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MACROPRUDENTIAL POLICIES AND MONETARY POLICY‡

Banking Panics as Endogenous Disasters and the Welfare Gains from Macroprudential Policy†

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As many authors have noted (e.g., Schularick and Taylor 2012, Krishnamurthy and Muir 2017), historical episodes of financial crisis share similar features. Crises are usually preceded by credit booms. When booms go bust, credit spreads rise, and a deep economic contraction follows. Moreover, this sharp contraction in financial and real economic activity usually happens in the absence of any large exogenous disturbance to the economy. In this respect, the Great Recession was a typical financial crisis episode. At the epicenter was a run on shadow banks that caused credit spreads to skyrocket and eventually led to a deep and prolonged contraction in economic activity. Also, the crisis was preceded by a period of expanding credit that laid the seeds of the subsequent collapse.

One of the most important policy challenges in the aftermath of the Great Recession is the design of macroprudential policies that can prevent the recurrence of the economic disasters associated with financial crises. The argument in support of macroprudential regulation is based on the idea that by restricting financial intermediation, macroprudential policies can prevent the large credit booms that are the root cause of financial crises. There is, however, an important caveat to this approach. While crises are usually preceded by credit booms, most credit booms do not result in financial crises. That is, in the language of Gorton and Ordonez (2019), there are both "good booms" and "bad booms." Moreover, in the data, good booms are much more frequent than bad ones. If regulators can't tell bad credit booms from good ones, attempts at preventing crises will often end up stifling good booms.

In a recent paper (Gertler, Kiyotaki, and Prestipino forthcoming), we study macroprudential regulation in a model that features this policy trade-off between preventing a crisis and stifling a good boom. Building on our previous work (Gertler, Kiyotaki, and Prestipino 2020), we characterize banking panics as endogenous economic disasters and model the credit booms preceding crises as the result of optimistic beliefs about future returns on bank credit. If these expectations are disappointed, the system is left vulnerable to a banking panic. If, on the contrary, the beliefs turn out to be correct, a "good boom" ensues. A calibrated version of the model captures both the average output drop during historical episodes of financial crisis and the statistical relationship between credit booms and financial crises observed in the data. We then look for the optimal macroprudential rule within a set of simple rules and find that optimal macroprudential policy reduces the frequency of banking panics by half and achieves average welfare gains equivalent to a one-quarter percent permanent increase in consumption.

In this article, we delve deeper into the welfare implications of optimal macroprudential regulation and how they interact with our formulation of banking panics as endogenous economic disasters. While the low observed frequency of financial crises limits the size of the unconditional gains from macroprudential regulation,

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avoiding the economic disasters associated with banking panics can achieve nonnegligible welfare gains. Moreover, there is large variation in the welfare gains from macroprudential policies depending on the state of the economy. These gains rise substantially when the run probability increases during a credit boom and, ex post, if a run is actually avoided. Finally, we argue that the welfare gains from macroprudential policies are largely driven by our modeling of financial crises as banking panics. In fact, in a version of our model in which panic runs are ruled out and financial contractions are driven by fundamental shocks only, the gains from macroprudential policy are substantially smaller. Intuitively, regulation is more powerful when it prevents a coordination problem from devolving into a full-blown crisis than when the contraction is induced by deteriorating fundamentals.

I. The Model

We now sketch our model economy. See Gertler, Kiyotaki, and Prestipino (forthcoming) for details. The framework is an infinite horizon endowment economy with two goods: consumption C_t and capital K_t. Capital does not depreciate and is fixed in aggregate supply, which we normalize to unity. Each unit of capital produces a stochastic amount, Z_t, of the consumption good at time t.

