The Fiscal Footprint of Macroprudential Policy[*]

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Abstract

Monetary policy has a fiscal impact through several channels and in some circumstances fiscal authorities may wish to dominate it turning inflation control into revenue generation. The same is true of macroprudential policy. Macro-prudential policies that increase the demand for government bonds by banks directly lower the cost of rolling over public debt, but decrease lending, real activity, and tax collections. They lower the incidence and fiscal cost of a financial crisis, but they make a fiscal crisis more likely. This paper characterizes the size and sign of this footprint, as well as the states of the world in which the temptation for fiscal policy to dominate may be higher.

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1 Introduction

Monetary policies leave a fiscal footprint. When the central bank cuts the interest rate, it increases the demand for its currency, and printing more banknotes to satisfy this demand raises seignorage revenues. It also causes unexpected inflation, which lowers the real value of the debt due by the government. Rolling over this debt is also cheaper as the price of new debt rises. And finally, if economic activity rises, tax revenues increase while social spending falls. These multiple channels of the fiscal footprint of monetary policy have been thoroughly discussed and measured. In a celebrated article, Sargent and Wallace (1981) showed that this footprint can lead an unpleasant monetary arithmetics: when the fiscal authority commits to not raise taxes to pay for spending, then a monetary authority that wants to prevent sovereign default must use its tools to generate the needed fiscal revenues, giving away the control of inflation.

This paper asks whether similar unpleasantries affect macroprudential policy. It builds a model to characterize the different channels from macroprudential policy to the fiscal burden of the government. The presence and intensity of these channels depends on whether the economy is going through a fiscal crisis, a financial crises, neither, or both. Understanding these channels provides the needed building block towards a study of the independence of macroprudential policy and the scope for it to become fiscally dominated.

Macroprudential policy is a wide umbrella under which fall many policies. Instead of trying to study one, or several of them, in detail, this paper takes a different approach. It focusses on a single proxy variable that is affected by several macroprudential policies: the share of government bonds held by banks. I denote this by β_t. A general feature of most macroprudential policies is that they try to make the banking system safer by increasing its holdings of safe assets. This is also the feature that historically gets taken over by fiscal concerns when during crises the fiscal authority is struggling to place the government debt. Policies like the liquidity coverage ratio are directly about setting β_t, while changes in risk weights that banks must give to assets to calculate capital ratios in practice have this effect due to the convention of giving a zero risk weight to national government bonds. Limits on leverage or capital requirements by themselves instead lower the demand for all assets by banks, including government bonds. Common to all policies though is that one of their direct effects is on β_t, so focussing on it captures an important part of macroprudential policy.

The other distinguishing focus of this paper is on the fiscal burden. This is defined as the resources the government must raise in order to satisfy the government budget constraint. Changes in β_t affect the payments associated with outstanding debt and the level of real

activity, and thus the needed tax rate that the fiscal authority must charge to pay for this debt. Macroprudential policy has a positive fiscal footprint if it increases the fiscal burden, so it tightens the resource constraint fo the government, and forces it to raise taxes.

These two focuses distinguish this paper from much of the literature studying macroprudential policy. A large strand of this literature (Farhi and Werning, 2016; Bianchi and Mendoza, 2018; Jeanne and Korinek, 2019) studies macroprudential policies as Pigouvian taxes and subsidies that correct externalities. The resulting fiscal footprint of these policies is then set to zero through offsetting lump-sum transfers. This paper instead focuses on the side of macroprudential policies that affect demand for safety, and on measuring their fiscal footprint. Another strand of the literature focusses on the redistributive effects of macroprudential policies, with an emphasis on housing markets (Svensson, 2018; Peydro et al., 2019). Unlike in this paper, in that literature there are typically no tax revenues as policies are implemented through quotas rather than taxes.

The model in this paper builds on three literatures. The demand for government bonds and their liquidity (or safety) premium is modeled as in Krishnamurthy and Vissing-Jorgensen (2015). The interaction between fiscal and financial crises creating a diabolic loop follows Bolton and Jeanne (2011); Balloch (2015), and is inspired by the facts reported in Bénétrix and Lane (2015); Bordo and Meissner (2016). The model of why regulation is needed for banks is similar to that in Farhi and Tirole (2018).

The paper is organized as follows. Section 2 introduces a simple partial equilibrium model of the government bond market. This provides the foundation for section 3 to define the direct fiscal footprint of macroprudential policies and to compare it to that of conventional and unconventional monetary policies. Section 4 then completes the description of the general-equilibrium model by adding bank credit, investment, real activity, tax revenues, and bailouts. Section 5 uses this model to characterize the indirect fiscal footprint of macroprudential policies. Section 6 then focuses on the interaction between macroprudential and fiscal policymakers. It shows how macroprudential policy can be affected by present-biased fiscal policymakers, by the presence of a fiscal crisis, by having fiscal support, and by the diabolic loop between banks and sovereigns. Section 7 concludes.

2 Partial equilibrium in the bond market

Since macroprudential policy affects the demand for bonds by one economic agent, the exposition of the model starts by describing the other actors in the bond market. The

partial equilibrium in this market immediately provides a direct impact of macroprudential policy.

2.1   Households

A representative household maximizes utility subject to a sequence of budget constraints:

$$\sum_{t=0}^{\infty} \psi^t u\left(c_t + \ell(b_t/p_t)\right) \quad \text{subject to:} \tag{1}$$

$$p_t c_t + d_t + q_t b_t \leq (1 + i_{t-1}^d)d_{t-1} + b_{t-1}\delta_t + z_t \tag{2}$$

The household receives utility from both consumption c_t and the liquidity benefits provided by the holdings of government bonds b_t through the increasing concave function $\ell(.)$. The price level is p_t, and both deposits in banks d_t and government bonds that sell for price q_t are denoted in nominal units and provide nominal returns. The interest rate on deposits is i_t^d, while government bonds usually pay back in full, but in case of default may pay only a fraction $\delta_t \leq 1$ of the promised repayment. Finally, the household receives dividends from the financial sector z_t.

The more uncommon part of this problem is the liquidity benefits from bonds. A recent literature (e.g., Krishnamurthy and Vissing-Jorgensen, 2012) has made this assumption in order to make sense of the observed downward-sloping relation between outstanding U.S. Treasury bonds, and the difference between their yield and the yield on corporate bonds, relating this to their relative safety and liquidity. This is also the reason why the assumption is made here. Modeling these liquidity benefits directly, through a search market for bonds as in Radde, Checherita-Westphal and Cui (2015), would multiply the effects of macroprudential policy and fiscal crisis on the demand for bonds, through the effect of policies on the market liquidity of the bonds.

The Euler equations associated with the optimal choices by this household are:

$$u_t'(.) = \psi(1 + i_t^d)u_{t+1}'(.)p_t/p_{t+1} \tag{3}$$

$$u_t'(.)(\ell_t'(.) - q_t) = \psi u_{t+1}'(.)p_t\delta_{t+1}/p_{t+1} \tag{4}$$

The first Euler equation expresses the indifference in depositing one more unit in the banks. The second one reflects the indifference with holding one more government bond. Relative to deposits, bonds may not pay in full because of default, but they provide liquidity benefits.

