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"Fear of Sovereign Default, Banks, and Expectations-Driven Business Cycles"

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Fear of Sovereign Default, Banks, and Expectations-driven Business Cycles

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Abstract

What is the effect of the fear of future sovereign default on the economy of the defaulting country? The typical sovereign default model does not address this question. In this paper we wish to explore the possibility that changing expectations about future default themselves can lead to financial stress (as measured by credit spreads) and recessionary outcomes. We exploit the "news-shock" framework to consider an environment in which sovereign debt-holders receive imperfect signals about the portion of debt that a sovereign may default on in the future. We then investigate how domestic banks can play a role in transmitting the expectation of default into a realized recession through the interaction of the domestic banks' holdings of government debt and their risk-weighted capital requirements. Our results suggest that, consistent with the data, even in the absence of actual realized government default, an increase in pessimism regarding the prospect of future default results in a rise in yields on government debt and an increase in interest rates on private domestic loans, as well as a recession in the economy.

KEYWORDS: expectations-driven business cycles, sovereign defaults; financial intermediation, news shocks, business cycles, interest rate spreads, capital adequacy requirements.
JEL CLASSIFICATION: E3, E44, F36, F37, F4, G21

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1 Introduction

International capital markets began anticipating a default by Greece (and potentially by other nations in the Euro zone) on its sovereign bonds months and even years before the actual event in early 2012. Over time, discussions in the financial press went from "will a default occur?" to "when the default occurs, how big will the losses be?" Over this period, Greece faced high and rising interest rates on its sovereign debt. The yield on ten year Greek sovereign bonds crossed over 10 percent in July 2010 and steadily increased to over 29 percent by February 2012. Meanwhile comparable rates in Germany (which shares a common currency and monetary policy) fell from 2.6 percent to 1.85 percent over the same period. In addition to the high yield, there was considerable volatility in the sovereign bond market driven by substantial uncertainty around the size of the eventual default. Each announcement by political leaders in Europe or by supra-national institutions like the IMF or the ECB (around, for example, the probability or size of a bailout fund for Greece) would cause dramatic swings in the yield on Greek bonds. This period also witnessed an ongoing and deepening recession in Greece in advance of any actual default by the government while interest rates on bank loans to private agents rose.

Data from other nations in the Euro-zone display similar patterns: rising yields on sovereign debt are accompanied by drops in economic activity as well as a rise in credit spreads (ie., the difference between bank deposit rates and loan rates). Starting with Greece in mid 2009, interest rates paid by the governments of Ireland and Portugal in 2010 and eventually by Spain and Italy spiked relative to German bonds. Figure 1 shows the interest rates on 10-year government bonds for Germany, Portugal and Greece. Figure 2 displays the behaviour of aggregate output while Figure 3 plots credit spreads for these countries [1]

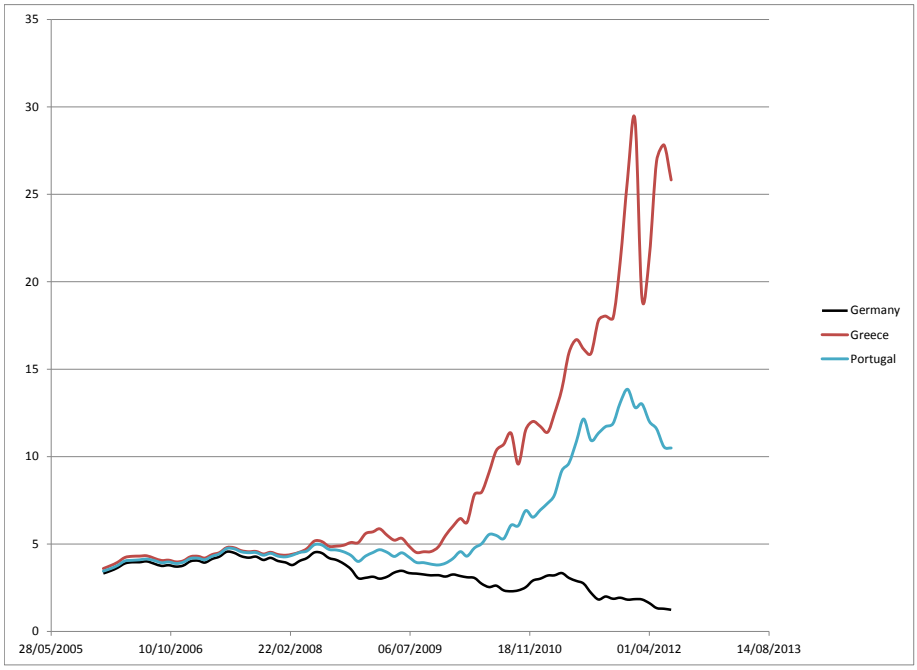
Motivated by these observations from the Euro-zone debt crisis, we propose a quantitative model that can explain these features of the data. We wish, in particular, to explore the possibility that **merely** the expectation of future default by a sovereign government could be responsible for a recession in the periods prior to the default event. We note that this is in contrast to the sovereign default literature where recessions occur either due to the disruptions caused by the default after it occurs or occur exogenously due to a sequence of bad endowment shocks.[2]

