Do Sounder Banks make Calmer Waters? The Link between Bank Regulations and Capital Flow Waves

By KRISTIN J. FORBES *

* Forbes: MIT-Sloan School of Management, 100 Main Street, Room E62-416, Cambridge, MA 02142 (kjforbes@mit.edu). Thanks to Dennis Reinhardt for assistance with data for this analysis, and to Francis Warnock for years collaborating on work behind this article.

One important lesson from the Global Financial Crisis (GFC) was that vulnerabilities in the financial system could amplify economic shocks and have devastating consequences for the broader economy. This has prompted a series of reforms aimed at strengthening financial systems through tighter prudential regulations (focused on the soundness of individual institutions) and macroprudential regulations (focused on the broader financial system). This paper tests if these reforms have meaningfully reduced one set of risks—of country vulnerability to capital flow "waves", i.e., to sudden stops and surges of capital flows from abroad.

The results support other work documenting changes since the GFC in how global factors affect capital flows (Avdjiev et al., 2019 and Forbes and Warnock, 2019), but finds mixed evidence on how regulations have affected the incidence of sharp capital flow movements. Prudential regulations (such as higher capital-asset ratios) appear to have reduced surges of capital inflows, but yielded less reduction in sudden stops. Tighter macroprudential regulations appear to have done little to reduce the incidence of capital flow waves to date—and if anything—are often correlated with an increased risk of sudden stops.

These muted effects of macroprudential regulations could be caused by several factors, including the limited application of macroprudential tools in many countries. The empirical results suggest, however, that at least part of the explanation is how regulations affect different types of capital flows. More specifically, while tighter regulations have decreased cross-border bank lending, this has corresponded to an increase in cross-border debt issuance (Avdjiev et al., 2019 and Shin, 2013). Bank flows have become more stable (and especially less prone to surges), while debt flows appear to be more prone to sudden stops. This does not mean that regulatory reform has failed—as most of the reforms to date have focused on strengthening banks at the core of the financial system. But the results do support other evidence that these regulations can shift risks outside the regulated financial sector in

ways that partially mute their benefits (as shown in Ahnert et al., 2019 for regulations on foreign currency exposure). Even if regulations accomplish their direct goals, these unintended consequences can still lead to choppy waters.

This paper builds on a literature showing that tighter prudential and macroprudential regulations correspond to a reduction in international bank lending (Forbes et al., 2017), and that banks with higher capitalization and deposit funding shares are less sensitive to liquidity risk (Buch and Goldberg, 2015). The results also build on a literature analyzing the Global Financial Cycle (Miranda-Agrippino and Rey, 2015). This includes Avdjiev et al. (2019), which shows that the shifting composition of global capital flows is driving their reduced sensitivity to the VIX, as well as Scheubel et al. (2019), which shows that the role of the "Global Financial Cycle" has moderated (but is still significant).

II. Extreme Capital Flow Episodes

In order to test if regulations and better capitalized banking systems have significantly reduced the incidence of sharp capital flow movements, this paper builds on the framework developed in Forbes and Warnock (2012, 2019). More specifically, these papers compile time-series data on gross capital inflows and outflows by foreigners and domestics for about 50 countries. Then they define capital flow "episodes" or "waves" as periods of sharp changes in four types of capital flows relative to historic norms for each country: surges (sharp increases in capital flows from foreigners); stops (sharp decreases in capital flows from foreigners); flight (sharp increases in capital outflows by domestics) and retrenchment (sharp increases in capital inflows from domestics).

The results below focus on the factors affecting surges and stops—the episodes driven by foreigners and which are the greatest concern for most countries. Forbes and Warnock (2019) provide updated estimates of these extreme capital flow episodes through 2018q4 and show that the incidence of surges has fallen since the GFC, but the incidence of sudden stops has only fallen modestly, with minimal reduction for emerging markets.