Combining the two gives the no-arbitrage condition between these two forms of savings:

$$q_t = \ell'_t(.) + \frac{\delta_{t+1}}{1 + i_t^d} \tag{5}$$

Government bonds earn a premium over the yield on deposits through two channels. First, insofar as the bonds default, the price of government bonds is lower. With uncertainty, there would also be a risk premium associated with it. Second, because of their liquidity benefits, bonds command a premium over deposits. Importantly for this paper, this premium falls as the household holds more bonds because of diminishing marginal utility for the liquidity they provide. Thus, the demand function for government bonds by households is downward-sloping, like the empirical literature has found.

2.2 The net supply of government bonds

Macroprudential policy forces banks to hold an amount of bonds that is at least β_t. Because the marginal source of funds for the bank are deposits, and the price of bonds carries a liquidity premium and thus holding bonds gives a lower yield, then banks would not want to hold any bonds at all. Therefore, macroprudential policies directly set the amount of bonds they hold, β_t. In reality, the effect of policy on banks' bond holdings is surely not exactly one-to-one, but since this paper is using β_t as a proxy for a host of different policies, each with a different impact on the bond holdings by banks, making this stark assumption is consistent with treating it as a proxy for macroprudential policies as a whole.

The central bank takes deposits from banks and pays interest on these reserves. Because banks must be willing to hold these deposits at the central bank in equilibrium, the central bank effectively sets the interest rate on deposits i_t^d, since this is monotonically linked to the interest rate it pays on reserves, say i_t^v. With these reserves the central bank buys government bonds in amount v_t.

The government issues an amount of bonds B_t. Market clearing in the bond market therefore requires:

$$B_t = b_t + \beta_t + v_t. \tag{6}$$

Government bonds are held by households, banks, and the central bank.

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2.3 Macroprudential policy and the price of bonds

Figure 1 plots the supply and demand for government bonds. The supply curve comes from equation (6) and the demand curve from equation (5).

A tighter macroprudential policy, by raising β_t, shifts the supply to the left. It therefore raises the price of bonds q_t, by increasing the liquidity premium. More bonds are now held by banks, and fewer are held by households.

How does this compare with monetary policy? Conventional monetary policy lowers interest rates, thus shifting the demand curve to the right. It also raises the price of bonds, but now with no changes in bond holdings by anyone. There is no effect on liquidity premia as well.

Quantitative easing instead raises v_t, which just like macro-prudential policy raises the price of bonds by shifting the supply to the left and raising the liquidity premium. Differently though, the bond holdings of banks are unchanged, and it is the central bank that holds the extra bonds.

3 The direct fiscal impact of macroprudential policies

By raising the price of bonds, macroprudential policy directly lowers the financing costs of the government. This direct fiscal impact has a fiscal footprint that can be compared to that of monetary policy.

3.1 Defining fiscal footprint

The government collects a real fiscal surplus s_t, which increases with the tax rate τ_t. It further receives a dividend from the central bank d_t and it must satisfy a budget constraint every period:

$$p_t s_t + p_t d_t + q_t B_t \geq \delta_t B_{t-1}. \tag{7}$$

The intertemporal budget constraint over two successive dates then is:

$$\frac{q_{t+1} B_{t+1}}{p_{t+1}} + s_{t+1} \geq \frac{\delta_{t+1} p_t}{q_t p_{t+1}} \left[\frac{\delta_t B_{t-1}}{p_t} - s_t - d_t \right] - d_{t+1}. \tag{8}$$
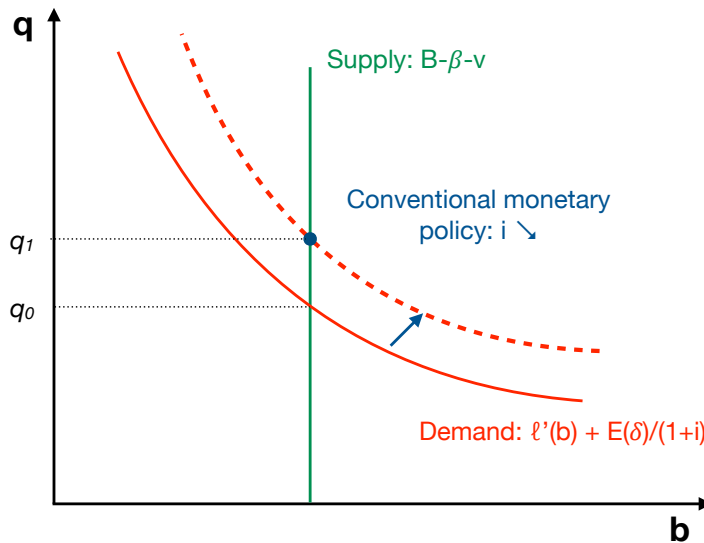
The right-hand is the *fiscal burden* faced at $t+1$. Without further borrowing, it represents the needed fiscal surpluses that the government must generate to satisfy the budget constraint.
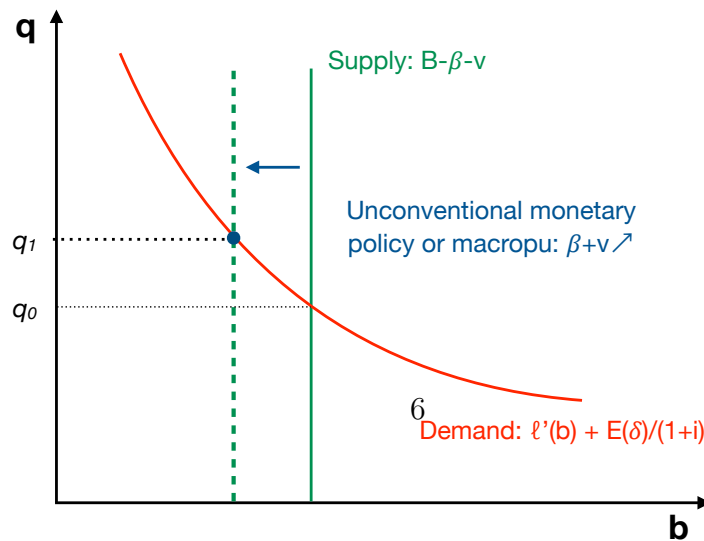
Figure 1: The market for government bonds

(a) Price in equilibrium
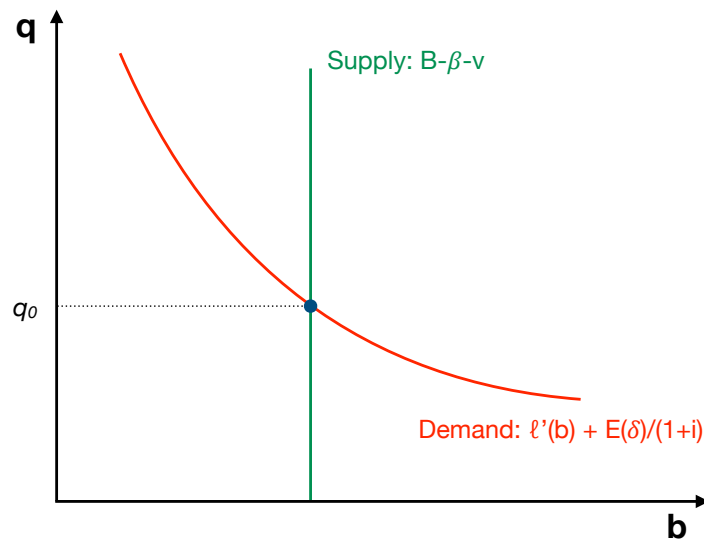
(b) Effect of conventional monetary policy

(c) Effect of unconventional and macroprudential policies

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If a policy raises (lowers) the burden it has a positive (negative) *direct fiscal footprint* because it tightens the constraint faced by the fiscal authority.

