)							
Δ(Credit/GDP)$_{t-1}$	2.704**	3.097**	10.06***	1.723	0.394	3.255**	5.145***		1.553	-4.253
	(1.365)	(1.504)	(3.118)	(2.013)	(9.529)	(1.460)	(1.718)		(2.875)	(18.51)
(Real house price growth)$_{t-1}$	1.201	0.430	-3.789	-4.272*	-17.25*	2.675*	2.176		-4.296	-22.19
	(1.458)	(1.385)	(3.958)	(2.199)	(10.28)	(1.618)	(1.826)		(5.096)	(31.36)
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				9.677***					23.84***	
				(3.570)					(5.527)	
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				8.633***					10.47*	
				(2.847)					(5.490)	
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$					52.14***			Not Enough Variation		98.90***
					(13.72)					(37.41)
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$					10.56					30.48
					(12.19)					(36.86)
(Capital adequacy ratio)$_{t-1}$						-17.33**	-21.97**		-22.33**	-6.685
						(7.647)	(9.330)		(9.677)	(59.72)
(Return on assets)$_{t-1}$						-13.56	-14.68		-18.97	-505.6*
						(36.83)	(37.13)		(37.30)	(293.3)
(Nonperforming loans ratio)$_{t-1}$						1.212	2.906		0.0314	11.23
						(2.871)	(3.327)		(4.318)	(21.52)
Constant	-3.467***	-4.288***	-7.359***	-3.501***	-4.689***	-1.196	-2.463**		-0.930	-1.270
	(0.196)	(0.301)	(1.903)	(0.201)	(0.652)	(0.955)	(1.168)		(1.194)	(7.657)
R-squared	0.0135	0.161	0.433	0.0884	0.545	0.0836	0.345		0.346	0.756
Observations	1023	981	336	981	336	464	464		464	150

Table 3. Panel Logit Estimation: Impact of Crises Experienced in Trade Partners and Loan Recipients on Domestic Crisis Probabilities (continued)
(B) Fixed Effect

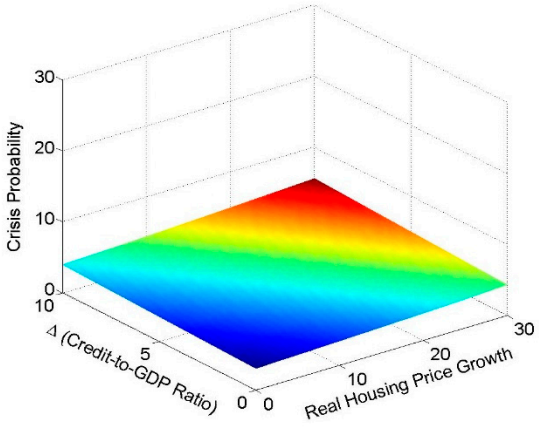
	(1)	(2)	(3)	(4)	(5)	(1')	(2')	(3')	(4')	(5')
(Dummy, at least one top-10 trade partner in crisis)$_{t-1}$		2.441***					4.565***			
		(0.375)					(1.169)			
(Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$			5.205***							
			(1.568)							
Δ(Credit/GDP)$_{t-1}$	1.310	1.750	15.14***	0.101	4.057	1.215	-0.124		-1.891	
	(1.825)	(1.482)	(4.505)	(2.524)	(15.34)	(3.485)	(5.080)		(4.768)	
(Real house price growth)$_{t-1}$	-0.869	-2.271	-6.798	-4.713*	-21.93	2.206	-0.987		-11.62	
	(1.750)	(1.755)	(5.080)	(2.414)	(14.49)	(2.460)	(3.921)		(10.85)	
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				12.88***					25.65**	
				(4.761)					(12.42)	
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				6.753*					19.73	
				(3.479)				Not Enough Variation	(14.00)	Not Enough Variation
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$					62.65***					
					(22.42)					
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$					10.70					
					(15.35)					
(Capital adequacy ratio)$_{t-1}$						-83.20***	-127.1***		-114.8**	
						(31.36)	(48.42)		(53.89)	
(Return on assets)$_{t-1}$						-18.43	-41.23		-11.35	
						(83.43)	(141.4)		(121.6)	
(Nonperforming loans ratio)$_{t-1}$						-9.191	-23.05		-41.27*	
						(8.230)	(15.20)		(21.48)	
R-squared	0.00372	0.225	0.626	0.105	0.693	0.176	0.717		0.588	
Observations	690	663	275	663	275	160	160		160	

Note: All banking crisis years except the start year are eliminated from the sample. Fixed effects estimates are only undertaken for countries with at least one year of a banking crisis. Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

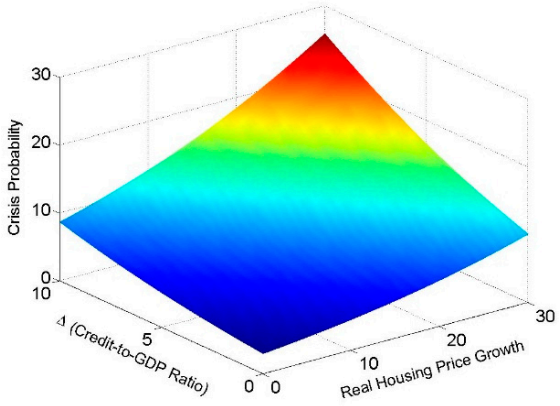
Figure 2. Illustration of the Estimated Crisis Probability

(Based on models (1) and (4) of Table 3 (A))

Model (1): Without trade partners



Model (4): When at least one of top-10 trade partners is in crisis



V. Influence of Macroprudential Policies in Trade Partners and Loan Recipients

A. Preliminaries

It is natural to conjecture that, given statistically significant contagion effects, sound macroprudential policy adopted in partner countries would decrease the probability of a domestic banking crisis. In order to determine whether this conjecture is empirically supported, we first investigate how two financial sector indicators—real credit growth and real house price growth—tend to evolve around the tightening or loosening of a top-10 partner's macroprudential tools.[23] Then we proceed to look directly at whether the use of macroprudential policies in partner countries lowers a country's own crisis probability (based on logit models) in the following subsections.

The data on macroprudential tightening are based on Tables B1 and B2 in Akinci and Olmstead-Rumsey (2015). These tables provide information on the tightening or loosening of each of the nine macroprudential tools in a given quarter of the year for a number of countries.[24]

[23] Some of the tools may be not be used expressly to limit *excesses* of real credit and house price growth as we do not know whether they were deployed for this purpose, but do appear to be aimed at these two areas of known vulnerability.

[24] These nine tools are the cap on the LTV ratio, the cap on the DTI ratio, housing-related countercyclical capital requirements, housing-related loan-loss provisioning, other housing measures, non-housing-related

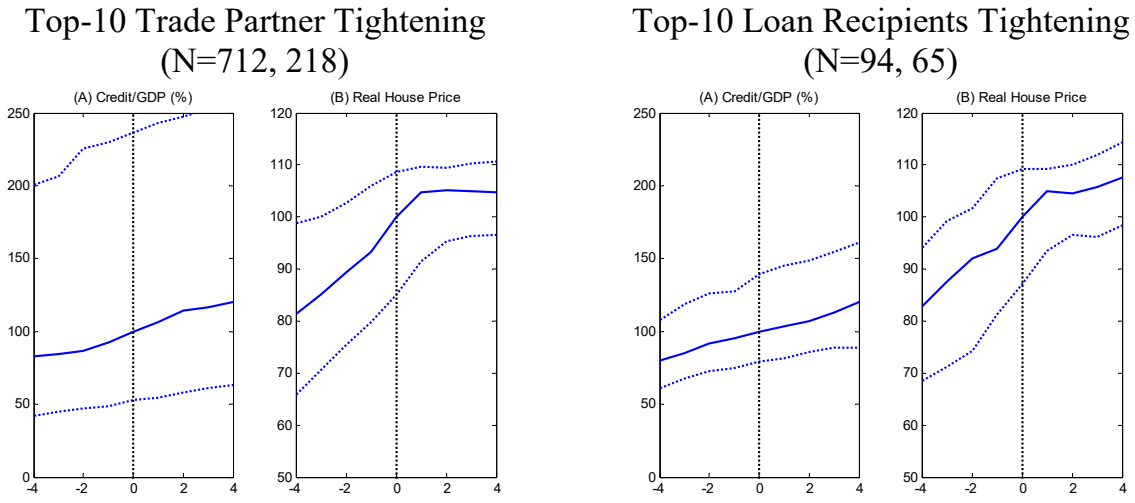
(continued…)

In our analysis, we define a discrete value, "macroprudential tightening/loosening indicator," which is equal to one (+1) when a country tightened at least one of the nine macroprudential tools, minus one (-1) when it loosened any of them, and zero (0) otherwise, in each quarter. Then, the annual observations are created by summing up the four quarters of the year. (See Appendix I.) For example, if an economy tightened twice and loosened once over a year, the annual observation for this indicator will be one. If a country tightened in one quarter and loosened in another within a specific year, we assign a value of zero. Then, for a given country, a top-10 partners' macroprudential "impulse" is defined as the sum of "macroprudential tightening/loosening indicator" for these partners. Hence, the partners' impulse can be up to the value of ten (+10) if all top-10 partners are tightening and down to the value of minus ten (-10) if all top-10 partners are loosening.