Forbes and Warnock (2012) also document that global factors, and especially measures of global risk (such as the VIX) are highly correlated with all types of sharp capital flow episodes. Updated analysis in Forbes and Warnock (2019), however, suggests that this link may have weakened since the GFC. Table 1 reports a similar set of results to that in Forbes and Warnock (2019) using the sample and specification that will form the baseline for the remainder of this paper. It estimates the model:

$$(1) \qquad Prob(e_{it} = 1) = F\left(\mathbf{\Phi}_{t-1}^{\text{Global}}\mathbf{B}_{\text{G}} + \mathbf{\Phi}_{i,t-1}^{\text{Contagion}}\mathbf{B}_{\text{C}} + \mathbf{\Phi}_{i,t-1}^{\text{Domestic}}\mathbf{B}_{\text{D}}\right),$$

where e_{it} is an episode dummy variable equal to 1 if country i is experiencing a capital flow episode (surge, stop, flight, or retrenchment) in quarter t; $\mathbf{\Phi}_{t-1}^{\text{Global}}$ is a vector of global factors lagged by one quarter (global risk, global interest rates, global GDP growth, and changes in global oil prices)[1]; $\mathbf{\Phi}_{i,t-1}^{\text{Contagion}}$ is a vector capturing if another country in the same region is also experiencing the same type of capital flow episode; and $\mathbf{\Phi}_{i,t-1}^{\text{Domestic}}$ is a vector of domestic variables (domestic GDP growth and GDP per capita). Because episodes occur irregularly, $F(\cdot)$ is asymmetric, so I estimate equation (1) using the complementary logarithmic framework, which assumes that $F(\cdot)$ is the cumulative distribution function of the extreme value distribution. The probability of each type of episode is estimated separately, and then I use a seemingly unrelated regression technique to allow for cross-episode correlation in the error terms. Standard errors are also clustered by country.

The subset of these estimates reported in Table 1 are consistent with earlier work. Most important for the analysis below, over the full sample period (1990-2018) the probability of experiencing a stop or surge episode is significantly correlated with global factors, as well as with domestic and contagion variables.

TABLE 1— PROBABILITY OF EXPERIENCING A SURGE OR STOP IN CAPITAL FLOWS FROM ABROAD

	Full Period (1990-2018)		Post-GFC (2010-2018)	
	Surges	**Stops**	**Surges**	**Stops**
Global risk	-0.777**	1.081**	-0.550	0.298
	(0.180)	(0.175)	(0.539)	(0.728)
Global interest	0.133**	0.149**	0.104	0.230
rates	(0.027)	(0.033)	(0.163)	(0.187)
Global	0.320**	-0.168**	-0.133	0.191
GDP growth	(0.085)	(0.055)	(0.193)	(0.202)
Δ *oil prices*	0.001	0.001	0.007	-0.019**
	(0.002)	(0.002)	(0.005)	(0.006)
Regional	0.668**	0.691**	0.694*	0.002
contagion	(0.237)	(0.178)	(0.413)	(0.380)
Domestic	0.021**	-0.072**	0.069	-0.083**
GDP growth	(0.006)	(0.014)	(0.046)	(0.042)
GDP per capita	-0.000	-0.002	-0.009	-0.032**
	(0.004)	(0.002)	(0.009)	(0.012)
Observations	***4,238***	***4,238***	***1,461***	***1,461***

Notes: Estimated using complementary logarithmic framework, which assumes that F(.) is the cdf of the extreme value distribution. The probability of each episode (plus flight and retrenchment episodes) is estimated separately and then seemingly unrelated regression technique is used to allow for cross-episode correlation in error. Standard errors are clustered by country. ** Significant at the 5% level. * Significant at the 10% level.

Source: Author calculations.

The right of the table repeats the estimates for 2010-2018, however, and shows that many of these relationships have become insignificant since the GFC. While much of the academic literature has focused on whether the role of the VIX or Global Financial Cycle, has weakened, this set of results suggests that it is not just the VIX—but global variables more broadly. In

[1] Global risk is measured as the log of the vxo. Global interest rates is the shadow short-term rate for the US, Japan, Euro area and UK from Leo Krippner's RNBZ web site. Global growth is year-over-year global GDP growth from the IMF's WEO dataset.

fact, oil prices is the only global variable that is significantly correlated with stops or surges since the GFC. This diminished role of global factors could simply be spurious and reflect events over the last decade or the short window.[2] The results, however, are also consistent with arguments that tighter financial regulation since the GFC has reduced the sensitivity of capital flows to global risk.