3.2   The fiscal footprint of macroprudential policy

Because macroprudential policy is an ex ante policy, a change in β_t has no effect on default, fiscal surpluses or dividends this period, but only potentially on the next period. Monetary policy in turn keeps the price level under control. Simply taking derivatives of the fiscal burden provides the first result of this paper.

Proposition 1. *Tighter macroprudential policy (higher β_t) has a negative direct fiscal footprint:*

$$-\left(\frac{\delta_{t+1}\delta_t B_{t-1}}{q_t^2 p_{t+1}}\right)\left(\frac{\partial q_t}{\partial \beta_t}\right) < 0. \tag{9}$$

Macroprudential policy raises the price of government bonds. By making banks hold more government bonds, the financing needs of the government are partially met. This allows the government to roll over its debt at a better price, and so it loosens the constraint facing the fiscal authority.

3.3   Comparison with identical policies

How does this footprint compare with that left by monetary policy? A difficulty with making any comparisons across policies is to define the relevant units for the comparison. A 1% change in β_t is not comparable with a 1% change in interest rates or a 1% increase the balance sheet of the central bank. Common to all these policies though is their impact on bond prices, as the previous section showed. This leads to a natural definition of *identical policies*: a macroprudential policy (β_t), conventional monetary policy (i_t^d) and unconventional monetary policy (v_t) have identical price impact if they have the same effect on bond yields $1/q_t$.

Conventional monetary policy controls inflation. There are many different ways to model this link, all of which share the prediction that lower rates raise inflation since this is what we observe in the data. To keep the focus on macroprudential policies, I simply assume that $\partial p_{t+1}/\partial i_t^d < 0$.[1] As for unconventional monetary policy, I assume that the central bank follows a net-income dividend rule, so that its solvency is always guaranteed and all

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[1]I also assume that monetary policy's impact on real activity and fiscal surpluses only materializes next period, consistent with the delayed effects observed in the data.

fiscal consequences are immediately transmitted to the government (Hall and Reis, 2015). Therefore if i_t^v is the interest rate paid on reserves:

$$p_{t+1}d_{t+1} = [\delta_{t+1} - (1 + i_t^v)q_t] v_t. \tag{10}$$

To conclude the description of monetary policy, one must determine what is the relative interest-rate premium between reserves and government bonds. Because, in the data, reserves are overnight, while the average duration of government bonds is above one year, it is not trivial to sign this term. Instead, I define it as $\mathcal{L}(v_t/p_t, b_t/p_t) = \ell'(b_t/p_t)(1 + i_t^v)$, and allow it to be either positive or negative, increasing or decreasing.

Given a description of how monetary policy works, and a definition of the units to use to compare policies, the following results compares the direct fiscal footprint of macroprudential policies with that of monetary policies:

Lemma 1. *A conventional monetary policy with the same price impact as a macroprudential policy exceeds its fiscal footprint by:*

$$-\left(\frac{\delta_t \delta_{t+1} B_{t-1}}{q_t p_{t+1}^2}\right)\left(\frac{\partial p_{t+1}}{\partial i_t^v}\right)\left(\frac{\partial q_t}{\partial i_t^v}\right)^{-1} \leq 0. \tag{11}$$

An unconventional monetary policy with the same price impact as a macroprudential policy exceeds its fiscal footprint by:

$$\mathcal{L}_t + \mathcal{L}_t'(.)v_t + \mathbb{E}_t(\delta_{t+1}) - \delta_{t+1}. \tag{12}$$

The extra fiscal impact from conventional monetary policy comes from inflating away some of the public debt. Quantitatively, this effect is typically quite small (Hilscher, Raviv and Reis, 2014), but it always contributes to reduce the fiscal footprint. Thus, for a government solely focussed on the direct fiscal footprint, all else equal, conventional monetary policy will have a larger impact than macroprudential policies.

Quantitative easing brings in two extra effects. First, by issuing reserves to buy government bonds, the central bank earns the relative premium between these two assets ($\mathcal{L}_t$). By replacing the bonds in the hand of households by reserves in the hands of bank it changes this relative premium $\mathcal{L}_t'(.)$. If reserves and bonds do not provide any liquidity services, then the Modigliani-Miller result of Wallace (1981) would hold and the sum of these two terms would be zero.

Second, the proposition allowed for expected default to possibly differ from actual default.

Government bonds may default while reserves do not since they are the unit of account. If this default is priced in, because actual and expected default coincide, then this has no effect on the net income of the central bank, and leaves no fiscal footprint. In case there is an unexpected default though, quantitative easing lowers the net income of the central bank because it is holding more of the defaulting bonds while paying more interest on reserves. Losses for the central bank translate into smaller dividends to the fiscal authority and thus a positive fiscal footprint (Reis, 2017).

All combined, the fiscal footprint of macroprudential policy is comparable to that of monetary policy. The extra terms are plausibly empirically small. At the same time, conventional monetary has the more negative footprint. Perhaps this is why why it is so often used during extreme fiscal crises, leading to the hyperinflation that routinely arise in crisis times (Cagan, 1956).

To keep the focus on macroprudential policy, from this point onwards, I will assume away monetary policy. That requires assuming that $v_t = 0$, so there is no relevant central bank balance sheet with no bonds or reserves, and that $1 + i_t^d = \psi^{-1}$ so that there is no inflation and $p_t = 1$ at all dates.

4 The model of production and financing

Macroprudential policies also have an indirect fiscal footprint by changing the fiscal surplus for a given tax rate. This section integrates the model of households and bonds into a general equilibrium model of banks, firms, and real activity to study these further effects.

4.1 Firms and production

A measure one of atomistic entrepreneurs every period have access to a production technology that will produce the goods that households can consume. Each firm produces π_{t+1} goods. Production requires setting up a firm, and this costs some initial capital.

If the firm is set up in period t to engage in production at $t + 1$ then this cost is a fixed amount κ. The return that results from k_t firms being set up is then $(\pi_{t+1} - \kappa)k_t > 0$. I assume that $\pi_{t+1} - \kappa > i^d$, so production is profitable. Was it not for financial constraints, then all available investment resources would be employed in this regular form of investment.