Rather than revisiting the long literature on why or when government defaults occur, we wish to take the possibility of defaults as given and explore a number of potential consequences of the uncertainty around the size of future losses that are anticipated by bond-holders, often termed "haircuts" in the financial press. We model the pay-off on government bonds as an exogenous process, and think of the

[1] Indeed these patterns are not restricted to the euro-zone. Similar phenomena can be seen in earlier Latin American crisis episodes. The emerging economy business cycle literature emphasizes the role of fluctuation in sovereign debt yields as a source of recessions (see Garcia-Cicco et al. (2010), Neumeyer and Perri (2005), Uribe and Yue (2006) and the references therein).

[2] See Mendoza and Yue (2012), Yue (2010), Arellano (2008), etc for models of sovereign defaults. Some models actually have sequences of declining TFP but we include them in our statement above since output would fall in these cases even if agents did not change their input decisions. Sosa-Padilla (2012) is an interesting exception in this literature because the sovereign's default causes a credit crunch in banks which leads to a fall in output.

Figure 1: Spreads vs. Germany - Ten year govt bond yield



influences on the pay-off to include any event which may impact bondholders' real return including external bail-out funds which may reduce the size of the haircut. While this notion is most directly linked to an actual default on debt obligations, it can also more generally be thought to include other possibilities such as the impact of a change in exchange rate regime. This case is especially relevant in the context of the EU crisis as bondholders of peripheral EU countries fretted about the impact on their real returns of these debt-issuing countries exiting the Euro. By treating the bond payoff as exogenous, we are following a long history of researchers who incorporate exogenous default, such as Duffie and Singleton (1999), who treat default as an unpredictable event governed by a hazard-rate process, or Iacoviello (2010) and Kollmann et al. (2011) who incorporate exogenous default in a structural business cycle framework closer to ours. While many strides have been made by researches such as Mendoza and Yue (2012) in incorporating endogenous default into business cycle models, we think that treating default as an exogenous stochastic process is reasonable in the context of the EU crisis, given the myriad external actors and institutions involved in determining the prospect and size of default for a given EU member country. Furthermore by doing so, we can then explicitly investigate the role of uncertainty about default by following the approach of the news-shock literature whereby agents receive imperfect signals about future realizations of some stochastic process. In particular, we present a model where agents receive imperfect signals that alter their expectation about future payoffs to holding government bonds.

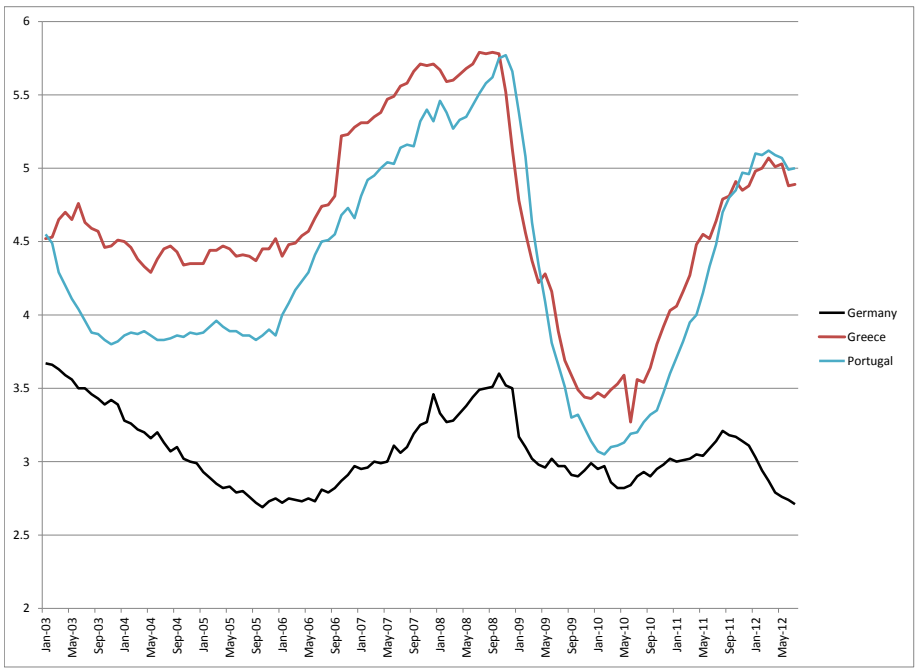
While it is clear why fear of default would lead to an increase in the interest rate charged by lenders to (say) the government of Greece, it is not necessarily obvious

Figure 2: Constant price GDP, index

why this fear might lead to higher borrowing costs for private sector agents. This issue is side-stepped in the two literatures that are closely related to our work: the sovereign default literature as well as the emerging economy business cycle literature. For example, Mendoza and Yue (2012), perhaps the leading work on the relationship between business cycles and sovereign defaults, force the link between the two interest rates by assuming that the defaulting government can divert the repayment of private loans, so that, in effect, both government and private agents default at the same time. Since lenders make losses on both public and private debt, interest rates on both are forced to rise together. See Neumeyer and Perri (2005) for another example. An alternative approach involves assuming away the distinction between sovereign debt and private debt as in Uribe and Yue (2006).