Figure 3 illustrates the evolution of the credit-to-GDP ratios and real house prices around the year in which the impulse is positive. The tightening of any of top-10 partners (i.e., a positive impulse) seems to be associated with a slowdown in real house price growth in the domestic economy, although there seems to be only a marginal impact on credit growth. In general, this supports the conjecture that tightening macroprudential policies can affect the financial sector of its trade and banking partners' domestic economies.

Figure 3. Financial Sector Indicators around Top-10 Partners' Macroprudential Tightening

(Year 0: Positive partners' macroprudential impulse)



Solid line: Median. Dotted lines: 25 and 75 percentiles. Normalized to 100 at year 0.

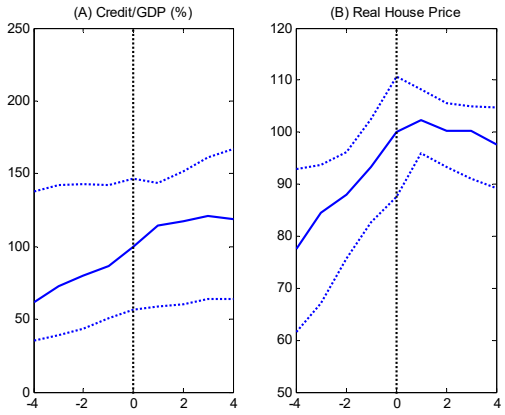
countercyclical capital requirements, non-housing-related loan-loss provisioning, consumer loan measures, and credit growth limits. No information is available in this dataset on the level of these tools, only whether they were raised or lowered.

We next examine whether the tightening of one or more top-10 trade partners matters when it is executed *in addition* to a domestic tightening of macroprudential policies. Figure 4 illustrates the evolution of the credit-to-GDP ratios and real house prices around domestic tightening with and without one or more tightenings of the top-10 trade partners (i.e., when the impulse is positive and when it is not). The results suggest that both credit growth and house price growth appear to slow down (or even fall in the case of the latter) when both the domestic authorities and at least one partner employ tightening policies simultaneously.[25] This suggests that foreign macroprudential policies could play an important role in domestic evolution of financial sector indicators by reinforcing (or even superceding) domestic macroprudential policies.[26]

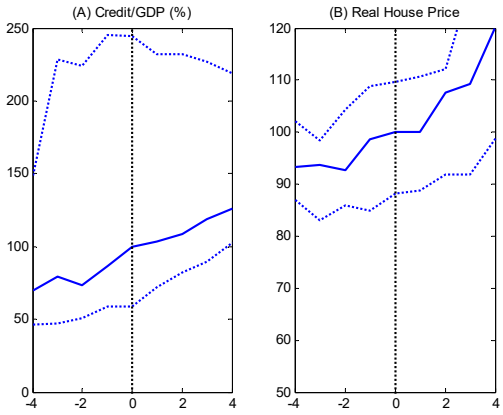
Figure 4. Domestic Macroprudential Tightening with and without the Tightening of One or More of Top-10 Trade Partners

(Year 0: Domestic Tightening)

Domestic Tightening *with* One or More of Top-10 Trade Partner Tightening (N=57, 37)



Domestic Tightening *without* One or More of Top-10 Trade Partner Tightening (N=22, 14)



Solid line: Median. Dotted lines: 25 and 75 percentiles. Normalized to 100 at year 0.

B. Influence of Macroprudential Policies in Partners on Domestic Credit Growth and House Price Growth

We proceed to examine the impact of "coordinated" or simultaneous macroprudential tightenings first on these intermediate target variables (in this subsection) and then on the crisis

[25] See Akinci and Olmstead-Rumsey (2015) for own country effects of tightening on these intermediate targets.

[26] Figure B1 and Figure B2 in the Appendix duplicate Figure 3 and Figure 4 but using LTV and DTI measures only when computing macroprudential impulse. However, the number of observations using loan recipients is too small to make definitive conclusions regarding effectiveness.

(continued…)

probabilities themselves (in the next subsection).[27] We report the results based on pooled regression, fixed-effects panel regression, and Arellano-Bond (1991) GMM estimation (which is to help mitigate endogeneity issues).[28]

- In Table 4 (Part (A)), real credit growth at year *t* slows when at least one of the top-10 trade partners tightens macroprudential policies within the same year, even after controlling for real GDP growth, lagged real credit growth, and other domestic banking variables. This occurs regardless of the econometric methodology used.[29] Interestingly the country's own tightening of macroprudential policies does not have a statistically significant effect on real credit growth.

Table 4. Impact of Domestic and Top-10 **Trade Partners'** Macroprudential Tightening on Financial Sector Indicators

(A) Dependent Variable: Real Credit Growth
(In percent)

	Pooled		Fixed Effect		GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
(Real credit growth)$_{t-1}$	0.248***	0.250***	0.0963***	0.101***	0.0795**	0.0846***
	(0.0334)	(0.0336)	(0.0369)	(0.0381)	(0.0319)	(0.0274)
(GDP growth)$_t$	1.333***	1.281***	1.617***	1.568***	1.513***	1.466***
	(0.130)	(0.126)	(0.141)	(0.140)	(0.142)	(0.117)
(Dummy, own tightening)$_t$	0.504		0.568		1.021	
	(1.195)		(1.268)		(1.354)	
(Net number of top-10 trade partners tightening)$_t$	-0.599**		-0.761***		-0.843***	
	(0.237)		(0.241)		(0.247)	
(Dummy, own tightening)$_{t-1}$		-0.293		-0.504		-0.305
		(1.216)		(1.304)		(1.176)
(Net number of top-10 trade partners tightening)$_{t-1}$		-0.390		-0.386		-0.397*
		(0.238)		(0.240)		(0.204)
(Capital adequacy ratio)$_{t-1}$	22.58*	22.98*	-12.65	-13.84	-3.944	-18.35
	(11.90)	(12.20)	(15.53)	(16.99)	(17.08)	(15.58)
(Return on assets)$_{t-1}$	106.6***	140.8***	115.8***	152.5***	110.4***	145.2***
	(32.61)	(33.39)	(34.04)	(34.98)	(35.09)	(30.54)
(Nonperforming loans ratio)$_{t-1}$	-4.197	-2.726	-38.25***	-33.91***	-30.25***	-35.50***
	(6.897)	(7.191)	(9.354)	(9.856)	(9.504)	(8.558)
Constant	-1.240	-1.623	6.186***	5.555**	5.073**	6.786***
	(1.716)	(1.807)	(2.342)	(2.652)	(2.465)	(2.337)
R-squared	0.301	0.314	0.285	0.292		
Observations	711	665	711	665	711	665

[27] In Table 4, the dependent variable is the real growth rate of credit. This is because the independent variables already include the GDP growth, and hence, to avoid spurious correlation, the dependent variable should not have the GDP in its computation.

[28] See also Cerutti, Claessens, and Laeven (2017) for a discussion on using GMM estimation.

[29] Specifications (5) and (6) reject the null hypothesis that overidentifying restrictions are valid (as in Sargan test). However, the fixed-effect regression excluding the lagged real credit growth as an explanatory variable does not change the main result. That is, the coefficients for "net number of top-10 trade partners tightening" at *t* and *t-1* are still negative and statistically significant at 1-percent and 10-percent levels, respectively.

Table 4. Impact of Domestic and Top-10 **Trade Partners'** Macroprudential Tightening on Financial Sector Indicators (continued)

(B) Dependent Variable: Real House Price Growth
(In percent)

	Pooled		Fixed Effect		GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
(Real housing price growth)$_{t-1}$	0.394***	0.414***	0.304***	0.320***	0.281***	0.302***
	(0.0341)	(0.0343)	(0.0366)	(0.0379)	(0.0318)	(0.0338)
(GDP growth)$_t$	1.375***	1.443***	1.678***	1.720***	1.901***	1.935***
	(0.107)	(0.0996)	(0.117)	(0.111)	(0.106)	(0.101)
(Dummy, own tightening)$_t$	0.332		1.910*		2.177**	
	(0.964)		(1.046)		(1.061)	
(Net number of top-10 trade partners tightening)$_t$	-0.0927		-0.167		-0.301	
	(0.197)		(0.201)		(0.198)	
(Dummy, own tightening)$_{t-1}$		-2.607***		-1.323		-1.607
		(0.974)		(1.085)		(1.110)
(Net number of top-10 trade partners tightening)$_{t-1}$		-0.464**		-0.446**		-0.570***
		(0.186)		(0.189)		(0.189)
(Capital adequacy ratio)$_{t-1}$	-7.833	-1.787	-14.55	-3.702	-27.90**	-19.70
	(10.66)	(11.22)	(13.59)	(14.78)	(14.07)	(15.92)
(Return on assets)$_{t-1}$	18.86	7.775	47.98*	58.45*	44.37	63.00*
	(27.03)	(28.56)	(29.06)	(31.25)	(29.75)	(33.09)
(Nonperforming loans ratio)$_{t-1}$	-7.575	-5.529	-4.239	0.257	-5.454	-3.166
	(5.903)	(5.959)	(7.829)	(8.021)	(7.899)	(8.415)
Constant	-0.934	-0.819	-1.130	-1.936	0.374	0.0894
	(1.437)	(1.528)	(1.890)	(2.082)	(1.913)	(2.214)
R-squared	0.468	0.498	0.480	0.504		
Observations	552	520	552	520	552	520

Note: Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

- According to Table 4 (Part (B)), the effect of macroprudential policies on real house price growth is present, but requires time to manifest itself. Both an own-country tightening and a trade partner's tightening statistically significantly lower domestic house price growth after one year for the pooled regression while the trade partners tightening matters regardless of the econometric technique.[30]
- To summarize, macroprudential tightening in trade partners affects real domestic credit growth as well as, in some specifications, real house price growth.