Given financial constraints, there may be some capital left over for period $t+1$. If instead the firm is only set up then, at $t+1$, right before production takes place, then the setup costs of this make-do investment are higher, and they rise convexly with the amount of make-do

Figure 2: Investment costs
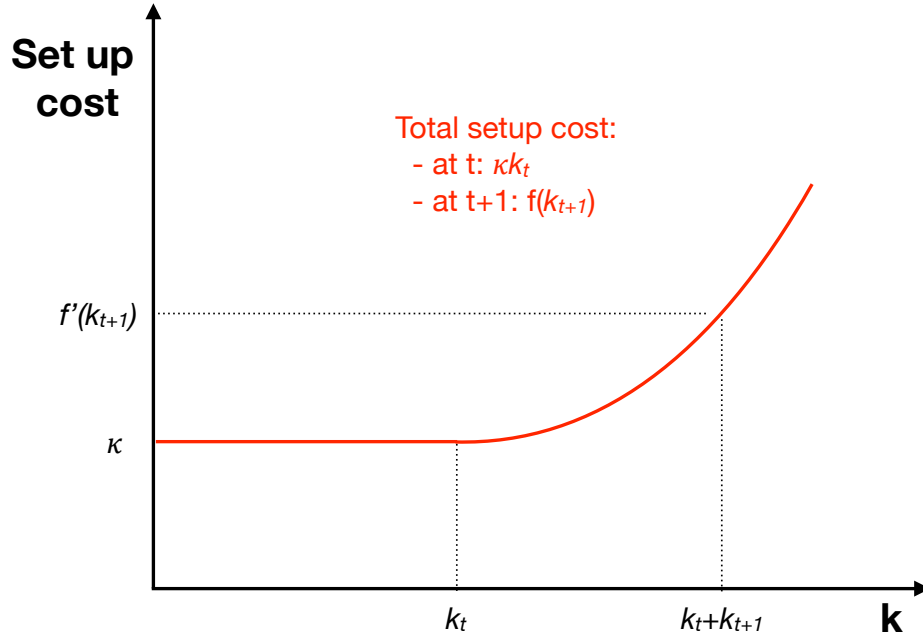
investment. Letting k'_{t+1} denote make-do investment, then the net return from make-do investment is: $\pi_{t+1}k'_{t+1} - f(k'_{t+1})$ where the function $f(.)$ has the properties: $f'(0) \geq \kappa$ and $f''(.) \geq 0$.

Figure 2 plots the marginal costs of production. A social planner would like to push k_t all the way to the right, by financing all firms ahead of time, and there would be no make-do investment. However, if k_t is not sufficiently high, and some ideas are still available, then the optimal amount of make-do investment is: $f'(k^*_{t+1}) = \pi_{t+1}$, as long as $k_t + k^*_{t+1} < 1$, so not every single firm is financed. I assume this is always the case.

However, entrepreneurs have no capital. Each entrepreneur must get it from the bank it is matched too.

4.2   Banks and credit

Every period, a unit measure of potential bankers breaks from the household and is given some capital. A fraction of these become actual bankers by being matched with entrepreneurs. What it means to be a banker is to have a monitoring technology that allows the banker to collect payment from the credit to firms. For simplicity, I assume that in the relation with

the entrepreneurs, the bankers have all of the bargaining power, but this is immaterial to the results.

To fund credit in the first period, these banks can either use their net worth n_t or the deposits they collected from the household. The households do not have the monitoring technology, so they need to use the banks to have access to the returns from production. The resource constraint of the banking sector therefore is:

$$\kappa_t k_t + q_t \beta_t = n_t + d_t. \tag{13}$$

In attracting depositors, the bankers suffer from a commitment problem. They can abscond with part of the payoff from the loan paid by the entrepreneurs, but before paying the depositors. However, absconding implies losing a fraction γ of the loans payoff, as well as all of the bonds being held by the bank, which can be captured by the depositors. The incentive constraint for the bankers to not abscond with the deposits then is:

$$(1-\gamma)(1-\tau_{t+1})(\pi_{t+1}-\kappa)k_t \le (1-\tau_{t+1})(\pi_{t+1}-\kappa)k_t + \delta_{t+1}\beta_t - (1+i_t^d)d_t. \tag{14}$$

Holding with equality, this puts a constraint on the leverage of the bank.

4.3   Interbank markets and bailouts

Of the potential bankers, the ones who do not become bankers are instead financiers. They have capital n' at date t but are not matched with firms. They then arrive in period $t+1$ with only one possible use for this capital: to lend it to the matched banks in an interbank market. These loans can then be used for loans to make-do investment that is paid back at the end of the period. For simplicity, again I assume that the financier captures all of the payoff from make-do investment, although this is inessential.

Financiers are senior relative to deposits. As in the real world, on account of being better informed, wholesale funders of banks are quicker to run than depositors. Moreover, make-do investment cannot be absconded with by the banker making the loans, since the financiers can perfectly monitor the bankers. However, loans in the interbank market require posting margin in the form of government bonds, the only traded financial asset in the economy. In particular, letting x_{t+1} be the amount lent in the interbank market, and the margin be ξ, then the following constraint must be met:

$$(1-\xi)x_{t+1} \le \beta_t \delta_{t+1}. \tag{15}$$

Interbank markets give rise to a moral hazard problem. Because it is socially optimal to undertake k^* of make-do investment, if the bankers do not have the capital to do so, the government will want to give them the missing capital. The government cannot commit not to do it, so that letting T_{t+1} denote the bailout funds, total investment ends up being determined by:

$$f(k_{t+1}) = x_{t+1} + T_{t+1}. \tag{16}$$

This is the fundamental moral hazard problem in the model that regulation tries to solve. Macroprudential policy raises the bonds that banks hold, thus raising their ability to obtain funds in the interbank market to award make-do loans. This lowers the chance of a bailout being needed and the size of this bailout.

4.4   Flow of funds in the economy and the evolution of net worth

Every period, the household gives capital to new bankers, and collects the profits from the firms, the financiers, and a fraction α of the bankers which stops operating. The bankers that cease operation are replaced by new banks with initial capital n given by the household. Therefore, the flow of funds to the household is:

$$z_{t+1} = \alpha(1 - \tau_{t+1})(\pi_{t+1} - \kappa)k_t + (1 - \tau_{t+1})(\pi_{t+1}k'_t - f(k'_{t+1}) + T_{t+1}) - n' - n. \tag{17}$$

The first term is the return from the bankers whose operations cease. The second term is the payoff from the financiers, who only operate for that period and return all the profits from make-do investment, which they received in the interbank market. Bailouts raise their profits, because they reduce the amount of the make-do investment they must finance with their own capital. The third and fourth term are the fixed lump-sum amounts given to all bankers that the household does not control. Recall that entrepreneurs, for simplicity, earned no net profits after paying off their loans. Without this assumption, the expression above would be exactly the same but some fraction of the first two terms would refer to the profits of the entrepreneurs.

The evolution of net worth of the bankers as a whole is then:

$$n_{t+1} = (1 - \alpha)(1 - \tau_{t+1})(\pi_{t+1} - \kappa)k_t + (1 - \alpha)n_t + n. \tag{18}$$

The bankers return to the household a fraction α of their end-of-period net worth, which includes the net worth they had before plus the returns from investment, and receive from

it the injection of new net worth n. Because net worth constrains the ability of the bank to raise deposits and make loans, negative shocks to the right-hand side, propagate into the the next period. This makes financial crises potentially long lived, as in Gertler and Kiyotaki (2010).