Claims on capital may be held either by banks or directly by households. Let K_t^b be capital holdings by banks and K_t^h holdings by households. In equilibrium, total holdings equal total supply:

$$K_t^b + K_t^h = 1. \tag{1}$$

We suppose that households are less efficient in evaluating and monitoring capital projects than banks are. We capture this notion by assuming that household direct finance entails a management cost, $(\alpha/2)\left(K_t^h\right)^2$, which is increasing and convex in the quantity of directly held capital, K_t^h. The increasing marginal managerial cost is meant to capture that a household has limited capacity to manage capital.[1]

The aggregate resource constraint is given by

$$C_t = Y_t = Z_t + W - \frac{\alpha}{2}\left(K_t^h\right)^2, \tag{2}$$

where W (for labor income) is a fixed endowment of the consumption good. Note that the model implies that net output declines as the share of bank financing of capital falls because of the direct managerial costs $(\alpha/2)\left(K_t^h\right)^2$. Thus, the model captures in a reduced form way that disintermediation leads to a drop in output.[2]

Absent any friction in the ability of banks to intermediate capital, banks would hold the entire capital stock. The economy would reduce to a Lucas tree economy in which consumption varies exogenously with dividend yields Z_t and there is no room for banking panics.

We make two key assumptions that limit banks' ability to intermediate funds and open the door to banking panics. First, we assume that markets are incomplete and banks can raise external finance from households only by issuing short-term risky debt. That is, bank deposits, D_t, pay a stochastic return, R_{t+1}, given by

$$R_{t+1} = \begin{cases} \bar{R}_t & \text{if no run at } t+1 \\ \dfrac{\left(Z_{t+1} + Q_{t+1}^*\right)K_t^b}{D_t} & \text{if run at } t+1 \end{cases}, \tag{3}$$

where $\bar{R}_t$ is a fixed promised rate and Q_t^* is the liquidation price of capital. As discussed below, when a run happens, the liquidation value of banks' assets $\left(Z_{t+1} + Q_{t+1}^*\right)K_t^b$ is below banks' total liabilities $D_t\bar{R}_t$, so the households' return on deposits is below the promised rate $\bar{R}_t$.

Second, we introduce a moral hazard problem between bank managers and depositors. We suppose that the banker may secretly divert a fraction of funds for personal use. The cost to the banker of siphoning funds is that depositors can shut down the bank at the beginning of the subsequent period. As a result, depositors limit the amount they lend to banks in order to ensure that bank managers do not have incentives to divert assets. In particular, letting N_t be aggregate bank net worth and Q_t the market value of capital, the

[1] We also assume that households can inject equity into banks at a cost. Since equity injections are not crucial for illustrating the key mechanism of the model, we abstract from them here.

[2] Gertler, Kiyotaki, and Prestipino (2020) provides a more realistic description of how a banking collapse leads to an output collapse. In that framework, the banking panic leads to a sharp contraction in investment, which reduces aggregate demand and output due to nominal rigidities.

incentive constraint on banks implies an aggregate capital requirement κ_t^m:

$$(4) \qquad \frac{N_t}{Q_t K_t^b} \geq \kappa_t^m.$$

Crucially, κ_t^m is always strictly positive, implying that banks cannot operate without net worth. If depositors lend money to a bank with zero net worth, the bank will simply steal the funds. As we show next, this consideration is key to our characterization of the bank run equilibrium.

A. *Bank Runs as Endogenous Economic Disasters*

We model bank runs as a rollover panic, similar to the Cole and Kehoe (2000) model of self-fulfilling debt crisis. In particular, a self-fulfilling bank run equilibrium (rollover crisis) exists if an individual depositor correctly believes that when all other depositors do not roll over their deposits, he would lose money by rolling over. This condition is met if banks' net worth goes to zero in the event of the run. As we discuss above, any household that lends money to a zero-net-worth bank will simply have its money stolen.