III. Regulations and Capital Flow Waves

To test if tighter regulations since the GFC could be reducing capital flow waves, I extend the vector of domestic variables ($\mathbf{\Phi}_{i,t-1}^{\text{Domestic}}$) in equation 1 to control for macroprudential regulation and the strength of each country's banking system. More specifically, I measure macroprudential regulation as the number of times that macroprudential regulations were tightened for 17 different types of tools over the last two or last five years, based on the Integrated Macroprudential Policy (iMapp) database in Alam et al. (2019).[3] To capture the strength of the domestic banking system, I control for either: bank regulatory capital to risk-weighted assets (%) or the Z-score for the banking sector[4], both from the World Bank's Global Financial Development Database, October 2019. All data is quarterly, except those on the domestic banking system, which are interpolated from the original annual data.[5]

Table 2 reports estimates for these additional variables in regressions predicting stops and surges (with the full set of results for the other control variables in Table 1 and other types of capital flow episodes not reported). The top shows results for the new variables added individually, and the bottom when macroprudential regulations (over the last five years), bank capitalization and bank z-scores are included simultaneously.

TABLE 2— EFFECT OF REGULATIONS ON PROBABILITY OF EXPERIENCING A SURGE OR STOP

Individual controls:	**Surges**	**Stops**	**# obs**
Δ *macropru regs*	0.027	0.100**	4,099
(2 years)	(0.035)	(0.038)	
Δ *macropru regs*	-0.025	0.059**	3,808
(5 years)	(0.026)	(0.023)	
Capital-asset	-0.080**	0.008	3,135
ratio (risk-wtd)	(0.034)	(0.027)	
Bank Z-score	-0.012	0.018**	3,590
	(0.009)	(0.007)	
Simultaneous controls:			
Δ *macropru regs*	-0.035	0.066**	3,019
(5 years)	(0.025)	(0.028)	
Capital-asset	-0.074**	0.016	
ratio (risk-wtd)	(0.035)	(0.028)	
Bank Z-score	-0.010	0.015*	
	(0.010)	(0.009)	

Notes: See notes to Table 1.

[2] Risk measures, however, are consistently significant in a comparable 8-year window before the crisis, from 2000 to 2007.

[3] A tightening (loosening) in each type of regulation is a +1 (-1) and the total changes are summed over each quarter.

[4] The Z-score captures the probability of default of a country's commercial banking system and is calculated as the buffer of the banking system (capitalization and returns) to the volatility of returns.

[5] All control variables are lagged by one quarter, except the interpolated data that was originally annual and is lagged four quarters.

The estimates show that higher capital-asset ratios correspond to a significantly lower chance of surges of capital inflows (in each specification, as well as in unreported results with other combinations of control variables). The magnitude of the estimates also suggests that this effect is meaningful. The ratio of regulatory capital to risk weighted assets increased by an average of 5.0 percentage points in the sample from 2007 through 2016, which corresponds to a reduction in the probability of experiencing a stop of 40 percentage points. To put this in context, the average incidence of sudden stops was 15% over each quarter from 1990–2018, but increased to 80% at the start of 2009.

Many of the other estimates in the table, however, are insignificant, and some have the opposite sign than expected—particularly for stops. For example, countries that have tightened macroprudential regulation more (over either time horizon), and countries with higher Z-scores, are significantly more likely to experience stops. There is also no evidence that higher capital-asset ratios helped insulate economies against the risk of a sudden stop.

IV. What Explains the Muted Effects of Regulations on Capital Flow Waves?

Other than the large impact of capital ratios on surges of capital inflows, the impact of the regulations examined above on capital flow waves appears to be muted. There are a number of possible explanations, some of which can explain why macroprudential regulations may even have increased some countries' likelihood of experiencing sudden stops.