5 The indirect fiscal footprint of macroprudential policies

In the full model, the government budget constraint is still the same, given by equation (7). Therefore, the direct fiscal impact of macroprudential policies is the same. The *indirect fiscal footprint* is the change in the tax rate τ_{t+1} required to keep the fiscal surplus s_{t+1} unchanged in response to an increase in β_t. That is, it takes into account how macroprudential policies affect government spending and the tax base, thus requiring changes in the tax rate to satisfy the government budget constraint.

The primary surplus of the government is the sum of the tax revenues minus the bailout costs, and minus some exogenous public spending (g_t):

$$s_{t+1} = \tau_{t+1}(\pi_{t+1} - \kappa)k_t + \tau_{t+1}(\pi_{t+1}k_{t+1} - f(k_{t+1})) - T_{t+1} - g_{t+1}. \tag{19}$$

The fiscal authority chooses the tax rate τ_{t+1}. As for default, the fiscal authority will always want to avoid it. However, there is a limit on the taxes it can charge: $\tau < \bar{\tau} < 1$, understood as a limit on the ability to collect taxes and get the economic agents to comply. If at this maximum tax rate, the fiscal surplus is not enough to pay for the fiscal burden, then default results.

5.1 Effect of macroprudential policies on activity

Banks hold as few bonds as they can. Financing investment is more lucrative than make-do investment, and financiers will not want to give them side payments to convince them otherwise since they would also prefer the government to finance the make-do investment later on. Moreover, because of the liquidity premium of bonds, raising deposits to hold bonds is a loss-making activity. Formally, the derivative of bank's dividends with respect to bonds is:

$$\underbrace{1 - (1 + i^d)q}_{\leq 0 \text{ safety premium}} - \left(\frac{\ell'(1 + i^d)}{1 + i^d - \gamma(\pi - \kappa)} \right) \underbrace{(\pi - \kappa - 1 - i^d)}_{\geq 0 \text{ opportunity cost}} b \leq 0. \tag{20}$$

If the government provided no bailouts, then tighter macroprudential policy would raise k_{t+1} and thus increase economic activity resulting from make-do investment. Instead, government bailouts are given by:

$$T_{t+1} = \max\{0, f(k^*_{t+1}) - \beta_t \delta_{t+1}/(1-\xi)\}. \tag{21}$$

Therefore, tighter macroprudential regulation lowers the extent of the bailout and the likelihood that it is positive. Thus, it implicitly lowers required taxes, which also raises real activity. This is the beneficial side of macroprudential policies.

The cost side of macroprudential policies is that banks investing in bonds lowers their credit to firms and so investment. Moreover, by lowering their profits, it also lowers their ability to raise deposits and thus again the loans they make. Overall, the effect of macroprudential policy on investment is negative.

Lemma 2. *Tighter macroprudential policy reduces investment since:*

$$\kappa k_t = \underbrace{\left(\frac{1+i^d_t}{1+i^d_t - \gamma(\pi_t - \kappa)} \right)}_{\geq 1 \; leverage} n - \underbrace{\left(\frac{\ell'_t(1+i^d_t)}{1+i^d_t - \gamma(\pi_t - \kappa)} \right)}_{\geq 0 \; leveraged \; safety \; premium} b. \tag{22}$$

With more investment, tax revenues rise.

5.2 The indirect fiscal footprint

Combining the positive and negative impacts of macroprudential policy on real activity and tax collections as well as a bailout spending provides the key result of this section.

Proposition 2. *The indirect fiscal footprint of macroprudential policy can be positive or negative, as it is the sum of the effect on repressing lending:*

$$-\frac{\partial \tau(\pi_{t+1} - \kappa)k}{\beta_t} = \tau_{t+1}(\pi_{t+1} - \kappa)\left(\frac{\ell'(1+i^d_t)}{1+i^d_t - \gamma(\pi_{t+1} - \kappa)(1-\tau_{t+1})} \right) \geq 0, \tag{23}$$

and the effect on avoiding bailouts, or lowering their costs:

$$\frac{\partial T_{t+1}}{\beta_t} = -\delta_{t+1}/(1-\xi) \;\; if \; \beta_t < \bar{\beta} \; , \; and \; zero \; otherwise \leq 0. \tag{24}$$

Macroprudential policy represses economic activity, which lowers tax revenues, but it also lowers the chances of a bailout. In this sense, it is a precautionary ex ante fiscal policy.

In a stochastic model, this would show up as a mean-variance trade-off. On the one hand, macroprudential policies may lower the expected mean of tax collections, but on the other hand they lower the incidence and severity of the tail events when bailouts are needed.

Even without uncertainty, the effect of macroprudential policy depends on whether there is a crisis, of a fiscal or financial nature. The next section defines these terms to study the interaction between the two policy authorities. Before that, the paper discusses dynamic effects.

5.3 The dynamic effect of macroprudential policy

Tighter macroprudential policy lowers bank profits. As banks must hold more bonds, they make losses because they are paying a higher deposit rate than the bond yield. Moreover, they are able to raise fewer deposits, and thus to leverage their net worth as much. As a result a higher β_t lowers n_{t+1}. This in turn implies that less lending will happen that period, and thus less investment takes place that will give output in $t+2$. This effect propagates over time, so that even a temporary increase in β_t affects investment, output, and tax revenues into the infinite future as net worth of bank converges back to its steady state.

Because net worth is the only state variable in the economy, this financial channel is the only dynamic channel present. A richer model with capital accumulation, or nominal rigidities would generate further dynamic propagation mechanism from the side of aggregate supply and aggregate demand, respectively. All combined these dynamic effects would make the positive indirect fiscal footprint of macroprudential policy larger.

At the same time, the fiscal authority could partly respond to the negative direct fiscal footprint by lowering taxes today or in the future. Smoothing the tax rate over time would imply that the return on investment is now higher at all future dates. This is a permanent shock to the profitability of banks that leads to the accumulation of higher net worth. With it comes higher investment, output, and tax revenues. Therefore, the negative direct fiscal footprint would also be larger once dynamic effects are taken into account.

6 The interaction between fiscal and macroprudential authorities

In the simple model, macroprudential policy chooses β_t, while fiscal policy chooses τ_{t+1}. Because of the fiscal footprint, the former affects the choice of the latter. In the simple

model, the only choice that the fiscal authority faces at $t+1$ is whether to allow for default or raise taxes. I assume that the fiscal authority always wants to avoid default, so it will set taxes at their upper bound before default happens. The problem that arises, and which the paper now studies, is how does macroprudential policy affect the taxes that the fiscal authority must charge.

The answer turns out to depend on whether the economy is in a crisis. There are two types of crisis possible, and so four possible scenarios considered in this section.