In the "good" equilibrium at $t+1$, where a run does not occur, banks have sufficient assets to pay depositors their promised rate:

$$(5) \qquad (Q_{t+1} + Z_{t+1})K_t^b > \bar{R}_t D_t.$$

A second equilibrium, in which depositors' run on banks is possible at $t+1$ if banks' liquidation forces the value of banks' assets below their promised obligation of deposits:

$$(6) \qquad (Q_{t+1}^* + Z_{t+1})K_t^b < \bar{R}_t D_t.$$

The liquidation price of capital, Q_{t+1}^*, is lower than the price at which capital trades normally, Q_{t+1}, because of households' limited ability to absorb assets from the banking sector. To see this, let $\Lambda_{s,s+1}^*$ denote the household stochastic discount factor between s and $s+1$ if a run happens at s. The liquidation price is determined by households' demand for capital:

$$(7) \quad Q_s^* = E_s\left[\Lambda_{s,s+1}^*(Z_{s+1} + Q_{s+1})\right] - \alpha K_s^h,$$

evaluated at $K_s^h = 1$. When depositors run on banks, they are forced to absorb the entire capital stock, causing the marginal cost of household finance, αK_s^h, to rise to the maximum and the price of capital to drop to a fire sale value. If this drop is enough to cause banks to fail—i.e., condition (6) is satisfied—a bank run is self-fulfilling. Similarly, the run causes output and consumption to drop discontinuously to values C_{t+1}^* and Y_{t+1}^*, which, by the resource constraint (2) evaluated at $K_{t+1}^h = 1$, are given by

$$(8) \qquad C_{t+1}^* = Y_{t+1}^* = Z_{t+1} + W - \frac{\alpha}{2}.$$

While condition (6) determines whether a run is possible, to determine whether the run happens we assume that depositors use a stochastic nonfundamental coordination device, which we call a sunspot. Let ι_{t+1} be a sunspot variable that takes on a value of unity if the sunspot occurs and zero otherwise. A run occurs at $t+1$ if (i) condition (6) is met and (ii) $\iota_{t+1} = 1$. We assume the sunspot appears with fixed probability $\varkappa$. Then the probability of a run p_t is given by the product of the probability a run equilibrium exists times the probability of a sunspot, as follows:

$$(9) \quad p_t = \Pr_t\left\{(Q_{t+1}^* + Z_{t+1})K_t^b < \bar{R}_t D_t\right\} \cdot \varkappa.$$

Equation (9) describes how the probability of banking panics varies endogenously with the health of banks' balance sheets. A panic equilibrium is more likely to exist if (i) bank leverage is high (measured by the ratio of the deposit obligations to the book value of assets, $D_t\bar{R}_t/K_t^b$) and (ii) the liquidation price Q_{t+1}^* is low. Equation (9) in conjunction with equation (8) thus captures our modeling of banking crises as endogenous economic disasters. If a run happens, then as equation (8) suggests, output drops suddenly and a deep recession follows.

B. *Credit Booms*

We model credit booms by appealing to optimistic beliefs, similar in spirit to Geanakoplos (2010) and Bordalo, Gennaioli, and Shleifer (2018). We assume that bankers occasionally become optimistic about future returns on capital. With some fixed probability, bankers receive news that a large positive realization of Z_t might occur sometime in the future. Upon receiving the news at time t^N, bankers are uncertain about both *whether* and *when* this productivity boom will happen. In particular, we assume that the initial probability that the shock will eventually happen, $\bar{P}_{t^N}$, is smaller than (but very close to) unity. Conditional on the shock happening, bankers believe that the shock will materialize within T quarters, but the exact quarter in which it happens is also random and is modeled as the discrete approximation of a truncated normal distribution $t^N + i \in \{t^N + 1, \ldots, t^N + T\}$. As time passes, bankers observe Z_{t^N+i} and use Bayes' law to update their beliefs.

Notice that the process naturally generates both "good booms" and "bad booms." Early on, bankers steadily raise their forecasts of the near-term return on capital and hence increase intermediation by borrowing aggressively from households. If the productivity boom actually happens, the economy experiences a "good boom," in which credit and output grow faster and a bank run is not possible. On the contrary, if time passes without the realization of the shock, bankers become less certain it will ever occur, the optimism proceeds to vanish, and the system is left vulnerable to a run.