First, many of these regulations have only been implemented recently, and there may not have been sufficient time to evaluate how they perform across the full business cycle. The characteristics of the last decade—of a sluggish recovery in many countries combined with extremely expansionary monetary policy in advanced economies—may have masked underlying relationships since the GFC.

Second, although prudential and macroprudential regulations have been tightened in most economies since the GFC, they may not have been sufficiently adjusted to meaningfully decrease the probability of capital flow waves. This is likely a greater issue for macroprudential regulations, where there has been more limited progress to date. For example, on average the ratio of bank's regulatory capital to risk-weighted assets has increased substantially—from 12.6% at end-1998, to 13.1% at end-2007, to 18.1% at end-2016. In contrast, macroprudential regulations have only been tightened a total of 6 times per country since 1990, and tightened less than once a year (on average) over the five years

through 2017. Many of these "tightenings" in macroprudential policy have also been fairly minor, and many of the macroprudential tools that have stronger support have rarely been triggered. For example, the counter-cyclical capital buffer is one of the macroprudential tools that has broader academic and policy support, but it was tightened only six times in the sample.

A third reason why these results may suggest muted effects of regulatory reforms—and especially macroprudential regulations—is endogeneity. Countries that are at greater risk from movements in capital flows, whether due to country characteristics or changes in the global environment, could be more likely to tighten regulations. This could generate a positive correlation between tighter regulations and the incidence of capital flow waves—even if the regulations reduce the chance of an episode, holding everything else constant. As a rough test if this could be affecting the results for macroprudential regulations, I reestimate the regressions from Table 2, but use two more detailed measures of changes in macroprudential regulation: only related to capital and liquidity requirements and only related to housing or foreign currency exposures. The second group of measures are adjusted more often in countries more vulnerable to foreign currency risk or that have recently experienced an increase in housing prices or exchange rate volatility (Ahnert et al., 2019). The results for each of these more detailed measures, however, are basically unchanged from the baseline in Table 2.

A final reason why the effect of these regulations may appear to be muted is that most have focused on banks, while Table 2 evaluates the impact on waves in total capital flows—which include bank flows, as well as foreign direct investment and portfolio debt and equity flows. Could any effects of regulations on banking flows be difficult to capture due to simultaneous changes in other types of capital flows?

To test this, I repeat the earlier analysis from Table 2 estimating the incidence of four types of capital flow episodes, while controlling for changes in global, contagion, and domestic variables—except estimate the model separately for three types of capital flows: bank, portfolio debt, and portfolio equity.[6] Coefficient estimates for changes in macroprudential regulations and the strength of the banking system are reported in Table 3. The results suggest that the effects of regulations vary across different types of capital flows.

[6] Bank flows includes bank and "other" capital flows. Results for equities are not reported but are basically the same as for debt.

TABLE 3— EFFECT OF REGULATIONS ON PROBABILITY OF EPISODES FOR DIFFERENT TYPES OF CAPITAL FLOWS

	Banking Flows			Debt Flows		
Individual controls:	**Surges**	**Stops**	**# obs**	**Surges**	**Stops**	**# obs**
Δ *macropru regs*	-0.010	0.022	4,099	-0.044	0.076*	4,059
(2 years)	(0.035)	(0.044)		(0.039)	(0.039)	
Δ *macropru regs*	0.022	0.023	3,808	-0.036	0.070**	3,756
(5 years)	(0.026)	(0.033)		(0.026)	(0.024)	
Capital-asset	-0.077**	-0.036	3,135	-0.098**	-0.038	3,139
ratio (risk-wtd)	(0.031)	(0.032)		(0.038)	(0.032)	
Bank Z-score	-0.028**	0.002	3,590	-0.018	0.020**	3,558
	(0.012)	(0.009)		(0.012)	(0.007)	
Simultaneous controls:						
Δ *macropru regs*	0.019	0.036	3,019	-0.061*	0.059**	3,018
(5 years)	(0.030)	(0.035)		(0.034)	(0.026)	
Capital-asset	-0.067**	-0.035		-0.104**	-0.029	
ratio (risk-wtd)	(0.031)	(0.034)		(0.039)	(0.034)	
Bank Z-score	-0.027**	0.008		-0.013	0.013*	
	(0.011)	(0.011)		(0.013)	(0.007)	