First, the economy is in a *fiscal crisis* if $\delta_{t+1} < 1$ so there is default on government bonds. This happens when debt is so high that not enough tax revenues can be collected to pay for it:

$$\delta_t B_t > q_t \left[(\pi_{t+1} - \kappa)\bar{\tau} k_t + \bar{\tau}(\pi_{t+1} k_{t+1} - f(k_{t+1})) - T_{t+1} - g_{t+1} \right]. \tag{25}$$

Second, the economy is in a *financial crisis* if $T_{t+1} > 0$ so a bailout is needed. This happens when macroprudential policy was too lax:

$$\beta_t < (1 - \xi)f(k_{t+1}^*)/\delta_{t+1}. \tag{26}$$

6.1   The present-bias for tighter macroprudential policy

The first case is when the economy is in quiet times, as there is neither a fiscal nor a financial crises. In this case, the following result holds:

Proposition 3. *If there is no fiscal or financial crisis, then tighter macropru (higher β) leads taxes to rise (higher τ) if the crowding-out of lending is larger than the price impact, which happens if the elasticity of the safety premium is small enough:*

$$\frac{1}{\kappa k} \times \frac{1 + i^d}{1 + i^d - \gamma(\pi - \kappa)} > \left(-\frac{\ell''(.)}{b\ell'(.)} \right) \times \frac{b}{q}. \tag{27}$$

In quiet times, the indirect fiscal footprint of macroprudential policy is unambiguously positive. Tighter policy lowers credit by banks and thus real activity and tax revenues, forcing the fiscal authorities to raise the tax rate. At the same time, the direct fiscal footprint is, as always, negative. The proposition states the condition for the indirect to exceed the direct footprint at date $t+1$. The overall footprint then propagates over time through the financial channel of net worth accumulation.

There is another subtle interaction with time. The negative direct fiscal footprint operates at date t as the policymaker is rolling over its debt then and benefitting from the higher

bond prices. The positive indirect fiscal footprint occurs instead at date $t + 1$ when the tax revenues fall and the fiscal authorities are forced to raise taxes.

A present biased politician that, in the extreme, cares only about outcomes at date t, will therefore be biased towards tighter macroprudential policy. The negative effects on financial and real activity are only felt in the future. The positive effects of leaving a lower fiscal burden are felt today. Tighter macroprudential policy becomes a tool that a present-biased fiscal authority would be tempted to use to more easily place its bonds.

6.2   Unpleasant macroprudential arithmetics

The second case occurs when there is no financial crisis, but there is a fiscal crisis, since taxes are at their limit ($\tau = \bar{\tau}$) and yet default happens ($\delta < 1$). In this case:

Proposition 4. *If $T = 0$, but $\tau = \bar{\tau}$, then tighter macropru (higher β) makes the fiscal crisis more severe (lower δ) if the price impact is smaller than the crowding-out of lending, as in proposition 3.*

The channels at play are the same as in quiet times, but now instead of a positive fiscal footprint raising taxes, it instead makes default worse. If the indirect fiscal footprint exceeds the direct one, then tighter macroprudential policies by tightening the budget constraint of the government lead to a lower recovery rate on the government bonds.

Imagine then a circumstance where the fiscal authority can commit to a lower upper limit on taxes. This could happen through the election of a fiscally irresponsible politician that refuses to raise taxes. Or it could come about because of a crisis in the collection of fiscal revenues as a result of civil unrest or other institutional failures. More indirect, but with similar effects, would be a sudden realization that the amount of inherited debt to pay is higher than was previously anticipated. A combination of all three of these are typical of countries going through severe fiscal crises.

The macroprudential policymaker will then face a dilemma. Avoiding a financial crisis may require some relatively high β_t. But, lowering the extent of the fiscal crisis calls for lower β_t if the condition in the proposition is met and the total fiscal footprint is positive. The policymaker then faces an unpleasant arithmetics, much like the central bank did in Sargent and Wallace (1981). Preventing default requires it to have looser macroprudential policy than it might have wanted, potentially causing a financial crisis.

This imagined circumstance has some mapping to reality. Historically, periods of high inflation often come together with financial repression (Reinhart and Sbrancia, 2015). Both

are driven by fiscal crises that activate unpleasant arithmetics, both monetary and macro-prudential. The most frequently used policy tool in those times are reserve requirements that force banks to hold a large amount of government liabilities in the form of reserves. This maps directly into β_t in the model, even if it is not often described as a macroprudential policy. The line that separates macroprudential policies from financial repression is a thin one.

More recently, discussions of banking union in Europe have revolved around whether there should be concentration limits on the amount of national debt a bank can hold, or similarly around whether national sovereign debt should stop receiving a zero risk weight in banking regulation. Proponents of these policy reforms point to the European sovereign debt crisis of 2010-12, during which the high bond holdings by banks created a diabolic loop between sovereigns and banks (Brunnermeier et al., 2016; Farhi and Tirole, 2018). Opposers of these policies point to the same crisis, and argue that the ability to use "moral suasion" to convince domestic banks to hold domestic sovereign debt was crucial at the height of the crisis to prevent failed debt auctions and a worse crisis. This argument maps directly into the unpleasant macroprudential arithmetics, even if the tool was not macroprudential policy directly.

6.3 The present absence of conflict

The third case occurs when there is no fiscal crisis, but instead a financial crisis, so government bonds pay in full ($\delta = 1$) but the financial system requires a bailout ($T > 0$).

Proposition 5. *If $\delta = 1$, but $T > 0$ then tighter macroprudential policies (higher β) lead taxes to rise (higher τ) if the crowding-out of lending exceeds the price impact <u>plus</u> the lowering of the bailout size:*

$$\frac{1}{\kappa k} \times \frac{1 + i^d}{1 + i^d - \gamma(\pi - \kappa)} > \frac{1}{q\ell'(.)} \left(-\ell''(.) + \frac{1}{(1 - \xi)\tau k} \right). \tag{28}$$

In a financial crisis, the negative indirect fiscal footprint of macroprudential policy becomes active. Tighter policy lowers the size of the needed bailout, which lowers the fiscal burden. Whether this is enough to now make tighter policy lower or raise taxes depends on the condition in the proposition, but $\partial \tau / \partial \beta$ is unambiguously lower relative to the previous two cases.

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Following the financial crisis of 2008-10, macroprudential policies became tighter in most financial centres. Policies like the liquidity coverage ratio were introduced, capital requirements were raised, and new macroprudential authorities were created while existing ones were expanded. In the United Kingdom, macroprudential policy was moved into the remit of the independent Bank of England, while in the European Union a new supra-national regulator was created, the Single Supervisory Mechanism, to supervise systemic institutions independently form national authorities. All combined, national fiscal authorities across most developed countries were willing to give more independence and tools to macroprudential policymakers.

Proposition 5 rationalizes this movement of power. The prospect of a new financial crisis drove these changes. The fiscal footprint of these tighter policies was smaller, and maybe even negative during these times. Thus, there was no conflict between the fiscal and macroprudential policymakers. Both agreed with tighter policies since financial and fiscal goals coincided.