Instead of forcing the two sets of interest rates to move together, we propose an alternative way to link them based on actual institutional arrangements. The link arises from the presence of domestic banks that borrow funds in order to make loans to both private firms and to the domestic government in a small open economy model. A crucial innovation is the introduction of bonds which have long maturity dates. In the typical DSGE model with government debt, it is standard to have bonds that mature in one period. In this setting, if agents anticipate defaults on bonds several periods out, then there is no need for them to react in the bond market until the period immediately before the actual default is expected to occur since these assets don't yet exist as part of loan portfolios. In contrast, in the case of a long bond, when news arrives today about the size of the "haircut" on future defaults, the price of the long bonds will plunge in order to compensate buyers for the lower future expected

Figure 3: Domestic bank credit spread: bank rate (1-5 year loans) less deposit rate (overnight rate, new business)



return, and existing bond-holders will be forced to take a capital loss immediately since these long bonds are part of existing loan portfolios. We build long maturity bonds into the model following the approach of Hatchondo and Martinez (2009) by assuming that government bonds pay an infinite stream of coupons that decay at a fixed rate. If domestic banks hold a lot of long term sovereign debt (as is the case in Greece where 60 percent of government debt is held domestically), then their balance sheets will take a large hit when news arrives of larger future sovereign defaults. Further, if the loss of bank equity/capital leads to tighter credit conditions such that loan rates rise relative to the safe rate, firms will borrow and invest less to compensate for rising borrowing costs, leading to a drop in demand for goods.

Why might a loss of bank capital lead to tighter credit conditions? In practice, banks face regulatory restrictions on their balance-sheet based on the so-called Basel Accords. One particular regulation that is relevant here is the capital adequacy requirement. We reflect this constraint in our model by assuming that banks are constrained in the amount of risk weighted loans that they can extend relative to the value of their equity, such that equity must be at least some fraction γ of risk-weighted loans, where γ might typically be a number like 8% [3] [4]. As a result, a

[3]In practice government debt is assigned a zero risk weighting so that banks can include government bonds in equity, but they do not count them in as part of risk-weighted loans. This may be one reason why banks hold so much sovereign debt.

[4]Iacoviello (2010) shows how one can alternatively think of this constraint as a standard collateral constraint on bank loans

fall in government bond prices lowers equity without lowering risk-weighted loans. Assuming banks face significant costs in deviating from the regulatory constraint, banks thus have a strong incentive to reduce dividend payments in order to increase the proportion of loans that are financed with its own funds as opposed to those of depositors [5]. Banks can thus use their funds to reduce deposits for a given level of loans, or increase loans for a given level of deposits. Yet since using its own funds to increase loans raises not just equity but also its fractional loan restriction, the contribution of loans to loosening the bank's constraint is only $1 - \gamma$ of what is obtained from reducing deposits, and thus the loan rate rises relative to the deposit rate to reflect this asymmetry at the margin.

Our bank capital requirement assumptions above are standard in the literature. For example, banking with capital constraints are studied by Mendoza and Quadrini (2010) (henceforth MQ) in a two country model. Like us, banks cannot issue equity in MQ so they must adjust their deposit and loan portfolios when the price of a fixed capital stock exogenously and unexpectedly falls. While banks in MQ carry a fixed capital stock whose price varies exogenously, banks in our set-up hold government bonds whose value is governed by a budget constraint for the government. Moreover MQ does not deal with news shocks.[6]

In order to be relevant for nations in the Euro-zone periphery, our small open economy (SOE) model has a fixed exchange rate and the features mentioned above. We have calibrated the model to nations in the Euro-zone periphery that have seen recent spikes in their sovereign debt yields: Greece, Portugal, Ireland and more recently Spain and Italy. Our calibrated model displays large recessions in response to news about an increase in the losses to bondholders on the debt to be defaulted upon two years before the event is expected to occur. The model behaves as described above: on arrival of the news, the price of government debt falls immediately, leading to a persistent fall in bank capital. The bank responds by cutting dividends and by reducing borrowing and lending. Loan rates rise, giving rise to a positive correlation between bank interest rate spreads and sovereign debt yields. Firms cut back on investment spending and hiring so output falls for an extended period. Borrowing from abroad also falls over this period. Perhaps an even more interesting case is the one in which initial fears of a rise in the size of the expected default turns out to be false. This may help to explain the fall in interest rates seen in some countries as fears of widespread default have lessened. Our model displays a large recession and a spike in interest rates on arrival of the news with an eventual recovery of economic activity and a return of yields to their previous levels. This entire episode occurs purely due to movements in expectations without any realized change in actual default size.[7]

[5] A bank that reduces its dividends enough such that they are negative would in effect be issuing equity. We effectively limit this possibility by following the standard practice in the literature of defining the bank's preferences as concave over its dividends.