Table 5 evaluates the use of macroprudential policies by loan recipient countries (as opposed to trade partners).

[30] Specifications (5) and (6) do not reject the null hypothesis that overidentifying restrictions are valid.

- Across all three methods, simultaneous tightening by at least one of the top-10 loan recipients lowers real credit growth, even when an "own" tightening is ineffective and other control factors are accounted for (Table 5, Part (A)).[31] Lagged tightening by financial partners also lowers real credit growth (except for the fixed-effect regression).
- For real house price growth, only in the pooled regression technique does the common usage of macroprudential tools by financial partners' lower house price growth in 10 percent level (Table 5, Part (B)).[32] Indeed, domestic use of such tools within the same year appears to have the opposite of their intended affect (raising house prices) perhaps because the authorities are just initially attempting to reign in the housing market. Such tools could take a bit longer to be effective given the inertia in house prices generally.

Table 5. Impact of Domestic and Top-10 **Loan Recipients'** Macroprudential Tightening on Financial Sector Indicators

(A) Dependent Variable: Real Credit Growth
(In percent)

	Pooled		Fixed Effect		GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
$(\text{Real credit growth})_{t-1}$	-0.156**	-0.198***	-0.206***	-0.255***	-0.232***	-0.271***
	(0.0635)	(0.0617)	(0.0660)	(0.0631)	(0.0501)	(0.0323)
$(\text{GDP growth})_t$	1.156***	1.207***	1.199***	1.286***	1.374***	1.433***
	(0.317)	(0.302)	(0.366)	(0.349)	(0.334)	(0.215)
$(\text{Dummy, own tightening})_t$	2.893		1.795		1.541	
	(2.356)		(2.556)		(2.524)	
$(\text{Net number of top-10 loan recipients tightening})_t$	-1.373**		-1.200**		-1.537***	
	(0.546)		(0.605)		(0.583)	
$(\text{Dummy, own tightening})_{t-1}$		2.393		1.236		0.109
		(2.413)		(2.544)		(1.704)
$(\text{Net number of top-10 loan recipients tightening})_{t-1}$		-1.230**		-0.819		-0.815**
		(0.530)		(0.554)		(0.372)
$(\text{Capital adequacy ratio})_{t-1}$	-53.82	-69.53**	-61.61	-90.10*	-127.7**	-164.6***
	(34.39)	(32.94)	(54.40)	(51.44)	(51.58)	(32.33)
$(\text{Return on assets})_{t-1}$	187.2	197.5	86.37	91.24	121.5	115.8
	(123.6)	(119.8)	(154.2)	(148.6)	(147.8)	(97.31)
$(\text{Nonperforming loans ratio})_{t-1}$	-6.236	-18.04	-65.31*	-68.37*	-57.57*	-80.72***
	(23.74)	(25.00)	(35.20)	(36.30)	(32.11)	(24.10)
Constant	12.19***	14.79***	16.00**	19.70***	24.41***	29.68***
	(4.618)	(4.531)	(7.030)	(6.849)	(6.554)	(4.228)
R-squared	0.136	0.171	0.135	0.177		
Observations	241	228	241	228	241	228

[31] As in Table 4, specifications (5) and (6) reject the null hypothesis that overidentifying restrictions are valid (using the Sargan test). The fixed-effect regression excluding the lagged real credit growth as an explanatory variable suggests that the coefficient for "net number of top-10 trade partners tightening" at *t* is negative and statistically significant at the 10-percent level, suggesting robustness of the results in (5) and (6).

[32] Specifications (5) and (6) do not reject the null hypothesis that overidentifying restrictions are valid.

Table 5. Impact of Domestic and Top-10 **Loan Recipients'** Macroprudential Tightening on Financial Sector Indicators (continued)

(B) Dependent Variable: Real House Price Growth
(In percent)

	Pooled		Fixed Effect		GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
(Real housing price growth)$_{t-1}$	0.394***	0.411***	0.272***	0.261***	0.178***	0.176**
	(0.0675)	(0.0712)	(0.0793)	(0.0836)	(0.0618)	(0.0694)
(GDP growth)$_t$	0.774***	0.872***	0.839***	0.894***	0.915***	1.077***
	(0.162)	(0.165)	(0.178)	(0.185)	(0.153)	(0.160)
(Dummy, own tightening)$_t$	3.194***		2.941**		3.518***	
	(1.122)		(1.203)		(1.135)	
(Net number of top-10 loan recipients tightening)$_t$	-0.279		-0.280		-0.0383	
	(0.261)		(0.279)		(0.261)	
(Dummy, own tightening)$_{t-1}$		-1.164		-1.782		-1.557
		(1.207)		(1.277)		(1.232)
(net number of top-10 loan recipients tightening)$_{t-1}$		-0.483*		-0.362		-0.271
		(0.268)		(0.282)		(0.261)
(Capital adequacy ratio)$_{t-1}$	17.92	28.30	19.86	22.20	28.16	37.42
	(18.06)	(19.26)	(26.21)	(28.85)	(24.16)	(27.31)
(Return on assets)$_{t-1}$	110.8*	123.6*	78.07	56.41	50.04	25.66
	(62.98)	(67.38)	(73.65)	(78.75)	(70.63)	(79.96)
(Nonperforming loans ratio)$_{t-1}$	-4.943	-5.288	-45.95*	-56.83**	-34.50	-46.86*
	(13.93)	(15.99)	(24.39)	(27.83)	(22.80)	(26.83)
Constant	-2.731	-3.277	-1.256	-0.218	-2.597	-2.391
	(2.380)	(2.580)	(3.260)	(3.693)	(2.945)	(3.469)
R-squared	0.510	0.511	0.382	0.380		
Observations	193	179	193	179	193	179

Note: Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

C. Influence of Macroprudential Policies in Partners on Domestic Crisis Probabilities

Intermediate target variables of macroprudential policies—real credit growth and real house price growth—tend to be affected by coordinated tightening in several specifications. Indeed, credit growth and house price growth are not cause for concern in and of themselves, but only when they are unsustainble and lead to financial sector weaknesses. Hence, we examine the effect of sole and "coordinated" macroprudential policies on the crisis probability.

Table 6 shows that, even after controlling for the lagged domestic credit growth and real house price growth, the probability of a domestic banking crisis decreases after two years when top-10 partners are tightening their own macroprudential policies (statistically significant at 10 percent level in several specifications). Interestingly, partner tightening is often associated with an *increase* in domestic crisis probabilities within *one* year following the impulse (although further associated with a decrease in probabilities two years hence). This may reflect the fact

that the sample size involving macroprudential tools is limited. Many countries in the sample experienced a crisis in 2008 and, as well, many countries tightened macroprudential policies in 2007. The materialization of the 2008 crisis following this broad tightening could show up as a negative relationsip between partner tighening and domestic crisis probabilities. Indeed, if a 2008 dummy is included as an additional explanatory variable in these specifications, this positive relationship with one year lag is no longer statistically significant at 10 percent level (See Parts (A) and (B) of Table B2 in Appendix II).

Another possibility is that the result reflects "leakages" of macroprudential policies to other economies (see also Section II). That is, tightening in partner countries could initially increase the domestic crisis probability through leakages (i.e., reallocation of the portfolios of international banks outside their home country where they face tightening pressures). Further studies on the impact of tightening on the behavior of international banks could shed light on this result.[33]

Table 6. Impact of Domestic and Top-10 Partners' Macroprudential Tightening on Crisis Probabilities

Dependent variable: Dummy indicating a banking crisis.
(Pooled Regression, 2000-2012)

(A) Trade Partners, All Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Credit/GDP)$_{t-1}$	-0.272	2.047	1.424	0.0115	0.575	0.137
	(1.690)	(1.647)	(1.780)	(1.585)	(1.548)	(1.638)
(Real house price growth)$_{t-1}$	0.214	0.770	0.743	0.437	0.499	0.370
	(1.837)	(1.843)	(1.959)	(1.845)	(1.809)	(1.858)
(Dummy, own tightening)$_{t-1}$	0.632		0.411			
	(0.540)		(0.645)			
(Number of top 10 trade partners tightening)$_{t-1}$		0.953***	1.086***			
		(0.176)	(0.203)			
Δ(Credit/GDP)$_{t-2}$	4.117***	4.117**	4.700***	4.169***	3.835***	4.068***
	(1.498)	(1.614)	(1.711)	(1.476)	(1.442)	(1.478)
(Real house price growth)$_{t-2}$	3.550	3.414	3.599	3.710	3.423	3.721
	(2.449)	(2.274)	(2.434)	(2.461)	(2.350)	(2.464)
(Dummy, own tightening)$_{t-2}$	-1.134		-1.175	-0.933		-0.771
	(0.818)		(0.910)	(0.801)		(0.814)
(Number of top 10 trade partners tightening)$_{t-2}$		-0.854***	-1.072***		-0.192	-0.218
		(0.258)	(0.327)		(0.181)	(0.197)
Constant	-3.396***	-5.181***	-5.471***	-3.311***	-3.134***	-3.053***
	(0.340)	(0.681)	(0.768)	(0.326)	(0.374)	(0.383)
R-squared	0.103	0.323	0.380	0.0954	0.0886	0.104
Observations	388	394	388	388	394	388

[33] Note that we do not find evidence in Table 4 that partner tightening increases domestic credit growth at the macro level.