6.4 The diabolic loop

The final case is when there is both a financial and a fiscal crisis. In that case, the extent of the crisis comes from the solution of a system of two equations, the government budget constraint and the financing needs for make-do investment:

$$\delta_{t+1}B_t = q(\beta_t)\left[(\pi_{t+1} - \kappa)\bar{\tau}k(\beta_t) + \bar{\tau}(\pi_{t+1}k_{t+1} - f(k_{t+1}))\right] - g_{t+1} - T_{t+1}, \qquad (29)$$

$$T_{t+1} = f(k_{t+1}^*) - \frac{\delta_{t+1}\beta_t}{1 - \xi}. \qquad (30)$$

The first equation has a negative relation between T and δ: a higher bailout increases fiscal spending, which lowers the recovery rate on government bonds, making default worse. The second equation also has a negative relation: a worse default lowers the available collateral for interbank markets, which leads to less private make-do investment and raises the extent of the bailout. Both equations are plotted in figure 3 for the relevant case where frictions in the interbank market are severe enough (ξ is large enough).

The intersection of the two curves gives the equilibrium extent of the two crises. By itself, this does not change the sign of the inferences from the previous proposition since now:

Proposition 6. *If there is a twin crisis, tighter macroprudential policies (higher β) worsen default (lower δ) if the crowding-out of lending exceeds the price impact plus the lowering of*

Figure 3: The joint determination of the twin crises
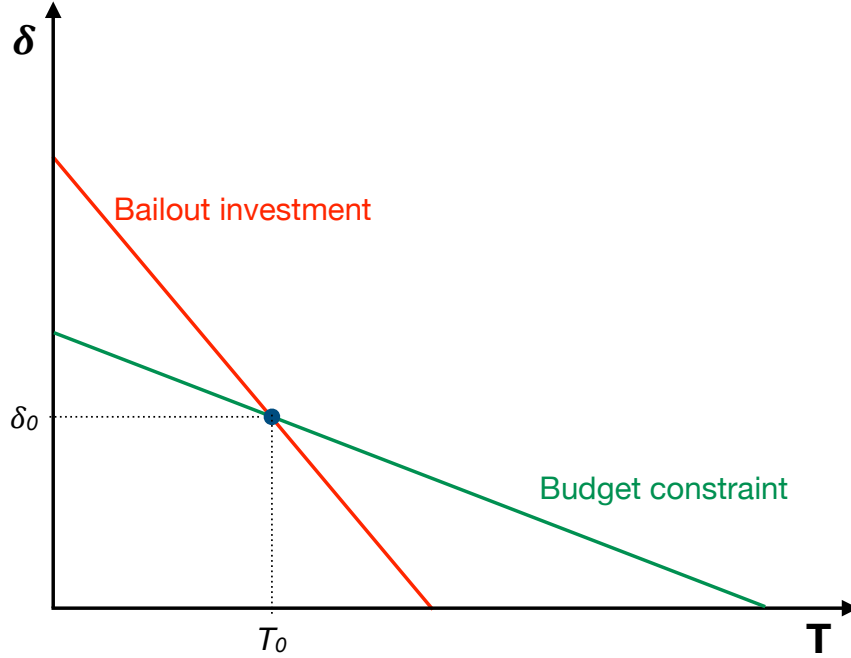

the bailout size, as in proposition 5.

In terms of the model, a higher β unambiguously shifts the investment line to the left, since for a fixed extent of default it increases collateral, raises private make-do investment, and lowers public bailouts. If the conditions in the proposition hold, the budget constraint of the government shifts left as well. The new equilibrium has a worse fiscal crisis, and a smaller financial crisis. Relative to the situation when $T = 0$, given by the intercept with the vertical axis, it is clear that the fiscal footprint is now larger. The financial crisis acts as a multiplier to the fiscal crisis. The reason is that by worsening default, tighter macroprudential default lowers collateral, and thus increases the size of bailouts. The top panel of figure 4 shows this case.

The middle panel of figure 4 instead shows what happens when the reverse condition holds and tighter macroprudential policies has an overall negative fiscal impact. Now the budget line shifts to the left. Again, there is a multiplier effect. By lowering the fiscal burden, macroprudential policy raises δ, which spurs activity in the interbank market and lowers the size of the public bailout.
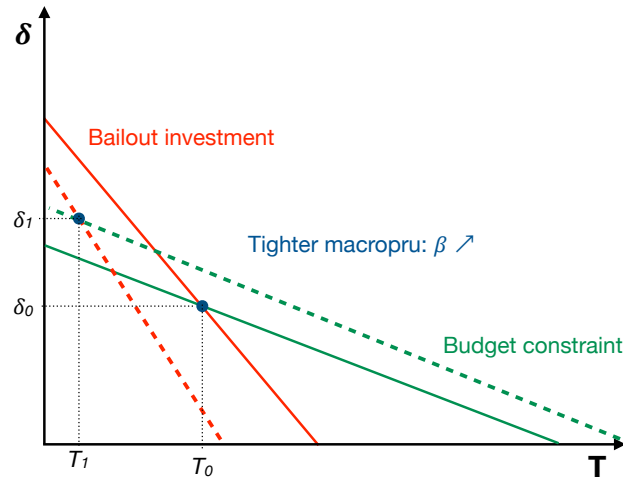
There is a different new dimension to macroprudential policy in a twin crisis. Imagine
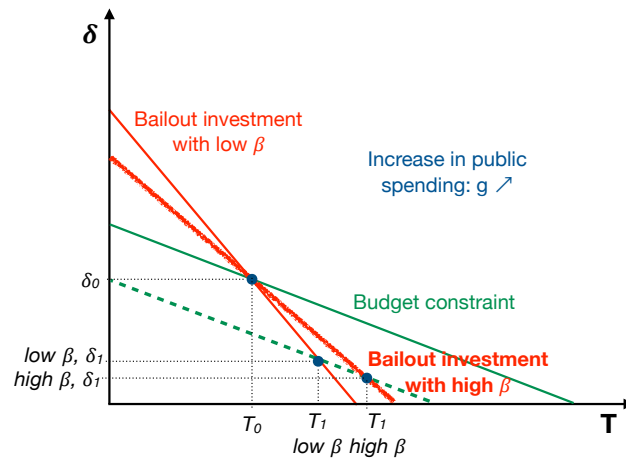
Figure 4: The diabolic loop

(a) Amplification of positive footprint
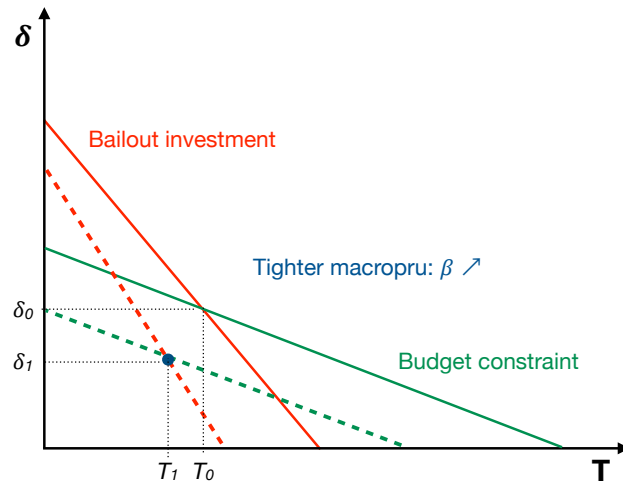
(b) Amplification of negative footprint

(c) Amplification of spending shocks

that public spending is unexpectedly higher (g rises). This shifts the budget constraint curve inwards. Because of the interaction with the investment line, this not only worsens default but also worsens the financial crisis. The reason is the diabolic loop: a worsening of public finances lowers the recovery rate on government bonds, which hurts financial markets, lowers private investment, and increases the size of bailouts.