[6] Enders, Kollman and Muller (2011) study the impact of exogenous loan defaults by firms on the international transmission of business cycles in a model of global banking with capital requirements. Capital constraints are also important in Iacoviello (2011) where bank capital is reduced by making one group of households exogenously default on their loans in a closed economy model without news shocks. See also Gerali et al (2010).

[7] In order to focus on the issues at hand we have omitted a discussion of anticipated fiscal policy which is relevant but also better understood. See for example, Leeper and Walker (2011).

Our model builds on the news shock literature popularized by Beaudry and Portier (2004, 2006) where agents receive news about future changes in aggregate TFP. News shocks about TFP in an open economy context are studied in Jaimovich and Rebelo (2008) and Beaudry et al. (2011). Durdu et al. (2010) study news about future endowment shocks in a model of sovereign default. Unlike these models, we focus on news about financial variables in a model where bank capital plays a crucial role in transmitting news shocks to the real economy. The focus on financial news as a source of business cycles is shared by Gunn and Johri (2011a,b) and by Gunn and Johri (2013) in fairly different closed economy contexts.

In the next section we present our model. Section 3 discusses how we parameterize the linearized model. Section 4 concludes.

2 Model

The economy is composed of four types of agents and a single produced good used for consumption and investment. The agents in the economy are households, firms, banks and the government. The economy can borrow and lend abroad at an exogenously given real interest rate. While all agents other than the government behave competitively, for notational simplicity we will have only one agent of each type in the economy.

2.1 Household

The representative household has access to a unit time endowment every period which can be devoted to working at a firm for N_t hours or used to consume leisure. Each period, preferences are defined over sequences of consumption C_t and leisure, $1 - N_t$ with expected lifetime utility defined as

$$\mathcal{U} = E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t), \tag{1}$$

where β is the household's subjective discount factor and the period utility function $U(C_t, N_t)$ follows the class of preferences described in King, Plosser and Rebelo (1988).

The household enters into each period with total assets, A_t, all of which are held as deposits with the domestic bank where they earn the riskless net interest rate rate, r_t^d. It receives the wage rate w_t for supplying N_t hours to the goods-producing firm, and receives any profits earned by the firm as the firm's owner as a lump sum payment denoted as Π_t. At the end of the period, the household uses this income for consumption, C_t, to pay lump-sum taxes to the government, T_t and the remainder, A_{t+1}, is deposited with the bank.

The household's period t budget constraint is given by

$$C_t + A_{t+1} = (1 + r_t^d)A_t + w_t N_t + \Pi_t - T_t, \tag{2}$$

where the interest rate r_t^d on current deposits is known at the time the deposit is made.

The household's problem is to choose sequences C_t, N_t, and A_{t+1} to maximize (19) subject to (2), yielding the respective first-order conditions

$$u_C(C_t, N_t) = \lambda_t^h \tag{3}$$

$$-u_N(C_t, N_t) = \lambda_t^h w_t \tag{4}$$

$$\lambda_t^h = \beta(1 + r_{t+1}^d) E_t \left\{ \lambda_{t+1}^h \right\}, \tag{5}$$

where λ_t^h refers to the Lagrange multiplier on (2). Since the household problem is standard, we do not discuss it further except to note for future use that (5) implies $\frac{1}{1+r_{t+1}^d}$ is equal to the household's risk-free rate as well as the firm's stochastic discount factor since it is owned by the household.

2.2 Firm

Once again we assume that there is a single competitive goods-producing firm that produces output Y_t using a constant returns to scale technology given by

$$Y_t = Z_t N_t^{\alpha} (u_t K_t)^{1-\alpha}, \tag{6}$$

where N_t is total hours-hired by the firm, K_t is the period t stock of physical capital held by the firm, and u_t is the utilization rate of that capital. Note that our notation anticipates market clearing so that we do not distinguish between quantities on the two sides of the market unless necessary. The firm accumulates capital via the following accumulation equation

$$K_{t+1} = [1 - \delta(u_t)] K_t + I_t, \tag{7}$$

where the function $\delta(\cdot)$ imposes a cost on the firm for increasing capacity utilization in the form of increased depreciation of capital, such that $\delta(\cdot)$ satisfies the conditions $\delta'(\cdot) > 0$, $\delta''(\cdot) \geq 0$.

To motivate a role for borrowing, we simply follow the practice common in the emerging economy business cycle literature and assume that the firm must borrow some fraction τ of its capital stock in advance of production [8], such that it faces the constraint

$$L_{t+1} \geq \tau K_{t+1}. \tag{8}$$

One interpretation of this constraint is that the amount τK_{t+1} represents the firm's ongoing working capital requirements, which by virtue of pre-determination, must be financed in advance of production the following period. Thus in period t the firm must borrow an amount L_{t+1} from the bank at the non-contingent rate r_{t+1}^L, paying back both the principal and interest the following period.