Table 6. Impact of Domestic and Top-10 Partners' Macroprudential Tightening on Crisis Probabilities (continued)

(B) Trade Partners, LTV/DTI Only

	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Credit/GDP)$_{t-1}$	0.0177	1.161	0.751	0.0584	0.489	0.0330
	(1.654)	(1.560)	(1.709)	(1.616)	(1.501)	(1.613)
(Real house price growth)$_{t-1}$	0.612	0.199	0.407	0.671	0.686	0.707
	(1.849)	(1.784)	(1.875)	(1.803)	(1.802)	(1.812)
(Dummy, own tightening LTV/DTI)$_{t-1}$	0.111		-0.298			
	(0.794)		(0.841)			
(Number of top 10 trade partners tightening LTV/DTI)$_{t-1}$		0.608***	0.660***			
		(0.201)	(0.210)			
Δ(Credit/GDP)$_{t-2}$	4.187***	3.570**	4.106***	4.214***	3.909***	4.243***
	(1.516)	(1.454)	(1.546)	(1.500)	(1.437)	(1.510)
(Real house price growth)$_{t-2}$	3.445	3.788*	3.919*	3.414	3.254	3.397
	(2.402)	(2.145)	(2.219)	(2.395)	(2.336)	(2.398)
(Dummy, own tightening LTV/DTI)$_{t-2}$	-0.926		-1.138	-0.886		-0.933
	(1.172)		(1.225)	(1.138)		(1.165)
(Number of top 10 trade partners tightening LTV/DTI)$_{t-2}$		-0.384	-0.386		0.0461	0.0472
		(0.263)	(0.278)		(0.219)	(0.238)
Constant	-3.386***	-3.981***	-4.053***	-3.383***	-3.431***	-3.426***
	(0.323)	(0.454)	(0.484)	(0.322)	(0.379)	(0.393)
R-squared	0.0899	0.132	0.147	0.0898	0.0815	0.0901
Observations	388	394	388	388	394	388

(C) Loan Recipients, All Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Credit/GDP)$_{t-1}$	-0.272	5.580*	5.779*	0.0115	4.061*	4.055*
	(1.690)	(2.983)	(3.059)	(1.585)	(2.390)	(2.382)
(Real house price growth)$_{t-1}$	0.214	-8.975	-7.563	0.437	-13.97**	-13.77*
	(1.837)	(7.854)	(8.253)	(1.845)	(6.940)	(7.025)
(Dummy, own tightening)$_{t-1}$	0.632		-0.337			
	(0.540)		(1.043)			
(Number of top 10 loan recipients tightening)$_{t-1}$		1.757***	1.924***			
		(0.487)	(0.573)			
Δ(Credit/GDP)$_{t-2}$	4.117***	6.406	7.003	4.169***	3.249	3.298
	(1.498)	(4.727)	(4.672)	(1.476)	(2.180)	(2.147)
(Real house price growth)$_{t-2}$	3.550	9.799*	14.32*	3.710	7.887	8.857
	(2.449)	(5.649)	(7.675)	(2.461)	(5.400)	(5.753)
(Dummy, own tightening)$_{t-2}$	-1.134		-1.999	-0.933		-0.732
	(0.818)		(1.884)	(0.801)		(1.242)
(Number of top 10 loan recipients tightening)$_{t-2}$		-1.223**	-1.210**		-0.0592	0.00200
		(0.512)	(0.586)		(0.292)	(0.311)
Constant	-3.396***	-6.273***	-6.851***	-3.311***	-2.575***	-2.612***
	(0.340)	(1.700)	(1.953)	(0.326)	(0.611)	(0.619)
R-squared	0.103	0.526	0.544	0.0954	0.117	0.122
Observations	388	118	118	388	118	118

Table 6. Impact of Domestic and Top-10 Partners' Macroprudential Tightening on Crisis Probabilities (continued)

(D) Loan Recipients, LTV/DTI Only

	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Credit/GDP)$_{t-1}$	0.0177	4.547*		0.0584	3.775	
	(1.654)	(2.460)		(1.616)	(2.350)	
(Real house price growth)$_{t-1}$	0.612	-17.11**		0.671	-15.07**	
	(1.849)	(7.808)		(1.803)	(7.276)	
(Dummy, own tightening LTV/DTI)$_{t-1}$	0.111					
	(0.794)					
(Number of top 10 loan recipients tightening LTV/DTI)$_{t-1}$		0.786**				
		(0.306)	Not Enough Variation			Not Enough Variation
Δ(Credit/GDP)$_{t-2}$	4.187***	3.509		4.214***	3.050	
	(1.516)	(2.367)		(1.500)	(2.171)	
(Real house price growth)$_{t-2}$	3.445	9.524*		3.414	8.629	
	(2.402)	(5.378)		(2.395)	(5.542)	
(Dummy, own tightening LTV/DTI)$_{t-2}$	-0.926			-0.886		
	(1.172)			(1.138)		
(Number of top 10 loan recipients tightening LTV/DTI)$_{t-2}$		-0.962*			-0.333	
		(0.545)			(0.473)	
Constant	-3.386***	-2.962***		-3.383***	-2.471***	
	(0.323)	(0.672)		(0.322)	(0.582)	
R-squared	0.0899	0.203		0.0898	0.125	
Observations	388	118		388	118	

Note: Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

While these results are suggestive that simultaneous deployment of macroprudential tools could be helpful in lowering contagious banking crises, it is worth noting that the macroprudential data base only begins in 2000 and many countries are only just beginning to use these tools. Further, we have only examined tightening (which we believe is likely to lower crisis probabilities). A full study would also ask whether loosening the policies increases crisis probabilities. Unfortunately, we have insufficient data to perform this alternative hypothesis. As well, we have no information regarding the levels at which these tools have been deployed.

We separately test whether LTV and DTI caps are effective in lowering crisis probabilities, as these are one of the most commonly used (or contemplated) tools in the macroprudential aresenal. In a number of studies (e.g., Arregui, et al. (2013), Bloor and McDonald (2013), and Darbar and Wu (2015)) they are found to be effective at quelling house price appreciation and have outward spillover effects (Buch and Goldberg (2017)). Interestingly, the results using LTV and DTI caps by the domestic country and by a partner country on the domestic crisis probabilities appear less strong than their impact on their intermediate targets of house price growth. This is probably because our sample does not have a sufficient number of countries using LTV and DTI caps prior to the 2008 crisis, which dominates the sample of crises. For

the same reason, the relatively stronger results obtained when all macroprudential tools are potentially deployed by both the domestic policymakers as well as trade partner countries' policymakers suggests that crises (even the 2008 one, in which housing played a central role) respond to other tools besides LTV and DTI caps. Note that we are only able to use trade partners to perform this analysis as not enough countries contribute to BIS data to provide meaningful empirical results.

D. Alternative Specifications

Several studies (including Hahm, Shin and Shin (2012)) have highlighted the role of noncore liabilities in the run-up to currency crises and to the 2008 banking crisis. Hence, in addition to other robustness checks (see Appendix II), we examine this variable specifically. Our main findings broadly hold. The results are reported in Table 7, which is broadly consistent with Table 6 although the sample size is smaller.

Table 7. Impact of Noncore Liabilities with Domestic and Top-10 Partners' Macroprudential Tightening on Crisis Probabilities

Dependent variable: Dummy indicating a Banking Crisis.
(Pooled Regression)

(A) Trade Partners, All Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Credit/GDP)$_{t-1}$	0.452	8.147	23.52	0.589	1.550	0.916
	(4.213)	(5.768)	(18.21)	(4.152)	(4.175)	(4.607)
(Real house price growth)$_{t-1}$	-1.927	3.878	-0.661	-1.999	1.257	-2.112
	(3.236)	(3.102)	(5.025)	(3.183)	(2.619)	(3.113)
(Dummy, own tightening)$_{t-1}$	0.186		-5.050			
	(1.005)		(4.310)			
(Number of top 10 trade partners tightening)$_{t-1}$		1.722***	4.805			
		(0.609)	(3.076)			
Δ(Credit/GDP)$_{t-2}$	0.0167	-4.425	-6.719	-0.0121	-0.164	-0.467
	(3.580)	(7.602)	(12.89)	(3.656)	(4.216)	(4.192)
(Real house price growth)$_{t-2}$	6.956	-2.097	4.134	7.132	3.886	7.113
	(4.710)	(4.784)	(8.084)	(4.587)	(3.711)	(4.441)
(Dummy, own tightening)$_{t-2}$	-18.46		-30.79	-18.79		-18.49
	(3414.6)		(2863.9)	(3716.9)		(2697.4)
(Number of top 10 trade partners tightening)$_{t-2}$		-1.184**	-3.509		-0.222	-0.246
		(0.591)	(2.480)		(0.346)	(0.382)
Δ(Noncore1/core deposits)$_{t-1}$	0.119***	0.0914**	0.353	0.121***	0.0743**	0.122***
	(0.0450)	(0.0439)	(0.248)	(0.0439)	(0.0342)	(0.0437)
Δ(Noncore1/core deposits)$_{t-2}$	0.0131	0.138	0.144	0.0134	0.0255	0.0162
	(0.0547)	(0.109)	(0.204)	(0.0541)	(0.0514)	(0.0530)
Constant	-4.830***	-9.413***	-20.36*	-4.820***	-4.469***	-4.484***
	(0.803)	(2.906)	(12.38)	(0.802)	(0.842)	(0.908)
R-squared	0.397	0.624	0.806	0.397	0.326	0.404
Observations	242	242	242	242	242	242

