Sudden Surges and Macroprudential Policies*

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Abstract

This paper estimates the unconditional probability of a sudden surge in private credit and investigates the extent to which macroprudential policies impact the duration of the period preceding such a surge. While we observe sudden surges of credit over periods in which macroprudential policies were enacted, we document that these policies were effective at lowering the probability of credit booms between 2000 and 2013.

Keywords: Macroprudential polices, Credit surges, Credit booms, Financial cycles
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1 Introduction

Macroprudential policies have been used recently in many countries to temper the expansion of private credit. Nevertheless, an examination of Figure 1 reveals episodes of credit surges during periods when some macroprudential polices were implemented. This observation raises the question about the effectiveness of macroprudential policies at preventing sudden surges of private credit. Credit growth positively contributes to economic growth (Garcia-Escribano and Han, 2015), yet a sudden credit surge can precipitate a financial crisis, which, in turn, can cause an economic downturn.

Traditional monetary policy tools are designed to target and affect the whole economy and can at times, depending on the situation, be ineffective at addressing certain localized issues. In such cases, macroprudential policies can be used to address growing risks in specific pockets of the economy that can negatively impact the entire economy. Some macroprudential instruments are loan-to-value ratio (LTV), debt-to-income ratio (DTI), reserve requirement ratio (RR) and leverage ratio (LEV). These policy instruments can be targeted at borrowers (caps on loan to value ratios, income to debt ration limit) or financial institutions (limits on leverage, dynamic provisioning).

Using quarterly data for household credit from the Bank of International Settlement (BIS), we estimate the unconditional probablity of a sudden credit surge between 2000 and 2013. Our approach represents a departure from most of the existing literature on the effectiveness of macroprudentia policiesl, which estimate the impact of such policy tools on the growth of credit (Cerutti et al. (2017)). While this is a valid approach, it is also important to note that credit growth is not in itself detrimental to the real economy, but it is the sudden surge in credit that presents significant risks. Thus, we use a variant measure of credit surges based on gross private credit.

2 Related Literature

This paper is closely related to two strands of literature: one strand focuses on the methodologies used to identify a period of credit surge and the other on the effectiveness of macroprudential policies.

Identifying credit/capital booms and surges:

Different methodologies have been proposed to identify periods of credit booms. Forbes and Warnock (2012) and Comelli (2015) use gross capital flows to identify periods of sudden stops. They define a sudden stop in a period if the change in capital flow is *two* standard deviations greater than the five year rolling mean for at least two consecutive quarters. The opposite prescription is used to identify sudden surges; that is, there is credit surge if credit to the household expands by *two* standard deviations

above the five-year mean. Along the same line, Magud et al. (2012) define a boom as a monotonic increase in trend capital flows with a structural change in the trend or capital flows in excess of the long term trend.

In contrast, Dell'Ariccia et al. (2012) use credit to GDP ratio to identify periods of credit booms. A credit boom exists, if the annual growth rate of credit to GDP ratio exceeds 10 percent and deviates from the trend by more than 1.5 times the historical standard deviation. There is also a credit boom if the annual growth rate is more than 20 percent.

Effectiveness of macroprudential policies:

The extant literature documents the effectiveness of macroprudential measures along different dimensions. Some policies have been found to be effective in slowing down household credit growth (Cerutti et al. (2017)), banks' leverage (Lim et al. (2011), Zhang and Zoli (2014)), and the growth rate of housing prices (Zhang and Zoli (2014)). Moreover, others have been effective at reducing the incidence of credit booms (Dell'Ariccia et al. (2012)).

Some studies have provided micro level evidence. For instance Jiménez et al. (2012) show that dynamic provisioning was effective in smoothing credit supply cycles in Spain. Igan and Kang (2011) use sectoral data from Korea to show that caps on loan-to-value and debt-to-income ratios were effective in reducing credit growth.

This paper contributes to this body of literature as follows. First, we characterize credit booms using gross private credit, rather than credit growth as is typical in the literature, and then estimate the probability of credit surges under macroprudential policies. In addition, we use a richer and more extensive data on macroprudential policies from Cerutti et al. (2017) and gross private credit data from the Bank of International Settlement.