Based on the structure above, the firm's profit in period t is given by

$$\Pi_t = Y_t - (1 + r_t^L) L_t - w_t N_t - I_t + L_{t+1}. \tag{9}$$

[8] We could motivate an alternative motive for firm-borrowing using one of the many alternative options in the literature without changing the fundamental mechanism in our model.

The firm chooses labour (N_t), capital (K_{t+1}), and loans (L_{t+1}) to maximize current and expected future profits,

$$\sum_{s=0}^{\infty} \beta^{t+s} \frac{\lambda_{t+s}^h}{\lambda_t^h} \Pi_{t+s}, \tag{10}$$

subject to the borrowing constraint and the capital accumulation equation, taking all prices and interest rates as given. Note that the term $\beta^{t+s}\frac{\lambda_{t+s}^h}{\lambda_t^h}$ is the household-owner's stochastic discount factor. The firm's problem yields the following first-order conditions

$$w_t = \alpha \frac{Y_t}{N_t} \tag{11}$$

$$\delta'(u_t)K_t = (1-\alpha)\frac{Y_t}{u_t} \tag{12}$$

$$1 + q_t^{lf} = \beta(1 + r_{t+1}^L)E_t \frac{\lambda_{t+1}^h}{\lambda_t^h} = \frac{(1 + r_{t+1}^L)}{(1 + r_{t+1}^d)}, \tag{13}$$

$$1 + \tau q_t^{lf} = \beta E_t \frac{\lambda_{t+1}^h}{\lambda_t^h} \left\{ (1-\alpha)\frac{Y_{t+1}}{K_{t+1}} + 1 - \delta) \right\}, \tag{14}$$

where q_t^{lf} refers to the lagrange multiplier on the borrowing constraint. Since the firm is owned by the household, it evaluates future profits at the same rate as the household evaluates an extra unit of consumption in the future.

The second equality in (13) uses this relationship as was discussed at the end of the previous sub-section. Equation (13) makes clear why the cost of borrowing one unit of goods is higher than unity for the firm : it must pay more to the bank for this good than is valued by the actual owners of the firm for whom it is investing in physical capital. It also makes clear why a rise in the credit spread will raise the borrowing costs for the firm and make them more reluctant to invest, a point to which we will return when discussing the results of the model. While the interpretation of the remaining first order conditions is obvious, we note that combining (13) and (14) to eliminate q_t^{lf} makes clear that the cost of an additional unit of capital is not merely the current lost profits (which are less than a unit of profit since the firm can borrow the rest) but also the future loan payments which depend on the going interest rate when the loan is contracted.

Regarding the firm's inequality borrowing constraint, because the household owns the firm, and thus the firm discounts its dividends with the household's stochastic discount factor, the bank could potentially obtain funds at opportunity cost r^d directly from the household by lowering its profits. Since in the steady state we consider $r^L > r^d$, given some need for funds, the firm wouldn't borrow from the bank at r^L when it can alternatively obtain funds from the household at a lower rate. Outside of steady, we consider episodes where r^L rises above r^d when expectations of default rise, and thus this argument becomes more pronounced. Thus we only consider an equilibrium where this constraint holds with equality, such that

$$L_{t+1} = \tau K_{t+1}. \tag{15}$$

2.3 Government

The government finances its spending G_t through lump-sum taxation T_t and new-debt issues in the form of long-duration bonds. To model the long-bonds in a tractable way, we follow the approach of Hatchondo and Martinez (2009) in assuming that each period the government issues bonds that provide an infinite stream of future coupons that decline at a constant rate δ_g. The government's accumulated sum of past bond contracts then summarizes its accumulated debt obligations in a single state variable. As discussed by Hatchondo and Martinez (2009), this particular coupon structure is a tractable way of approximating the debt-portfolio dynamics of a government that issues a portfolio of zero-coupon bonds of different maturities, where the proportion of bonds of a given maturity declines geometrically with maturity. As such, the rate of decrease of the coupon payment, δ_g, is associated with the average duration of the portfolio and thus can be tied down to the observed duration in the data.

The details of the government's financing are as follows. Each period, the government finances its spending G_t and coupon payments on accumulated debt B_t^g through lump-sum taxation T_t and new bond issues I_t^g, where each bond is a promise to pay $(1-\delta)^{s-1}$ units of consumption each future period $t+s$, where $s \geq 1$. Additionally, we allow the government to default on some fraction θ_t of its existing obligations. Since its existing obligations are long-duration bonds, they entail both current and future coupon payments, and thus a *current* default in outstanding debt obligations at time t impacts both current and future coupon payments for all bonds contracted in the past up to and including period $t-1$. A *current* default θ_t does not, however, impact coupons payments of new or future issuances. As discussed in the introduction, we represent this fractional default θ_t parameter as an exogenous process.