Table 7. Impact of Noncore Liabilities with Domestic and Top-10 Partners' Macroprudential Tightening on Crisis Probabilities (continued)

(B) Trade Partners, LTV/DTI Only

	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Credit/GDP)$_{t-1}$	1.274	2.658	3.850	1.613	1.341	1.576
	(3.890)	(4.441)	(4.102)	(3.744)	(3.856)	(3.642)
(Real house price growth)$_{t-1}$	1.098	1.845	1.779	1.226	1.576	1.418
	(2.850)	(2.936)	(3.131)	(2.648)	(2.702)	(2.713)
(Dummy, own tightening LTV/DTI)$_{t-1}$	0.770		0.504			
	(1.144)		(1.236)			
(Number of top 10 trade partners tightening LTV/DTI)$_{t-1}$		0.871**	1.020**			
		(0.393)	(0.438)			
Δ(Credit/GDP)$_{t-2}$	-0.432	-1.418	-2.330	-0.295	0.0358	-0.269
	(3.367)	(4.809)	(4.167)	(3.813)	(3.905)	(3.753)
(Real house price growth)$_{t-2}$	3.506	2.615	1.607	3.361	3.967	3.458
	(3.935)	(3.865)	(4.058)	(3.852)	(3.790)	(3.927)
(Dummy, own tightening LTV/DTI)$_{t-2}$	-14.03		-14.51	-14.45		-14.65
	(779.6)		(634.1)	(1146.8)		(1201.9)
(Number of top 10 trade partners tightening LTV/DTI)$_{t-2}$		-0.265	-0.186		0.140	0.185
		(0.467)	(0.525)		(0.438)	(0.486)
Δ(Noncore1/core deposits)$_{t-1}$	0.0799**	0.0732*	0.0832**	0.0829**	0.0754**	0.0832**
	(0.0392)	(0.0384)	(0.0404)	(0.0389)	(0.0348)	(0.0388)
Δ(Noncore1/core deposits)$_{t-2}$	0.0270	0.0478	0.0534	0.0243	0.0246	0.0235
	(0.0519)	(0.0592)	(0.0614)	(0.0518)	(0.0531)	(0.0532)
Constant	-4.708***	-5.879***	-6.117***	-4.642***	-4.976***	-4.858***
	(0.731)	(1.147)	(1.308)	(0.710)	(0.917)	(0.938)
R-squared	0.346	0.390	0.429	0.340	0.321	0.342
Observations	242	242	242	242	242	242

Note: Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

VI. CONCLUSION

We verified the impact of crises in the top-10 partner countries, using trade and financial linkages, on the probability of a domestic banking crisis. Our results confirm that, in addition to domestic information, policymakers need to consider whether their closest partner countries are in crisis when examining the risk of a crisis on their own country. The importance of contagious spillovers sets the stage for the use of simultaneous tightening of macroprudential policies by partner countries to have a mitigating effect.

The main contribution of our paper is that we examine the impact of the tightening of macroprudential tools in partner countries, separately and in addition to the tightening by domestic policymakers, on domestic intermediate targets (real credit growth and real house price growth) and the chances of a domestic financial crisis. Our results, using a database of macroprudential tool deployment, suggest a role for coordinated macroprudential policies across highly-linked countries to stem the risks of widespread banking crises. We show that partners' tightening tends to lower the precursors to crisis—that is, credit growth and house price growth. We also find that tightening policies by trade or financial partner countries can

help lessen the probability that the domestic country experiences a banking crisis (with caveats about the timing discussed in Section V). This result opens the door to a more formal discussion of how, exactly, countries could (or should) coordinate their use of macroprudential tools and how, exactly, transmission works to lower risks.

To date, the current methods of coordinating policies across countries rely mostly on information sharing and discussion within international fora. For example, the G-20 meetings and IMF Annual and Spring Meetings have discussed coordinated macroprudential policies. Basel III provides for "mandatory reciprocity" of the new countercyclical capital buffer—a mechanism whereby the home country is required to maintain at least the same countercyclical capital requirement as the host country for lending to the host country from its banks in that jurisdiction.[34] Although only one instance of coordination of a macroprudential tool, helpfully, "the Basel III standards do not preclude an authority from voluntarily reciprocating beyond the mandatory reciprocity provisions for the countercyclical capital buffer or from reciprocating other policy tools."[35] Given their explicit focus on financial stability, the Financial Stability Board and the IMF's Financial Sector Assessment Programs may provide guidance and peer pressure (if needed) regarding the modalities of internationally coordinated macroprudential policies. This paper proposes the first step by providing evidence about how cross-border coordination can lower the risks of banking crisis more than using domestic policies alone, but also suggests there may be "spillovers" or "leakages" in the short run with the opposite effect of increasing crisis probabilities in some instances. As well, addressing the "free rider" problem that partner countries' macroprudential policies may help the domestic economy to avoid a banking crisis without domestic policymakers taking any action will need to be considered seriously by international bodies. As such, impediments to coordination may make a forward progress difficult.[36]

Looking forward, in addition to further robustness testing, future research can focus on how (crisis) environments in partner countries can be explicitly considered in domestic early warning systems. For example, the number of partner countries in crisis can be included as an indicator in such a surveillance system. Further exploration about why trade linkages could be different from banking linkages in predicting crises or mitigating them with macroprudential tools could also be worthwhile as the exact channels are not elucidated in this exercise. Ideally, one would want to test the impact of policy loosening (as opposed the tightening considered here) as this may also have implications for coordination that could avoid negative spillovers after a crisis has erupted. We await more data to conduct this exercise.

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[34] The mandatory reciprocity is only required for jurisdictions that are members of the Basel Committee and is meant to be applied to internationally active banks. See FAQs on the countercyclical capital buffer in Basel III at http://www.bis.org/bcbs/publ/d339.pdf.

[35] See FAQs on the countercyclical capital buffer in Basel III at http://www.bis.org/bcbs/publ/d339.pdf.

[36] See also Cecchetti and Tucker (2015).

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Appendix I. Data

Table A1 lists the main variables and their data sources. Table A2 lists the countries in the BIS data. Bilateral banking claims are obtained from the BIS database, "New Consolidated Banking Statistics" where "broad" options (all banks, total claims, all instruments, all maturities, all currencies, and all sectors) are selected. The original data are quarterly, which are aggregated into annual data from 1970 to 2014 (final update as of November 2015). Table A3 and Table A4 report the country-year lists of banking crises and macroprudential policies.

Table A1. Data and Sources

Variable	Description	Source
Crisis year	Start year of banking crisis	Laeven, Luc and Fabian Valencia (2014)
Domestic credit to private sector	Domestic credit to private sector (ratio to GDP)	International Financial Statistics (IFS)
Real house price index	House price indices deflated by CPI	IMF Real Estate Markets Module
Top trade partners	Determined by ranking total trade volumes with partner countries	IMF Direction of Trade (DOT)
Top banking partners (loan recipients)	Determined by ranking total claims on partner countries	Bank for International Settlements (BIS) consolidated banking statistics
Capital adequacy ratio	Regulatory capital to risk-weighted assets	IMF Global Financial Stability Report (GFSR), and World Bank FinStats 2015 database
Return on assets	Return on assets	Bankscope – Bureau Van Dijk, and World Bank FinStats 2015 database
Bank nonperforming loans ratio	Bank nonperforming loans to total gross loans	IMF Global Financial Stability Report (GFSR), and World Bank World Development Indicators (WDI)