3 Analytical Framework

The literature proposes different drivers of credit surges and the concomitant systemic risk. First, under borrowing constraints or other financial frictions, pecuniary externalities emerge with over-borrowing, excessive risk-taking and excessive levels of short-term debt. Second, excessive optimism on the part of financial institutions during economic booms, and sudden risk retrenchment in downturns yield inefficient price signals in financial markets; a potential source of systemic risk. Under such circumstances, macroprudential policy tools such as LTV (borrower-oriented) and LEV (lender-oriented) serve to limit credit booms and mitigate uncertainty and risk.

4 Empirical Methodology

4.1 Characterization of Sudden Surges

We adopt the definition of a sudden stop in capital flows from Forbes and Warnock (2012) and characterize a household credit surge as a rise in gross credit extended to households that exceeds the five-year average by two standard deviations. We do not require this condition to last for a minimum of two consecutive quarters as in Forbes and Warnock (2012). Based on the preceding definition, a sudden surge episode is given by:

$$\Delta Cred_t \geq \mu_{5y} - 2\sigma_{5y} \tag{1}$$

where $\Delta Cred_t = Cred_t - Cred_{t-4}$ is the four-quarter change in gross credit issued ($Cred_t$), μ_{5y} is the five-year rolling mean of credit, and σ_{5y} is the asssociated five-year rolling standard deviation. Applying the definition, we observe one hundred and seventy five (175) instances of credit surge in the data set, with most of the credit booms occurring during periods in which macroprudential measures were enacted (Figure 1). Notably, not all countries in the sample experienced sudden credit booms (Figure 2).

4.2 Explanatory Variables

Data for the main explanatory variable, the macroprudential policy index, comes from Cerutti et al. (2017). It is an index that varies between 0 and 12 and represents the sum of the different macroprudential polices in place at a time. In all 12 policies are coded, each set to 1 when it is enacted and 0 when not enacted. Thus, for example, if there are 3 different macroprudential policies in place at the same time in any given quarter, the mpi is 3. If all 12 policies are in place then the index is 12. The twelve policy tools include: loan to value ratio, debt to income ratio, dynamic loan-loss provisioning, general counter-cyclical capital requirement, leverage ratio, capital surcharge on systemically important financial institutions, limits on interbank exposures, concentration limits, concentration limits, limits on foreign currency loans, reserve requirement ratios, limits on domestic currency loans, and tax on financial institutions. The data on macroprudential policy index is only available on an annual basis, so we assume that the index is constant for all the quarters in that year and disintegrate the annual data into a quaterly frequency.

The control variables in our estimation include a measure of financial openness to capture the ease with which capital flows in and out of countries, GDP growth to capture increase in investment needs by firms, exchange regime index, real interest rate, and credit to the private sector to capture the level of development of the financial sector. An indicator for the rule of law or government effectiveness is also included as a measure of the quality of institutions.

4.3 Estimation

The analyis is in two parts. First, we assess the effectiveness of macroprudential policies by estimating their impact on the unconditonal probability of a sudden surge in private credit. We then employ a duration model to estimate the extent to which macroprudential policies impact the duration until a sudden surge.

4.3.1 Unconditional probability of a credit surge

The dependent variable in this estimation is a credit surge dummy, which takes on the value of 1 when there is a credit surge and 0 otherwise. To estimate the impact of macroprudential policy our dependent variable, we employ the probit model:

$$Pr(Surge_{i,t} = 1|X_{i,t}) = \Phi(X_{i,t}\beta), \tag{2}$$

where Pr denotes probability, $Surge_{i,t}$ indicates whether country i experienced a credit surge in quarter t and Φ is the cumulative distribution function of the standard normal distribution. $X_{i,t}$ includes all the explanatory variables described above and β is a vector of estimated coefficients for each of the explanatory variables. This estimated probability is unconditional because it ignores past history of sudden surges. Finally, to address potential issues of endogeneity, we lag all the explanatory variables by one period.