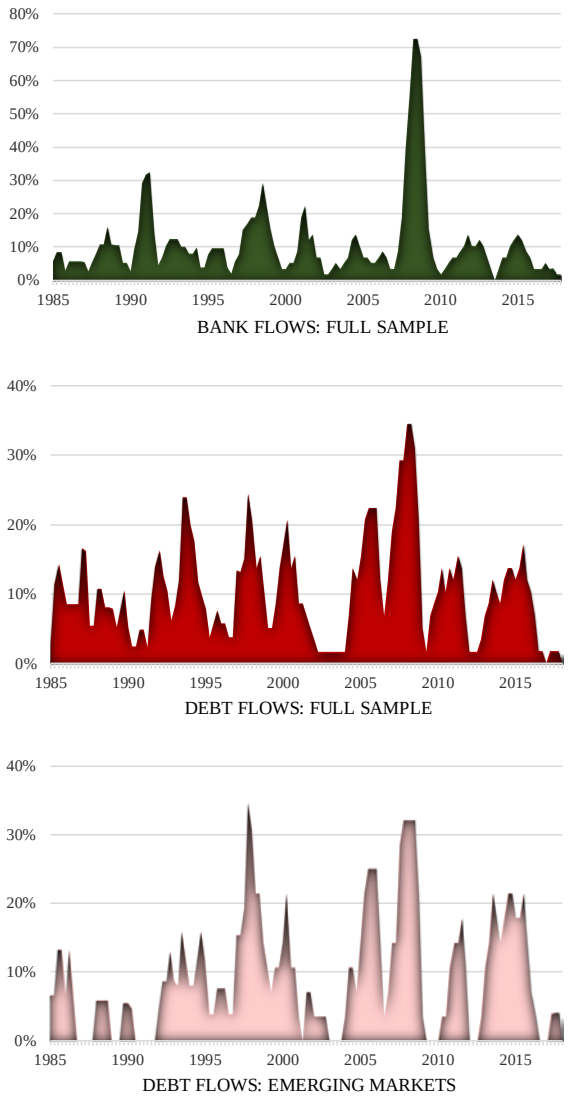
Notes: See notes to Table 1.

Countries with stronger banking systems (measured by capital-asset ratios or Z-scores) are significantly less likely to experience surges in bank flows, with mixed results on whether they are significantly less likely to experience surges in debt flows. None of the variables significantly reduces the chance of sudden stops in any type of capital flow. The unexpected positive correlation between tighter macroprudential regulation and stops for total capital flows (in Table 2), however, reflects the significant positive relationship with debt (and equity) flows. Tighter macroprudential regulations—which tend to focus on banks—are not significantly correlated with surges or stops in bank flows.

These results—while only suggestive—support recent work examining the direct and indirect effects of macroprudential regulations. Macroprudential regulations often affect their direct targets (banks) but can have unintended consequences and shift financial intermediation to other sectors of the economy, such as debt and equity markets. Ahnert et al. (2019) provide a concrete example consistent with the results in Table 3. They show that tighter macroprudential regulations on foreign currency (FX) exposures in banks cause a significant reduction in cross-border FX bank flows, but also cause companies to increase their FX bond issuance as it becomes more difficult to obtain FX loans from banks. These bonds—largely held in the "shadow" financial system—could be more vulnerable to sudden stops. If tighter macroprudential regulations decrease bank exposures to one set of risks, but increase the exposures of unregulated financial institutions to other types of risk, this could generate the positive correlation between macroprudential regulations and the incidence of stops in debt, equity, or total capital flows (but not bank flows)—as in Tables 2 and 3.