Table A2. Country List in BIS Data

Reporting Country	Counterparty Country			
Australia	Albania	Czech Republic	Kuwait	Romania
Austria	Angola	Denmark	Kyrgyz Republic	Russia
Belgium	Argentina	Djibouti	Latvia	Rwanda
Brazil	Armenia	Dominican Republic	Lesotho	Saudi Arabia
Canada	Aruba	Ecuador	Lithuania	Senegal
Chile	Australia	Egypt	Luxembourg	Serbia
Denmark	Austria	El Salvador	Macedonia, FYR	Sierra Leone
Finland	Azerbaijan	Estonia	Malaysia	Singapore
Greece	Bahrain	Finland	Maldives	Slovak Republic
India	Bangladesh	France	Mali	Slovenia
Ireland	Barbados	Georgia	Malta	Solomon Islands
Italy	Belarus	Germany	Mauritius	South Africa
Mexico	Belgium	Ghana	Mexico	South Korea
Netherlands	Benin	Greece	Moldova	Spain
Panama	Bhutan	Guatemala	Mongolia	Sudan
Portugal	Bolivia	Guinea	Morocco	Swaziland
South Korea	Bosnia and Herzegovina	Guinea-Bissau	Mozambique	Sweden
Spain	Botswana	Haiti	Myanmar	Switzerland
Sweden	Brazil	Honduras	Namibia	Syria
Switzerland	Bulgaria	Hong Kong SAR	Netherlands	Tanzania
	Burkina Faso	Hungary	New Zealand	Thailand
	Burundi	Iceland	Nicaragua	Togo
	Cambodia	India	Niger	Tunisia
	Canada	Indonesia	Nigeria	Turkey
	Cape Verde	Iraq	Norway	Uganda
	Chile	Ireland	Pakistan	Ukraine
	China	Israel	Panama	United Kingdom
	Colombia	Italy	Paraguay	United States
	Costa Rica	Jamaica	Peru	Uruguay
	Côte d'Ivoire	Japan	Philippines	Vanuatu
	Croatia	Jordan	Poland	Venezuela
	Cyprus	Kazakhstan	Portugal	Yemen

Table A3. List of Crisis Years/Countries

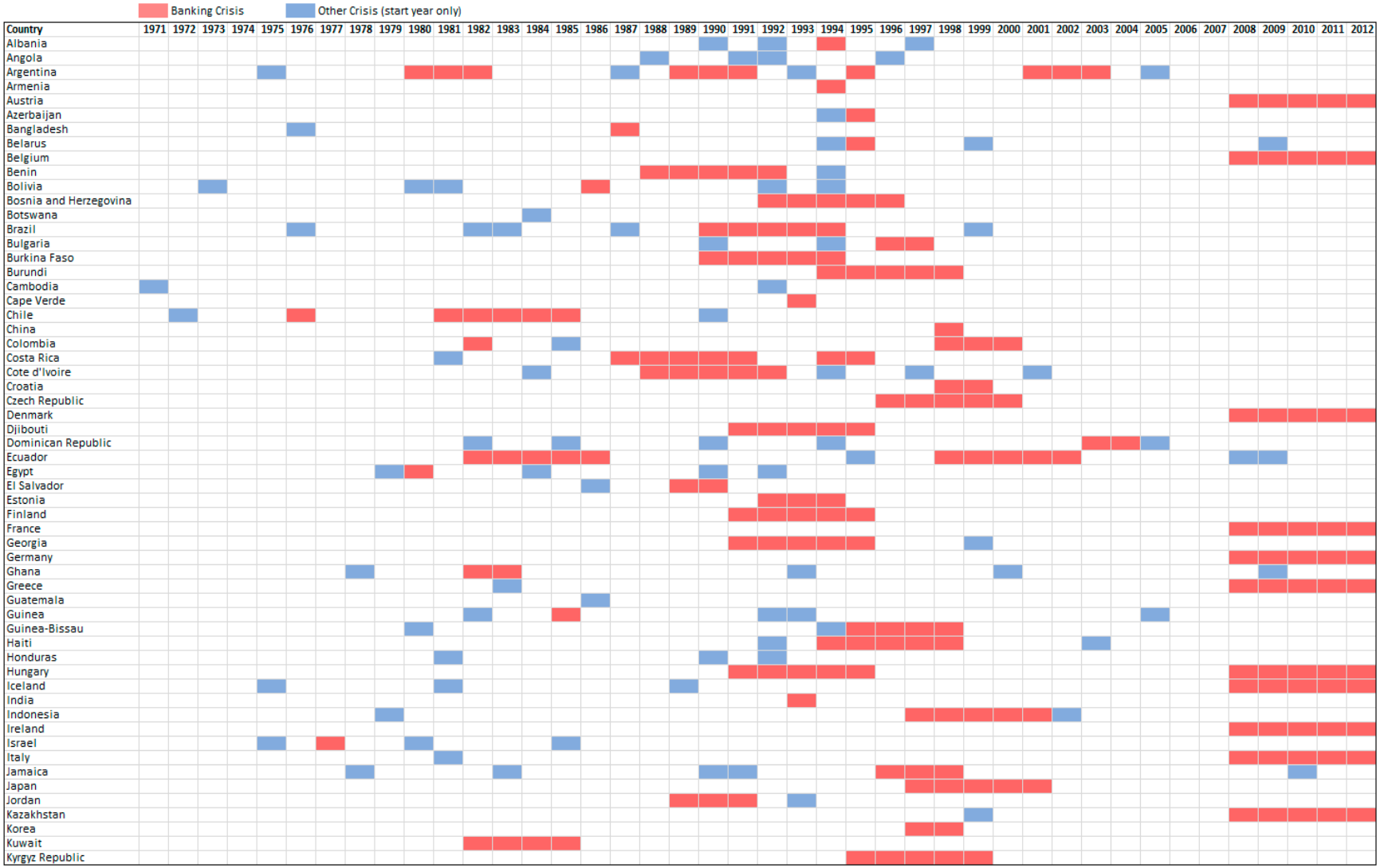


Table A3. List of Crisis Years/Countries (continued)

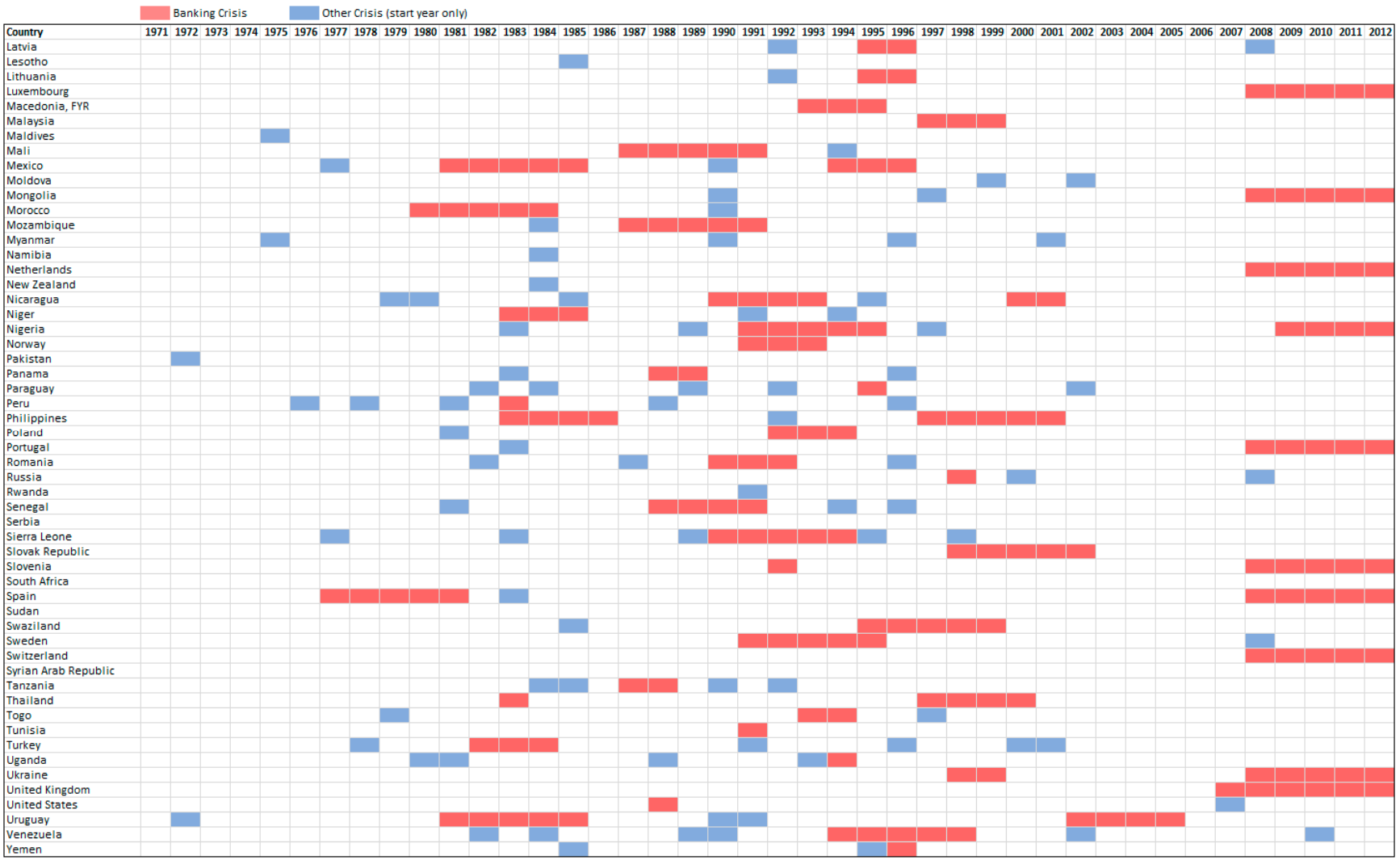
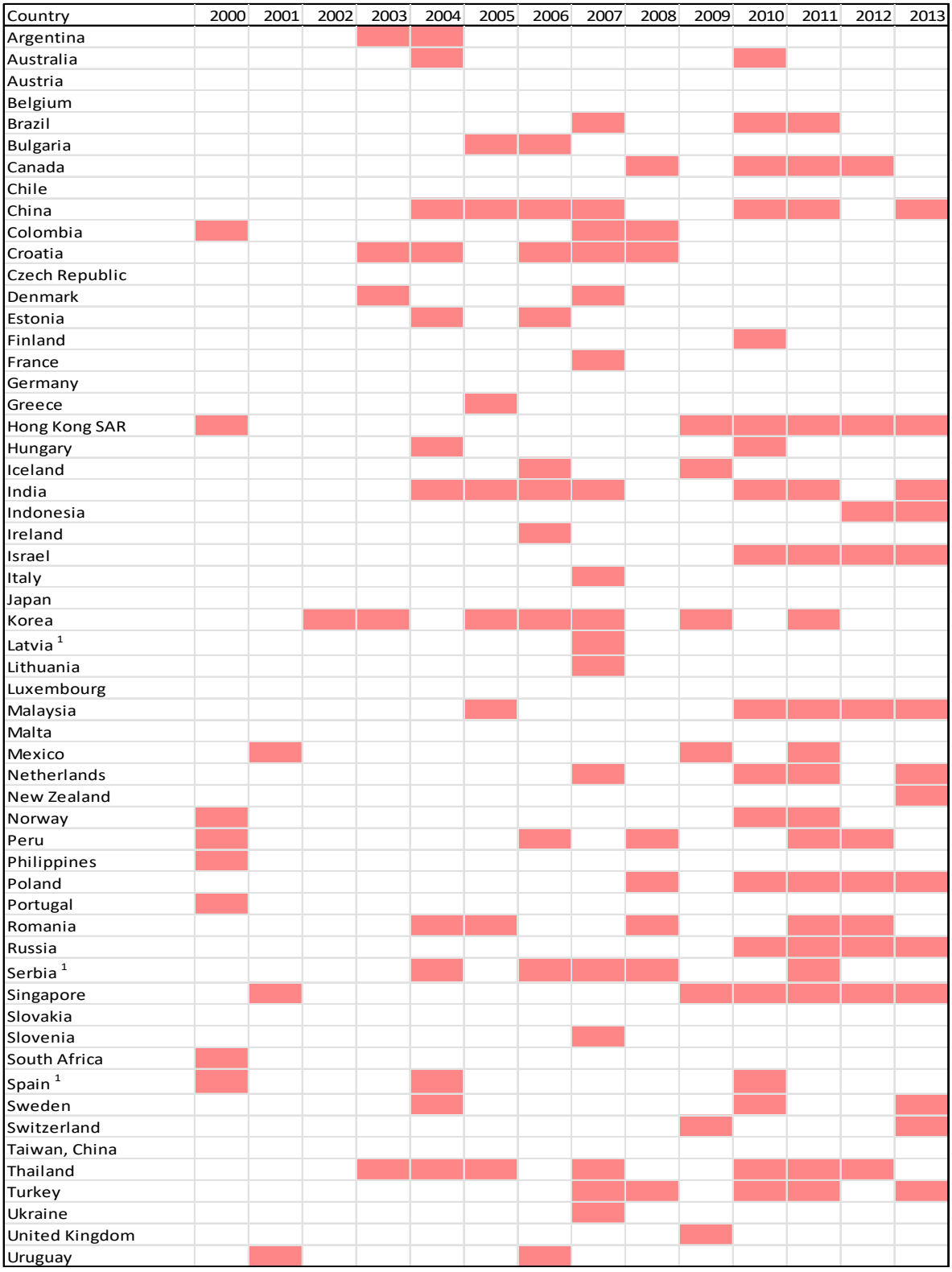