In any period t, the government's accumulated debt obligations are the sum of its entire history of past issuances and defaults,

$$B_{t+1}^g = I_t^g + \sum_{j=1}^{t} \theta_{t-j}(1-\delta^g)^j I_{t-j}^g = \theta_{t-1}(1-\delta^g)B_{t-1} + I_t^g. \tag{16}$$

We can then summarize the government's behaviour with its period t budget constraint,

$$G_t + \theta_t B_t^g = T_t + q_t^g I_t^g, \tag{17}$$

where q_t^g is the price of the long-duration bond, and its evolution of debt obligations,

$$B_{t+1}^g = \theta_t(1-\delta^g)B_t^g + I_t^g. \tag{18}$$

Note that the default parameter θ appears both in the budget constraint (17) as well as the debt obligation accumulation equation (18). This reflects the assumption that a default in period t affects both the current coupon payments on historical contracts made prior to period t (budget constraint) as well as the future coupon payments for these same historical contracts (debt accumulation). Note however that a default in period t does not affect the coupon payments associated with current and future issuances, I_{t+s} for $s \geq 0$.

In the current version of the model, we take both government tax policy T_t and the value of new debt issues $q_t^g I_t^g$ as exogenous, such that each period, government

spending G_t adjusts to satisfy the government budget constraint. This assumption has the advantage of isolating the banking-channel transmission of changes in the yield on government debt by removing any income effects on the household that would otherwise be associated with endogenously fluctuating taxes T_t which are relatively well understood[9].

2.4 Bank

The representative bank has preferences defined over sequences of consumption D_t with expected lifetime utility defined as

$$\mathcal{U}^b = E_0 \sum_{t=0}^{\infty} \beta^{bt} v(D_t), \tag{19}$$

where $\beta^b < \beta$ is the bank's subjective discount factor.[10] Here the period utility has the form

$$v(D_t) = \frac{1}{1-\sigma^B}\{D_t^{1-\sigma^B} - 1\}. \tag{20}$$

Each period, the bank makes 1-period loans L_{t+1} to the firm at risk-free rate r_t^L, in addition to purchases of new long-duration bonds, I_t^b, from the government. The bank's accumulated stock of government bonds, B_t^b, follows an analogous process to that of the government,

$$B_{t+1}^b = \theta_t(1-\delta^g)B_t^b + I_t^b, \tag{21}$$

where government defaults θ_t reduce the bank's outstanding holdings of government debt.

The bank finances these loans with 1-period deposits from the household at risk-free rate, r_t^d, from 1-period international borrowing, B_{t+1}^w at risk-free rate r_t^w, as well as its own end-of-period equity E_{t+1}.[11] The bank's end-of-period equity is defined as

$$E_{t+1} = L_{t+1} + q_{t+1}^g B_{t+1}^b - A_{t+1} - B_{t+1}^w. \tag{22}$$

We follow Kollmann et al. (2011) in assuming that the bank faces a capital requirement in the form of a penalty ϕ_t for deviating from some desired bank capital ratio, $\frac{E_{t+1}}{L_{t+1}} = \gamma$. Letting $x_t = E_{t+1} - \gamma L_{t+1}$, we assume that ϕ_t is defined as a convex adjustment cost according to

$$\phi_t = \phi(x), \phi'' > 0, \phi(0) = 0. \tag{23}$$

As is standard in small open economy models, the world interest rate is taken as given. Overall the small open economy can borrow or lend as much as it wishes

[9] In other versions of the model we obtain results for this alternate case where G_t is exogenous and T_t fluctuates to satisfies the government budget constraint. In contrast to the current model, increases in the government's debt obligations drive up its taxes T_t, impacting the household directly with a negative income effect. These results are available from the authors upon request

[10] It is quite common to model banks as agents with concave preferences (see Guerrieri et al. (2012), Kollmann (2012) and references within).

[11] Foreign borrowing does not play a crucial role in our story and can be eliminated from the model without adversely affecting model results which are available from the authors upon request.

without affecting the rate. This creates the well-known unit root in foreign bonds, making the quantity of B^W undetermined. To remove this unit-root, we follow the standard solution of including quadratic costs of adjustment $\frac{\psi_w}{2}(B_t^w - B^w)^2$ on B^w around a stationary steady-state level of foreign borrowing.

Based on the above discussion, the bank's budget constraint is

$$\begin{aligned} &D_t + q_t^g I_t^b + L_{t+1} + \frac{\psi_w}{2}(B_t^W - B^W)^2 = \\ &A_{t+1} + B_{t+1}^W + \theta_t B_t^b + (1 + r_t^L)L_t - (1 + r_t^d)A_t - (1 + r_t^W)B_t^W - \phi_t, \end{aligned} \tag{24}$$

where B_t^b evolves according to (21). As in the case of the government, note that the presence of θ in both the bank's budget constraint and as well as the evolution of its government debt holdings (21) means that a period t government default impacts both current coupon and future coupon payments of existing contracted debt.