While bankers use Bayesian updating to form beliefs after receiving the news, there is a "behavioral" dimension to belief formation. In particular, we assume that the prior probability bankers assign to the likelihood a boom will occur is higher than the true probability, while that of the households is lower. This belief heterogeneity helps capture credit booms quantitatively. One can view it as the "this time is different" mentality of bankers.

We next turn to describing these boom–bust cycles in credit and how macroprudential policy can improve welfare by preventing them.

II. Boom–Bust Cycles in Credit and the Welfare Effects of Macroprudential Regulation

We calibrate our model to match some key moments of financial and real economic variables. Importantly, we pick the curvature of households' costs of direct holdings, α, and the probability of observing a sunspot, $\varkappa$, to match the observed average drop in output during financial crises and the observed frequency of financial crises in advanced economies of roughly once every 25 years. Moreover, the model matches the statistical relationship between credit booms and financial crises observed in the data and can therefore capture the macroprudential policy trade-off between preventing a crisis and stifling a good boom discussed above.

Figure 1 shows a boom–bust cycle in credit in the decentralized economy and how macroprudential policy can effectively prevent it. The red dashed line describes how the decentralized economy responds to a news shock at time 1, assuming that the productivity boom never realizes. The top-left panel shows bankers' forecast of capital productivity one period ahead, together with the realized productivity, the black dotted line, which remains flat throughout the experiment. Expected productivity increases as the economy approaches the period when the productivity boom is most likely according to bankers' prior. However, because the productivity boom is not realized, the expected productivity begins to decline afterward. Bankers' optimism leads to an increase in bank net worth fueled by a surge in asset prices and an increase in intermediation funded by a rise in bank leverage. Higher leverage, in turn, causes the quarterly run probability to increase from below 1 percent in steady state to almost 7 percent at its peak. At this point we assume that a sunspot is observed, and since the economy is in a region where a run equilibrium exists, households refuse to roll over deposits and a banking panic occurs. The run leads to a fire sale of bank assets, causing bank net worth and bank intermediation to go to zero. The disintermediation of bank assets leads to a sharp drop in output of more than 10 percent and a slow recovery as bank net worth and bank intermediation gradually return to trend.

The blue solid line shows how the regulated economy responds to the same shocks. The macroprudential regulator sets a time-varying bank capital requirement $\bar{\kappa}_t$. We consider a simple policy rule for bank capital requirements that allows for a countercyclical buffer as follows:[3]

$$\bar{\kappa}_t = \begin{cases} \bar{\kappa} & \text{if } N_t \geq \bar{N} \\ 0 & \text{if } N_t < \bar{N}. \end{cases} \tag{10}$$

[3] In Gertler, Kiyotaki, and Prestipino (forthcoming), we show that having a countercyclical capital buffer is superior to having a fixed capital requirement. Relaxing the capital requirement in bad times facilitates the recovery from a crisis.