4.3.2 A Duration Model Approach

We also estimate the impact of macroprudential policies on the duration until a sudden credit surge. In particular we estimate the conditional probability of a sudden credit surge; that is, conditional on the fact that there was no sudden surge in credit in period $t-1$, what is the probability of sudden credit boom in period t? If macroprudential measures that have been implemented are effective, the duration of the period for which there is no sudden surge will be longer, hence we would expect a negative impact on the conditional probability. Since some countries experience multiple sudden credit booms in our sample, we reset the duration (time) variable to 0 after each period of credit boom.

The hazard model used to calculate the conditional probabilityfollows Lin and Ye (2011). If $F(t)$ is the cumulative probability distribution function of the duration T, then the probability that a country continues to not experience a sudden credit boom beyond t is given by the survival function $S(t) = Pr(T > t) = 1 - F(t)$. The function gives the conditional probability that a credit boom occurs during the next interval of time (δt), given that there is no credit boom at time t. The hazard function can be expressed as:

$$\lambda(t) = \lim_{\Delta \to \infty} \frac{pr(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t} \tag{3}$$

Using this hazard function, the survival function can be rewritten as:

$$S(t) = e^{-\lambda(t)} \tag{4}$$

where $\lambda(t) = \int_0^t \lambda(z)\, dz$ is the integrated hazard function. To study the conditional probability of a sudden credit surge, we specify the following proportional hazard function:

$$\lambda(t, X_{jy}, \beta, \lambda_0) = \lambda_0(t)\, e^{X_{jy}\beta} \tag{5}$$

- λ_0 is the baseline hazard corresponding to zero values of explanatory variables for the hazard.
- X_{jy}: a vector of co-variates for country y and period j with no credit boom.
- β: estimated parameters. Given an estimated parameter β_i, the risk of exiting a period of sudden stop (hazard rate) changes by $100\left(e^{\beta_i} - 1\right)$ when the corresponding variable x_i increases by one unit.

The model is estimated using the Cox (1975) partial likelihood technique, which uses the length of the spells to estimate the coefficient without having to posit a functional form for the underlying hazard.

5 Results

The estimates of the probit model are presented in Table 1. The estimated coefficient on the macroprudential policy variable is significant at the 1% level, and suggest that macroprudential policies lower the incidence of credit surge, such that the probability of a credit surge decreases with the number of macroprudential measures enacted. This attests to the effectiveness of such policies. In addition, the estimates presented in Table 2 suggest that prudential tools are associated with an increase in duration of the period preceding a sudden credit boom episode. This means that such policies delay the occurrence of another sudden surge in private credit after such an event has been realized. Although the results obtained from the estimation of the hazard model are not statistically significant, the sign on the coefficient estimate for macroprudential policy suggests a negative association between such policy measures and the likelihood of occurrence of a credit boom.

6 Conclusion

Using a variant measure of credit surges that is based on gross private credit, the data shows that credit surges occurred during periods when macroprudential measures

were in place. This notwithstanding, we find that macroprudential policies are associated with a decline in the likelihood of the incidence of a credit surge and serve to delay such events. The results, therefore, suggest that macroprudential policies remain a useful tool for minimizing the risk of financial crises triggered by rapid credit expansion.