As a final piece of evidence that increased regulations since the GFC may be reducing waves in bank flows, but provide less protection (or even increase the risk) of waves in debt flows, I return to the discussion in Section II of changes in the incidence of surges and stops (in aggregate capital flows) since the GFC.

FIGURE 1. INCIDENCE OF SUDDEN STOPS: DIFFERENT TYPES OF CAPITAL FLOWS AND COUNTRY GROUPS



Notes: Probability of an extreme capital flow episode for just bank or debt flows, calculated following the methodology in Forbes and Warnock (2012).

Source: Authors calculations, using data in Forbes and Warnock (2012).

Figure 1 returns to the analysis in Forbes and Warnock (2019) (discussed in Section II), which calculates the incidence of stops for just bank or debt flows. Sudden stops in bank flows occur less often during the post-GFC period of tighter regulation, with less reduction in the incidence of stops in debt flows, and no sign of moderation for emerging markets. In contrast, surges in bank and debt flows have decreased meaningfully for the full sample, as well as emerging markets (not shown). Changes in the global financial system since 2008 therefore seem to have reduced most forms of capital flow waves—except for sudden stops in debt flows—where the risks may even have increased for emerging markets.

VI. Conclusions

This paper provides mixed evidence on how regulations have affected the incidence of capital flow waves. Regulations which strengthen banks by increasing capital ratios appear to meaningfully reduce the risks around surges. Other macroprudential regulations, however, have provided less buffer against extreme capital flow episodes to date. This may reflect the limited use of macroprudential tools so far. But there also is tentative evidence that this reflects unintended consequences of these bank-focused regulations. While they may have reduced the volume and volatility of banks flows, and made banks more resilient, they have shifted financial intermediation outside the regulated sector and thereby may have increased the risk of sharp movements in debt and equity flows.

Finally, it is important to put these results in context. One of the primary goals of regulatory

reforms since the GFC was to reduce the amplification of shocks through the financial system. Even if these reforms have only had a muted effect in terms of reducing capital flow waves, they could still provide important benefits in terms of mitigating the negative effects of these waves on the broader economy. Even if the waters are not much calmer, the waves should do less damage.

REFERENCES

Alam, Zohair, Adrian Alter, Jesse Eiseman, Gaston Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang. 2019. "Digging Deeper – Evidence on the Effects of Macroprudential Policies from a New Database." IMF Working Paper No. 19/66.

Ahnert, Toni, Kristin Forbes, Christian Freidrich, and Dennis Reinhardt. 2019. "Macroprudential FX Regulations: Shifting the Snowbanks of FX Vulnerability?" NBER Working Paper 25083.

Avdjiev, Stefan, Leonardo Gambacorta, Linda Goldberg and Stefano Schiaffi. 2019. "The Shifting Drivers of Global Liquidity."

Buch, Claudia and Linda Goldberg. 2015. "International Banking and Liquidity Risk Transformation: Lessons from Across Countries." *IMF Economic Review 63(3): 377-410.*

Forbes, Kristin, and Francis Warnock. 2019. "Capital Flow Waves—or Ripples? Extreme Capital Flow Movements since the Global Financial Crisis. Mimeo.

Forbes, Kristin, and Francis Warnock. 2012. "Capital Flow Waves: Surges, Stops, Flight and Retrenchment." *Journal of International Economics* 88(2): 235-251.

Forbes, Kristin, Dennis Reinhardt and Tomasz Wieladek. 2017. "The Spillovers, Interactions, and (Un)intended Consequences of Monetary and Regulatory Policies." *Journal of Monetary Economics* 85(C): 1-22.

Miranda-Agrippino, Silvia and Hélène Rey. 2015. "World Asset Markets and the Global Financial Cycle." *NBER Working Paper 21722.*

Scheubel, Beatrice, Livio Stracca, and Cédric Tille. 2019. "The Global Financial Cycle and Capital Flow Episodes: A Wobbly Link?" *ECB Working Paper No. 2337.*

Shin, Hyun. 2013. "The Second Phase of Global Liquidity and Its Impact on Emerging Markets." Speech, Nov 3-5