Tighter macroprudential policy makes the investment curve flatter. As shown in the bottom panel of figure 4, this makes the diabolic loop worse. Because banks hold more bonds, the diabolic loop linking bank and sovereign health becomes tighter. If the g_t shocks dominate the variation in the data, then tighter macroprudential policy would raise volatility in financial markets.

To conclude, in a twin crisis, the fiscal impact of macroprudential policy is amplified. Whether the footprint is positive or negative, and whether fiscal shocks are positive or negative, it is larger. Tighter macroprudential policy enhances them further. Macroprudential policy is a powerful tool with large impacts on fiscal policy.

7   Conclusion

The model in this paper highlighted three fiscal footprints of macroprudential policy. First, tighter policy makes rolling over the public debt easier by rising the price of government bonds. Second, tighter policy reduces bank lending, investment, real activity, and future tax collections. Third, tighter policy lowers bailout costs, or their likelihood. Each of these three effects then propagates over time through their impact on the net worth of banks.

Compared to monetary policies, macroprudential policies have a comparable fiscal footprint. The direct footprint from conventional monetary policy is more negative because it also contributed to inflating some of the real value of the debt. The direct fiscal footprint from quantitative easing is less negative if there is unexpected default because some of the fiscal benefits of not repaying the debt in full are lost if that debt is held by the central bank instead of banks.

The spillover from the actions of an independent macroprudential regulator to fiscal policy take different shapes inside or outside of crisis. If there is neither, the model suggests that the more present biased are the politicians in charge of fiscal policy, the more they will favor tighter macroprudential policy in order to be able to roll over the debt. If there is a fiscal crisis, then an unpleasant macroprudential arithmetics can take over whereby macroprudential policy is dominated by the fiscal needs. In both cases, macroprudential

policy becomes close to financial repression, whereby the ability to influence the amount of bonds held by banks is actively used for fiscal gains.

Under the shadow of a financial crisis, macroprudential policy gains independence because preventing problems in the financial system will tend to ease the fiscal burden as well. A coincidence of goals between macroprudential and fiscal policymakers calls for tighter policies.

Instead, with a twin crises, a diabolic loop between banks and the sovereign amplifies the fiscal impact of macroprudential policy. Moreover, tighter macroprudential policy enhances the loop, and so makes fluctuations in the extend of the fiscal crisis more volatile.

This rich set of interactions can serve as the foundation for future work to study the adequate institutional design of macroprudential policy. Future research can build on them to ask whether and when macroprudential policy can be independent of fiscal policy, and whether it may be better for society to have macroprudential policy be set by the central bank, the Treasury, or an independent third agency.

Future research can also investigate specific macroprudential policies. This paper mapped how a proxy for these policies, in the form of the government bonds held by banks, maps into a fiscal footprint. Describing the further map from each individual policy to this proxy allows for quantifying the footprint of these policies.

References

Balloch, Cynthia Mei. 2015. "Default, Commitment, and Domestic Bank Holdings of Sovereign Debt." Columbia University manuscript.

Bénétrix, Agustín S., and Philip R. Lane. 2015. "Financial Cycles and Fiscal Cycles." Trinity College Dublin, Department of Economics Trinity Economics Papers 0815.

Bianchi, Javier, and Enrique G. Mendoza. 2018. "Optimal Time-Consistent Macroprudential Policy." *Journal of Political Economy*, 126(2): 588–634.

Bolton, Patrick, and Olivier Jeanne. 2011. "Sovereign Default Risk and Bank Fragility in Financially Integrated Economies." *IMF Economic Review*, 59(2): 162–194.

Bordo, M.D., and C.M. Meissner. 2016. "Fiscal and Financial Crises." Vol. 2 of *Handbook of Macroeconomics*, Chapter 0, 355–412. Elsevier.

Brunnermeier, Markus K., Luis Garicano, Philip Lane, Marco Pagano, Ricardo Reis, Tano Santos, David Thesmar, Stijn Van Nieuwerburgh, and Dimitri Vayanos. 2016. "The Sovereign-Bank Diabolic Loop and ESBies." *American Economic Review Papers and Proceedings*, 106(5): 508–512.

Cagan, Phillip. 1956. "The Monetary Dynamics of Hyperinflations." In *Studies in the Quantity Theory of Money.* , ed. Milton Friedman, 25–117. The University of Chicago Press.

Farhi, Emmanuel, and Iván Werning. 2016. "A Theory of Macroprudential Policies in the Presence of Nominal Rigidities." *Econometrica*, 84: 1645–1704.

Farhi, Emmanuel, and Jean Tirole. 2018. "Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops." *Review of Economic Studies*, 85(3): 1781–1823.

Gertler, Mark, and Nobuhiro Kiyotaki. 2010. "Financial Intermediation and Credit Policy in Business Cycle Analysis." In *Handbook of Monetary Economics.* Vol. 3, , ed. Benjamin M. Friedman and Michael Woodford, Chapter 11, 547–599. Elsevier.

Hall, Robert E., and Ricardo Reis. 2015. "Maintaining Central-Bank Solvency under New-Style Central Banking." *NBER Working Paper 21173*.

Hilscher, Jens, Alon Raviv, and Ricardo Reis. 2014. "Inflating Away the Public Debt? An Empirical Assessment." *NBER Working Paper 20339*.

Jeanne, Olivier, and Anton Korinek. 2019. "Managing credit booms and busts: A Pigouvian taxation approach." *Journal of Monetary Economics*, forthcoming(forthcoming): forthcoming.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen. 2012. "The Aggregate Demand for Treasury Debt." *Journal of Political Economy*, 120(2): 233 – 267.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen. 2015. "The impact of Treasury supply on financial sector lending and stability." *Journal of Financial Economics*, 118(3): 571–600.

Peydro, Jose-Luis, Francesc Rodriguez-Tous, Jagdish Tripathy, and Arzu Uluc. 2019. "Macroprudential policy and the housing market - Evidence from the UK." Bank of England.

Radde, Sören, Cristina Checherita-Westphal, and Wei Cui. 2015. "Government Bond Liquidity and Sovereign-Bank Interlinkages." Sonderforschungsbereich 649, Humboldt University SFB 649 Discussion Papers.

Reinhart, Carmen M, and M Belen Sbrancia. 2015. "The liquidation of government debt." *Economic Policy*, 30(82): 291–333.

Reis, Ricardo. 2017. "QE in the Future: The Central Bank's Balance Sheet in a Fiscal Crisis." *IMF Economic Review*, 1–42.

Sargent, Thomas J., and Neil Wallace. 1981. "Some Unpleasant Monetarist Arithmetic." *FRB Minneapolis Quarterly Review.*

Svensson, Lars E. O. 2018. "Do Amortization Requirements Benefit Well-Off and Hurt Liquidity-Constrained Housing Buyers?" Stockholm School of Economics.

Wallace, Neil. 1981. "A Modigliani-Miller Theorem for Open-Market Operations." *American Economic Review*, 71(3): 267–74.