The bank operatives competitively, taking prices as given to maximize (19) subject to (24), yielding the first-order conditions

$$\lambda_t^B = D_t^{-\sigma^B} \tag{25}$$

$$\lambda_t^B[1 + \phi'(x_t)] = \beta^B(1 + r_{t+1}^d)E_t\lambda_{t+1}^B \tag{26}$$

$$\lambda_t^B[1 + (1 - \gamma)\phi'(x_t)] = \beta^B(1 + r_{t+1}^L)E_t\lambda_{t+1}^B \tag{27}$$

$$\lambda_t^B q_t^g[1 + \phi'(x_t)] = \beta^B E_t\lambda_{t+1}^B\theta_{t+1}[1 + q_{t+1}^g(1 - \delta^b)], \tag{28}$$

$$\lambda_t^B[1 + \phi'(x_t)] = \beta^B E_t\lambda_{t+1}^B(1 + r_{t+1}^W + \psi_w(B_{t+1}^W - B^W)), \tag{29}$$

where λ_t^B is the Lagrange multiplier on (24).

Note from (26) and (27) that the loan rate and deposit rate are related by the expression

$$\frac{1 + r_{t+1}^L}{1 + r_{t+1}^d} = \frac{1 + (1 - \gamma)\phi'(x_t)}{1 + \phi'(x_t)}, \tag{30}$$

and that one impact of the capital sufficiency requirement, γ, is to induce a spread between the loan rate and the deposit rate. Clearly setting $\gamma = 0$ implies the two rates are the same. In the absence of this requirement restricting loans to be a multiple of end-of-period equity, banks would act as a frictionless conduit of funds from the households to firms in the model and variation in the price of government debt, while affecting bank capital, would have little impact on the borrowing costs of firms and through them, on the real economy.

Comparing (26) and (29) reveals that the bank must equate the value of expected borrowing costs associated with deposits from households and borrowing abroad (the right hand sides of the two equations). Since the world interest rate is a constant parameter, any changes to the risk free rate of households (also r_{t+1}^d) must be met by changes in foreign borrowing until the expected costs are equalized.

Note also that (30) reflects the asymmetric impact of loans and deposits on the firm's capital requirement. If the bank wants to increase its capital ratio, it can either maintain its existing level of loans and then forgo consumption to reduce its deposits, or alternatively, maintain its existing level of deposits and forego consumption to increase loans. The impact on the capital ratio of a marginal reduction in deposits is

larger than that of an increase in loans since the former only affects the numerator while the latter affects both numerator and denominator in the same direction. In a similar vein, a shock to government bond prices only affects the numerator of the capital ratio while a change in loans affects both. In the face of a shock to the value of its bond holdings, the bank has a number of margins on which to adjust. It can lower consumption to try to fully absorb the loss of equity but this is painful due to the curvature in the bank's preferences. It can leave loans at previous levels by allowing x to fall but this imposes adjustment costs captured by ϕ on the bank. It can also try to raise equity by borrowing less both from the household and abroad, but this leaves less funds for making loans which in turn further reduces equity. As a result, the bank will adjust on all of these margins so as to satisfy the efficiency conditions listed above. The bank will borrow less and lend less as well as reduce consumption while tolerating a small change in x. By (30) the change in x leads to a rise in r^L over r^d which raises the cost of borrowing for the firm leading it to lower borrowing and invest less in physical capital.

2.5 Stochastic process θ_t

As discussed earlier θ refers to the fraction of the government's debt obligations that it intends to honour. In the parlance of the financial press, $1-\theta$ refers to the size of the "haircut" that existing bond-holders will get when a default occurs. We model the size of the default as an exogenous process which evolves according to the stationary AR(1) process

$$\ln \theta_t = \rho \ln \theta_{t-1} + \mu_t, \tag{31}$$

where $\rho < 1$ and μ_t is an exogenous period t innovation which we will define further below. Note from (28) that negative shocks to θ will cause bond-holders to face a capital loss as the price of government bonds falls to compensate buyers for the lower expected return on their investment. While we will discuss the impact of shocks that are unexpected in this paper we are mainly interested in exploring the role of unanticipated shocks or "news shocks" about the value of θ at future dates which may or may not turn out to be realized. Later, when we parameterize the model, we will assume that the persistence of the shock process is zero so that there are no subsequent haircuts to bond holders that are induced by the current shock.

2.5.1 News shocks

Our representation of news shocks is standard and follows Christiano et al. (2008). We provide for news about θ_t by defining the innovation μ_t in equation (31) as

$$\mu_t = \epsilon^p_{t-p} + \varepsilon_t, \tag{32}$$

where ϵ^p_{t-p} is a news shock that agents receive in period $t-p$ about the innovation μ_t, and ε_t is an unanticipated contemporaneous shock to μ_t. The news shock ϵ^p_t has properties $E\epsilon^p_t = 0$ and standard deviation σ_{ϵ^p}, and the contemporaneous shock ε_t has properties $E\varepsilon_t = 0$ and standard deviation σ_{ε_x}. The shocks ϵ^p_t and $\varepsilon_{A,t}$ are uncorrelated over time and with each other.