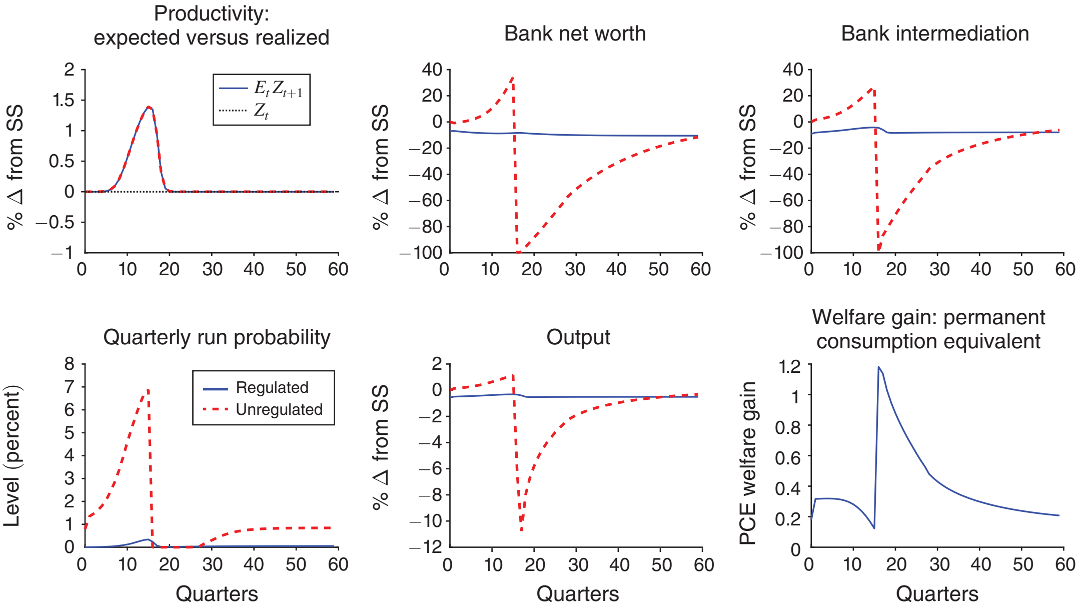

FIGURE 1. BOOM–BUST CYCLES IN CREDIT AND THE EFFECTS OF MACROPRUDENTIAL POLICY

Note: SS is steady state; PCE is permanent consumption equivalent.

The capital requirement for banks, κ_t, is now the maximum between the regulatory requirement $\bar{\kappa}_t$ and the market-imposed capital requirement κ_t^m. If bank net worth falls below $\bar{N}$, the regulatory requirement is lifted, and the market requirement κ_t^m applies.

The regulated economy depicted in Figure 1 features the capital requirement $\bar{\kappa}$ and threshold $\bar{N}$ that maximize unconditional welfare. Regulation makes banks safe. Due to the regulatory constraint on leverage, the news shock increases the run probability only slightly. Further, during the period where the panic occurs in the laissez-faire economy, the run equilibrium does not exist in the regulated economy. In this instance, the macroprudential policy ensures that bank portfolios are sufficiently resilient to rule out runs. Achieving banking stability comes at a cost: regulation reduces bank intermediation, causing asset prices, bank net worth, and output to be lower throughout the boom. These costs, however, are more than offset by the benefits of avoiding banking panics. The bottom-right panel shows the welfare gains from being in the regulated economy. Welfare is always higher in the regulated economy, even before the run is prevented. In particular, at time 1, when the news is received, the welfare gains of being in a regulated economy rise substantially, almost doubling from 0.18 to 0.32 percent of permanent consumption gains. As time passes without a run happening, the welfare gains slowly decline. This is because, by preventing the credit boom, regulation is also preventing the output boom that is associated with it in the decentralized economy. Finally, once the run happens, the welfare gains spike substantially, reaching 1.2 percent of permanent consumption gains. The sharp gain reflects that regulation would have prevented the run in this instance.

Despite the relatively low frequency of episodes of boom–bust cycles in credit like the one displayed in Figure 1, the stabilization properties of macroprudential policy have nonnegligible effects on average welfare. The overall effects of the optimal macroprudential policy on the run probability, output, and welfare are reported in the middle column of Table 1. For comparison, the left column reports the behavior of the decentralized economy. Macroprudential policy cuts the quarterly run probability by more than half, to 0.4 percent from 0.9 percent. While

TABLE 1—WELFARE GAINS FROM MACROPRUDENTIAL POLICY: THE ROLE OF BANKING PANICS

	Decentralized economy $(\bar{\kappa} = 0; \bar{N} = 0)$	Optimal regulation $(\bar{\kappa} = 0.12; \bar{N} = 0.8 \cdot N_{SS}^{DE})$	Optimal regulation no run case: $\varkappa = 0$ $(\bar{\kappa} = 0.11; \bar{N} = 0.8 \cdot N_{SS}^{DE})$
Run frequency	0.9	0.41	0
Average output Δ from DE	0	0.1	−0.08
Welfare gain Δ PCE	0	0.25	0.05
Welfare gain conditional on run Δ PCE	0	1.13	—