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Figures & Tables

Figure 1: Credit Surge During Periods of Macropudential Policies

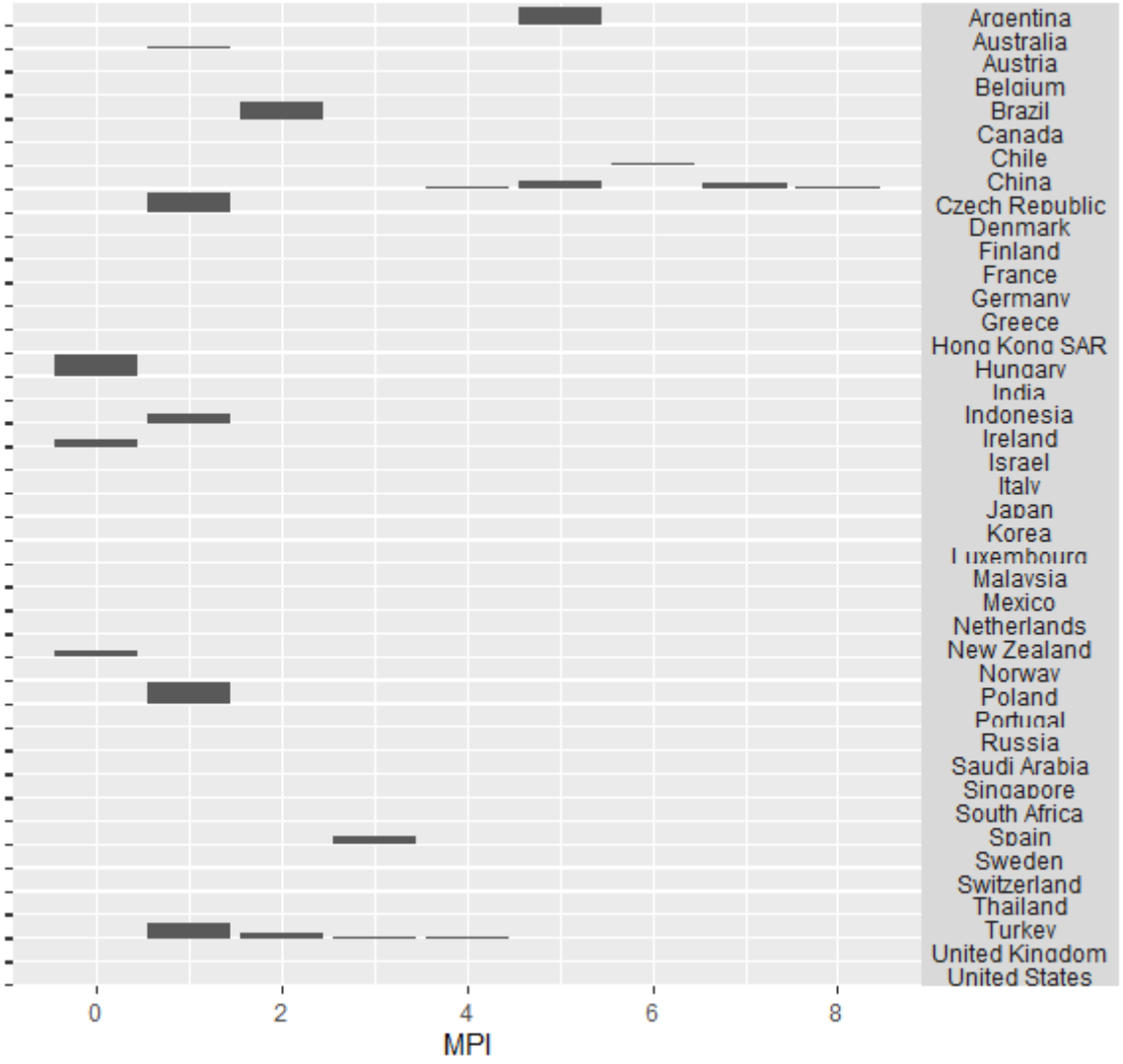

Figure 2: Credit Surge Between 2000 and 2013

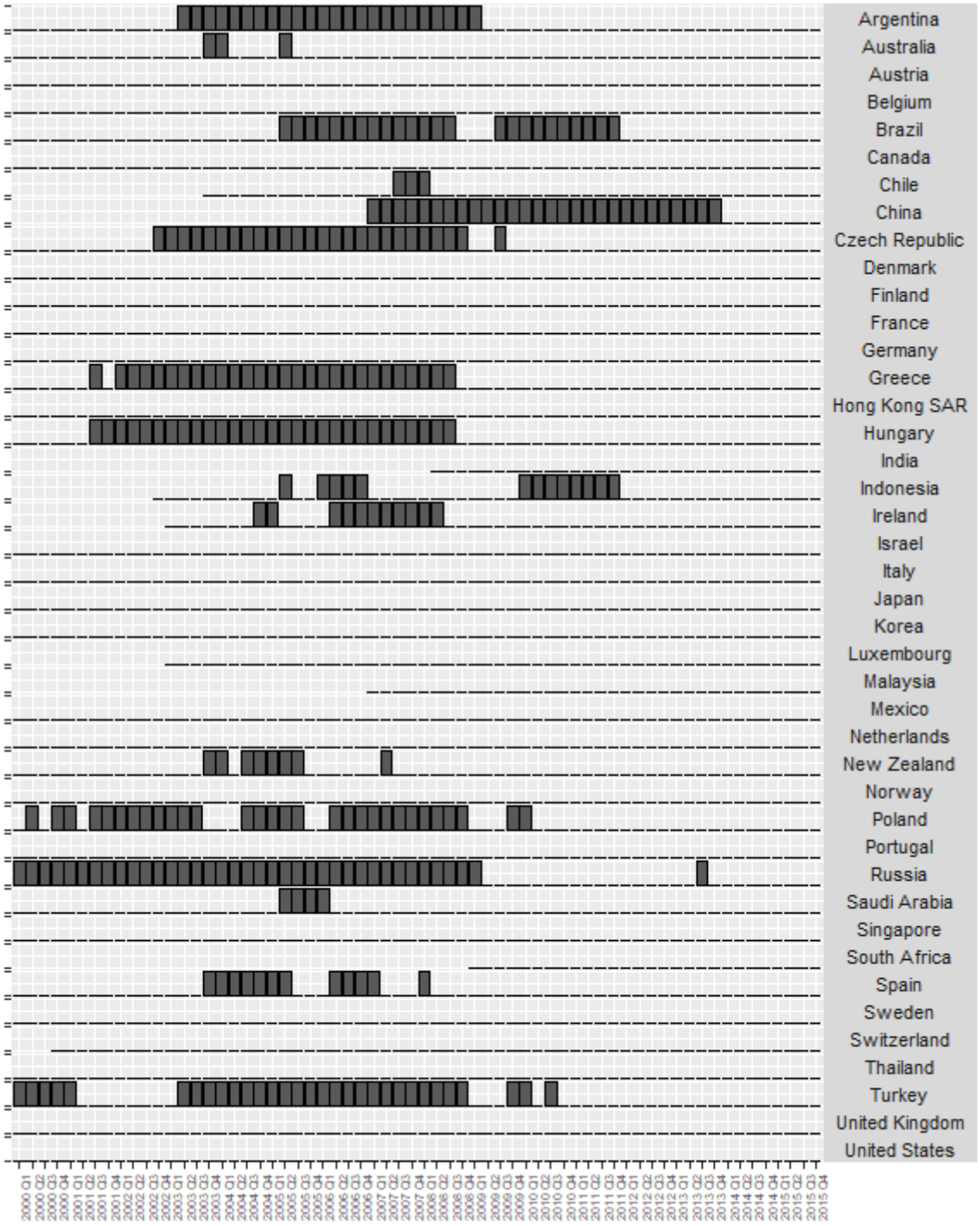

Table 1: Probit Model Estimations

	(1)	(2)
Macropudential policy	-0.91^{***}	-0.89^{***}
	(0.14)	(0.16)
GDP growth	0.15^{***}	0.14^{***}
	(0.02)	(0.02)
Credit to the priv. sect.	0.02^{***}	0.01^{**}
	(0.004)	(0.01)
Financial openness	0.25	0.07^{*}
	(0.56)	(0.056)
Exchange rate regime	0.04	0.34
	(0.28)	(0.26)
Real interest rate	-0.01	-0.003
	(0.01)	(0.01)
Rule of law	-1.80^{***}	
	(0.57)	
Government eff.		-0.43
		(0.47)
Log-Likelihood	-231.95	-236.65
Num. obs.	1271	1271

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 2: Duration Model Estimates

	(1)	(2)
Macropudential policy	−0.141	−0.157
	(0.145)	(0.144)
GDP growth	0.189*	0.209*
	(0.104)	(0.106)
Financial openness	−0.997	−1.886
	(1.443)	(1.504)
Credit to the priv. sect.	−0.006	−0.004
	(0.008)	(0.007)
Exchange rate regime	0.130	0.141
	(0.238)	(0.239)
Real interest rate	0.006	0.003
	(0.023)	(0.024)
Rule of law	−0.276	
	(0.492)	
Government eff.		−0.746
		(0.507)
		Observations
Observations	1,110	1,110
Log Likelihood	−61.169	−60.236
Note:		*p<0.1; **p<0.05; ***p<0.01