Table A4. Macroprudential Tightening Indicator



Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Argentina														
Australia														
Austria														
Belgium														
Brazil														
Bulgaria														
Canada														
Chile														
China														
Colombia														
Croatia														
Czech Republic														
Denmark														
Estonia														
Finland														
France														
Germany														
Greece														
Hong Kong SAR														
Hungary														
Iceland														
India														
Indonesia														
Ireland														
Israel														
Italy														
Japan														
Korea														
Latvia [1]														
Lithuania														
Luxembourg														
Malaysia														
Malta														
Mexico														
Netherlands														
New Zealand														
Norway														
Peru														
Philippines														
Poland														
Portugal														
Romania														
Russia														
Serbia [1]														
Singapore														
Slovakia														
Slovenia														
South Africa														
Spain [1]														
Sweden														
Switzerland														
Taiwan, China														
Thailand														
Turkey														
Ukraine														
United Kingdom														
Uruguay														

Note: This table is based on net of tightening/loosening macroprudential.

1/ Spain in 2008, Latvia in 2008, and Serbia in 2012 had both tightening and loosening macroprudential policies.

Appendix II. Robustness Checks

Alternative specifications were considered as below.

1. "Broad crisis" as opposed to banking crisis.
   A "broad crisis" variable is investigated, which consists of banking crisis, currency crisis, sovereign debt crisis, and sovereign debt restructuring. Results were similar to those reported, likely due to the heavy weight of banking crises in the sample.

2. Credit-to-GDP gap as an alternative credit measure.
   The credit-to-GDP gap is measured as the difference between the credit-to-GDP ratio and a trend estimated using a one-sided HP filter as recommended by the Basel Committee on Banking Supervision for constructing a countercyclical capital buffer. In the pooled regression in Table 3's Part (A), credit-to-GDP gap turns out to be slightly more significant than using change in credit-to-GDP. In the fixed effect regression (Part (B)), the gap measure is more significant compared to using change in credit-to-GDP ratio.

3. BIS data used to construct banking partners after 2014 excluded the following countries: France, Germany, Japan, Turkey, the UK and the United States. Including these countries over the period for which their data exists (prior to 2014) does not alter the results significantly and in several cases, it strengthens them.

4. Top-5 partners as opposed to top-10 partners. Results are similar.

5. Additional control variables, which yield similar results in general but in some cases notably reduce the sample size.
   - Broad money to total reserves ratio
   - Loan to deposit ratio
   - VIX (CBOE volatility index)
     While proven significant and positive, it is highly correlated with the 2008 dummy.
   - Dummy variable indicating whether domestic country or any of top partner countries had a geopolitical event.

Table B1. Panel Logit Estimation: Impact of Crises Experienced in Partner Countries on Domestic Crisis Probabilities (Duplication of Table 3, with Year-2008 Dummy Variable) Dependent variable: Dummy indicating a banking crisis.

(A) Pooled Regression

	(1)	(2)	(3)	(4)	(5)	(1')	(2')	(3')	(4')	(5')
(Dummy, year 2008)$_t$	3.916***	3.214***	6.619***	3.756***	8.404***	5.100***			4.632***	
	(0.411)	(0.589)	(2.013)	(0.444)	(2.830)	(0.803)			(0.955)	
(Dummy, at least one top-10 trade partner in crisis)$_{t-1}$		0.832								
		(0.568)								
(Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$			1.613							
			(1.726)							
Δ(Credit/GDP)$_{t-1}$	2.314	2.390	8.220***	3.006	7.627	4.859**			3.641	
	(1.567)	(1.581)	(3.172)	(1.998)	(7.112)	(2.051)			(2.939)	
(Real house price growth)$_{t-1}$	-1.532	-1.590	-22.08*	-4.859*	-45.22**	1.737			1.440	
	(1.691)	(1.686)	(11.54)	(2.728)	(21.54)	(1.977)			(5.974)	
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				-0.802					5.146	
				(2.970)					(5.694)	
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				4.646					0.607	
				(3.194)					(5.811)	
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$					35.09**		Not Enough Variation			Not Enough Variation
					(13.81)					
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$					13.53					
					(19.32)					
(Capital adequacy ratio)$_{t-1}$						-23.29**			-22.45**	
						(10.37)			(10.83)	
(Return on assets)$_{t-1}$						-69.75*			-67.70	
						(37.63)			(43.00)	
(Nonperforming loans ratio)$_{t-1}$						3.248			2.746	
						(4.313)			(4.615)	
Constant	-4.134***	-4.226***	-6.534***	-4.089***	-8.022***	-2.282*			-2.208	
	(0.263)	(0.294)	(1.437)	(0.268)	(2.365)	(1.302)			(1.373)	
R-squared	0.283	0.287	0.734	0.287	0.829	0.527			0.533	
Observations	1023	981	336	981	336	464			464	

Table B1. Panel Logit Estimation: Impact of Crises Experienced in Partner Countries on Domestic Crisis Probabilities (continued)
(B) Fixed Effect

	(1)	(2)	(3)	(4)	(5)	(1')	(2')	(3')	(4')	(5')
(Dummy, year 2008)$_t$	3.834***	3.066***	5.120**	3.746***		16.92				
	(0.460)	(0.631)	(2.382)	(0.506)		(14.34)				
(Dummy, at least one top-10 trade partner in crisis)$_{t-1}$		0.896								
		(0.601)								
(Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$			1.359							
			(1.871)							
Δ(Credit/GDP)$_{t-1}$	1.815	1.905	10.91*	2.832		11.57				
	(1.502)	(1.519)	(5.642)	(2.553)		(20.47)				
(Real house price growth)$_{t-1}$	-3.764**	-3.941**	-21.46	-5.416**	Not Enough Variation	-12.58		Not Enough Variation		
	(1.856)	(1.878)	(16.53)	(2.744)		(16.21)				
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				-1.786						
				(4.686)						
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 trade partner in crisis)$_{t-1}$				2.242						
				(2.773)						
Δ(Credit/GDP)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$										
(Real house price growth)$_{t-1}$ * (Dummy, at least one top-10 loan recipient in crisis)$_{t-1}$										
(Capital adequacy ratio)$_{t-1}$						-219.7				
						(195.4)				
(Return on assets)$_{t-1}$						-109.7				
						(250.8)				
(Nonperforming loans ratio)$_{t-1}$						22.36				
						(130.9)				
R-squared	0.377	0.382	0.829	0.376		0.895				
Observations	690	663	275	663		160				

Note: All banking crisis years except the start year are eliminated in the sample. Fixed effects estimates are only undertaken for countries with at least one year of a banking crisis. Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

Table B2. Panel Logit Estimation: Impact of Domestic and Top-10 Trade Partners' Macroprudential Tightening on Crisis Probabilities

(Duplication of Table 6, with Year-2008 Dummy Variable)
Dependent variable: Dummy indicating a banking crisis.