Notes: The output and welfare effects in the third column are computed in deviation from a decentralized economy in which the probability of a sunspot is set to zero. SS is steady state; PCE is permanent consumption equivalent; DE is decentralized equilibrium.

outside of crisis periods output is lower in the regulated economy, the reduction in the likelihood of costly banking panics causes average output to be 0.1 percent higher and reduces the variance and left skewness of the output distribution. This delivers a nonnegligible increase in average welfare: given log utility over consumption, the welfare gain is equivalent to a 0.25 percent increase in permanent consumption. Note that this is a very conservative estimate since we are using a coefficient of relative risk aversion of unity. Further, this gain is "unconditional" in the sense that it averages over the roughly 99 percent of the time that runs do not happen in the decentralized economy. When we condition on periods in which the decentralized economy experiences a bank run, the welfare gain from regulation jumps to a 1.13 percent increase in permanent consumption. In this instance, the regulated economy avoids the collapse, leading to substantial permanent gains in welfare.

Finally, to illustrate the role that preventing costly panics plays in the gains from macroprudential policy, in the right column we consider a version of the model where the sunspot is shut off so that runs are not possible.[4] Even when bank runs are ruled out, the presence of a pecuniary externality, as in Lorenzoni (2008), still allows for macroprudential regulation to improve upon welfare.[5] However, given that crises are now driven by fundamental shocks, regulation can only mitigate crises rather than avoid them. As a result, the optimal macroprudential rule for this case, portrayed in column 3, produces a welfare gain of only 0.05 percent of permanent consumption. Overall, our results suggest that the main welfare gains from macroprudential policy come from reducing the likelihood of banking panics that generate economic disasters.

REFERENCES

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer. 2018. "Diagnostic Expectations and Credit Cycles." *Journal of Finance* 73 (1): 199–227.

Cole, Harold L., and Timothy J. Kehoe. 2000. "Self-Fulfilling Debt Crises." *Review of Economic Studies* 67 (1): 91–116.

Geanakoplos, John. 2010. "The Leverage Cycle." In *NBER Macroeconomics Annual 2009*, edited by Daron Acemoglu, Kenneth Rogoff, and Michael Woodford, 1–65. Chicago: University of Chicago Press.

Gertler, Mark, Nobuhiro Kiyotaki, and Andrea Prestipino. 2020. "A Macroeconomic Model with Financial Panics." *Review of Economic Studies* 87 (1): 240–88.

Gertler, Mark, Nobuhiro Kiyotaki, and Andrea Prestipino. Forthcoming. "Credit Booms, Financial Crises, and Macroprudential Policy." *Review of Economic Dynamics*.

[4]The economy without sunspots experiences financial collapses with a similar frequency to our baseline economy. This is because bankers reduce precautionary behavior and may default with adverse productivity shocks because of insolvency (instead of panic runs)—that is, condition (5) is violated.

[5]In addition to the traditional externality on the price of capital, our model features another externality in that bankers fail to internalize the effect of their leverage on the run probability.

Gorton, Gary, and Guillermo Ordonez. 2019. "Good Booms, Bad Booms." *Journal of the European Economic Association*. https://doi.org/10.1093/jeea/jvy058.

Krishnamurthy, Arvind, and Tyler Muir. 2017. "How Credit Cycles across a Financial Crisis." NBER Working Paper 23850.

Lorenzoni, Guido. 2008. "Inefficient Credit Booms." *Review of Economic Studies* 75 (3): 809–33.

Schularick, Moritz, and Alan M. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008." *American Economic Review* 102 (2): 1029–61.