(A) Trade Partners, All Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
(Dummy, year 2008)$_t$	6.657***	4.386***	6.911***	6.666***	5.228***	8.026***
	(1.587)	(0.976)	(1.693)	(1.585)	(0.896)	(1.647)
Δ(Credit/GDP)$_{t-1}$	2.126	2.735	1.999	2.184	2.458	1.883
	(1.899)	(1.849)	(2.125)	(1.812)	(1.814)	(1.985)
(Real house price growth)$_{t-1}$	-1.082	-0.0279	-0.486	-1.060	-0.510	-0.959
	(2.342)	(2.155)	(2.413)	(2.327)	(2.155)	(2.475)
(Dummy, own tightening)$_{t-1}$	0.0760		0.547			
	(0.756)		(0.908)			
(Number of top 10 trade partners tightening)$_{t-1}$		0.429	0.542			
		(0.278)	(0.373)			
Δ(Credit/GDP)$_{t-2}$	6.448***	4.502**	7.353***	6.457***	4.333**	7.057***
	(2.261)	(1.988)	(2.487)	(2.260)	(1.933)	(2.344)
(Real house price growth)$_{t-2}$	1.961	0.102	-1.445	2.010	1.092	0.169
	(3.770)	(3.254)	(3.707)	(3.732)	(3.272)	(3.891)
(Dummy, own tightening)$_{t-2}$	-2.124**		-3.242***	-2.117**		-3.367***
	(1.038)		(1.227)	(1.039)		(1.237)
(Number of top 10 trade partners tightening)$_{t-2}$		-0.704*	-1.853***		-0.520	-1.670***
		(0.405)	(0.635)		(0.387)	(0.622)
Constant	-7.178***	-5.823***	-6.858***	-7.175***	-5.253***	-5.924***
	(1.621)	(1.059)	(1.796)	(1.622)	(0.926)	(1.473)
R-squared	0.620	0.558	0.693	0.620	0.545	0.682
Observations	388	394	388	388	394	388

Table B2. Panel Logit Estimation: Impact of Domestic and Top-10 Trade Partners' Macroprudential Tightening on Crisis Probabilities (continued)

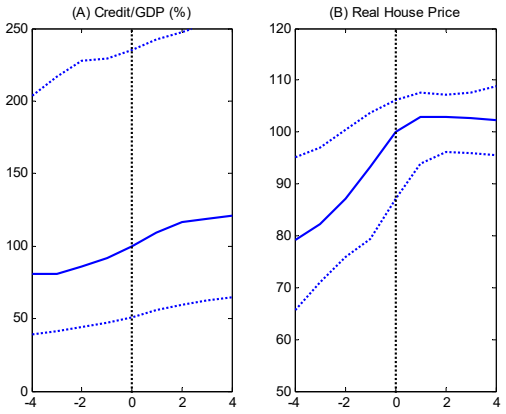
(B) Trade Partners, LTV/DTI Only

	(1)	(2)	(3)	(4)	(5)	(6)
(Dummy, year 2008)$_t$	6.659***	5.229***	7.357***	6.581***	5.343***	7.211***
	(1.601)	(0.958)	(1.706)	(1.572)	(0.926)	(1.591)
Δ(Credit/GDP)$_{t-1}$	1.631	2.649	1.357	2.188	2.486	2.115
	(2.007)	(1.885)	(2.232)	(1.846)	(1.805)	(2.047)
(Real house price growth)$_{t-1}$	-0.365	-0.703	-0.792	0.201	-0.801	-0.154
	(2.530)	(2.194)	(2.787)	(2.279)	(2.166)	(2.486)
(Dummy, own tightening LTV/DTI)$_{t-1}$	0.842		0.887			
	(1.258)		(1.326)			
(Number of top 10 trade partners tightening		0.173	-0.0590			
LTV/DTI)$_{t-1}$		(0.434)	(0.548)			
Δ(Credit/GDP)$_{t-2}$	6.610***	4.448**	6.801***	6.819***	4.517**	6.913***
	(2.380)	(1.912)	(2.383)	(2.359)	(1.893)	(2.335)
(Real house price growth)$_{t-2}$	-0.313	0.589	-1.506	-0.515	0.933	-1.842
	(3.473)	(3.402)	(3.971)	(3.429)	(3.277)	(3.789)
(Dummy, own tightening LTV/DTI)$_{t-2}$	-2.574		-2.913	-2.260		-2.497
	(1.694)		(1.778)	(1.605)		(1.634)
(Number of top 10 trade partners tightening		-0.612	-1.012*		-0.528	-1.030*
LTV/DTI)$_{t-2}$		(0.528)	(0.605)		(0.481)	(0.562)
Constant	-7.255***	-5.555***	-6.524***	-7.193***	-5.446***	-6.490***
	(1.626)	(0.973)	(1.585)	(1.603)	(0.922)	(1.543)
R-squared	0.606	0.541	0.630	0.604	0.540	0.627
Observations	388	394	388	388	394	388

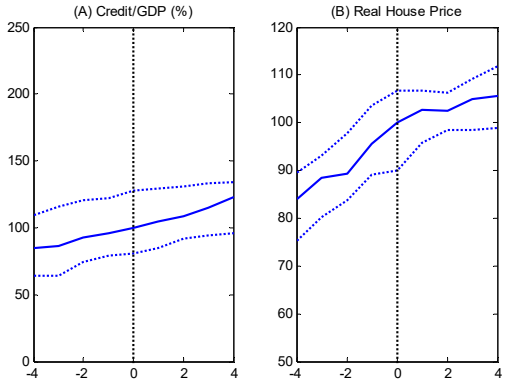
Note: All banking crisis years except the start year are eliminated from the sample. Standard errors in parentheses. ***: Significant at 1% confidence level. **: 5% level. *: 10% level.

Figure B1. Top-10 Partners' Macroprudential Tightening: **LTV and DTI only**
(Year 0 = Positive partners' Macroprudential macroprudential impulse is positive)

Top-10 Trade Partner Tightening
(N=539, 178)



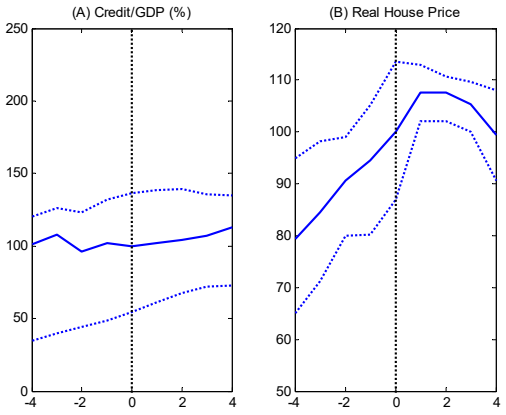
Top-10 Loan Recipients Tightening
(N=41,30)



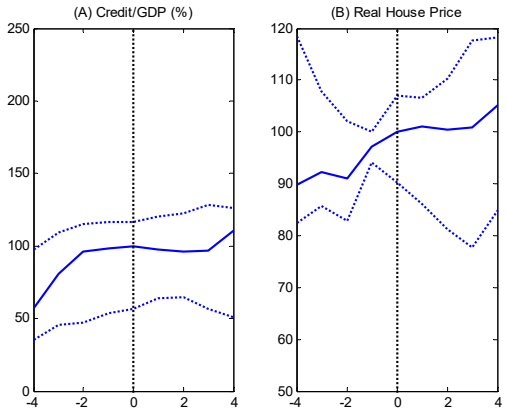
Solid line: Median. Dotted lines: 25 and 75 percentiles. Normalized to 100 at year 0.

Figure B2. Domestic Macroprudential Tightening with and without the Tightening of One or More of Top-10 Partners: **LTV and DTI only**
(Year 0: Domestic Tightening)

Domestic Tightening *with* One or More of Top-10 Trade Partner Tightening
(N=17, 12)



Domestic Tightening *without* One or More of Top-10 Trade Partner Tightening
(N=12, 10)



Solid line: Median. Dotted lines: 25 and 75 percentiles. Normalized to 100 at year 0.