2.6 Equilibrium

Equilibrium in this economy is defined by contingent sequences of C_t, N_t, I_t, D_t, I_t^g, A_{t+1}, L_{t+1}, K_{t+1}, B_{t+1}^g, B_{t+1}^w, w_t, r_t^d, r_t^l that satisfy the following conditions: (i) the allocations solve the household's, firm's and bank's problems, taking prices as given, and, (ii) all markets clear.

3 Parameterization

In this section we present an illustrative calibration based on available data from the Euro-zone periphery that we will use in the next section for our simulation analysis. We assign values to parameters using typical values established in the literature, or where there is a lack of precedent, we choose the parameters to match relevant steady state quantities in the model economy with analogous quantities in the data. Finally, we solve the model by using standard methods to linearize the non-linear system about the unique steady state.

We use preferences of the form used by King and Rebelo (2000) where the stand-in representative agent has the preference specification

$$u(C_t, N_t) = \frac{1}{1-\sigma}\left\{C_t^{1-\sigma}\upsilon^*(N_t)^{1-\sigma} - 1\right\}, \tag{33}$$

where $\upsilon^*(N_t) = \left[\left(\frac{N_t}{H}\right)\upsilon_1^{\frac{1-\sigma}{\sigma}} + \left(1-\frac{N_t}{H}\right)\upsilon_2^{\frac{1-\sigma}{\sigma}}\right]^{\frac{\sigma}{1-\sigma}}$, where H is the fixed shift length, and υ_1 and υ_2 are constants representing the leisure component of utility of the underlying employed group (who work H hours) and unemployed group (who work zero hours) respectively. For $\sigma > 1$ these preferences are not separable in consumption and leisure, and for $\sigma = 1$ they reduce down to standard separable indivisible labour preferences with log-consumption and linear leisure. We set the fraction of the population working on average, f^w to 0.6, and the average fraction of the time endowment allocated to market work N_{ss} to 0.3. In our impulse-response analysis, we set $\sigma = 2$, which is within the range of studies reported by King and Rebelo (2000) and equal to the value used in Gunn and Johri (2011a) and Gunn and Johri (2012).

3.0.1 Firm's Parameters

On the production side, we set labour's share in production, $\alpha = .67$ and impose constant returns on the production technology. The depreciation of physical capital, δ is set to the typical value of 0.025. We set the elasticity of capacity utilization, $\epsilon_u = .15$, the value used in Jaimovich and Rebelo (2009) and Gunn and Johri (2011a) and also explore a higher value of 0.56. While we have allowed the possibility for total factor productivity shocks to occur in the model, we do not explore them here so that $Z = 1$ in every period. The firm's problem involves the parameter τ which governs the fraction of the capital stock next period that must be acquired though loans. We target $\tau = .39$ which is chosen so that the loan to annual gdp ratio matches the mean value for the Euro Area as reported by Kollmann et al. (2011) of 0.9. The implied

steady state value for the capital output ratio implied by our parameter choices is 9.3 which is in the usual range of quarterly values used in the business cycle literature.

3.0.2 Government Parameters

Turning to the government, we follow standard practice and set the ratio of government spending to output equal to 0.2 while the fraction of taxes collected by the government in steady state is equal to .285. These values deliver bank holdings of government debt to total bank assets equal to 0.07 which is the value reported for Spain in IMF (2012) and we show sensitivity by picking a higher value so that bank holdings of government debt divided by bank's assets = 0.12 as is found in Greece. In steady state we assume that the government meets its entire debt obligations so that $\theta = 1$. We target the depreciation rate on government bonds, δ_b to match the average duration of bonds seen in the euro-zone periphery. According to Contessi (2012), Portugal, Italy, Spain and Greece had a weighted maturity as of December 31, 2011 of between 5-10 years so we picked 7.5 years for the model to target in steady state. Following Hatchondo and Martinez (2009) the duration in quarters can be calculated from

$$D = (1 + r^g)/(\delta_b + r^g)$$

where D refers to the duation and r^g to the implied constant yield on government debt from the formula:

$$r^g = (1/q^g) - \delta_b.$$

This gives us a value of $\delta_b = 0.023$.

3.0.3 Bank Parameters

The remaining parameters apply to the bank. Data on net external debt as a percentage of gdp varies widely for the Euro-zone periphery nations for the last ten years from about 30 percent to about 90 percent. We picked a conservative value of 50 percent for the steady state external debt to gdp ratio and show sensitivity to increasing this parameter. We vary the adjustment cost associated with changing external borrowing,ψ_w and show it's impact on the model in the next section. Our baseline value is 0.1. It plays no role in steady state but influences how strongly external borrowing reacts to changes in sovereign yields. We set the capital sufficiency requirement to 8 percent based on the so called Basel II documents and explore the impact of changing this number. Kollmann et al. (2011) use a value of 5 percent while Gerali et al. (2010) and Guerrieri et al. (2012) use values of 9 and 10 percent respectively. Turning to ϕ'', we set the baseline value to .25 as in Kollmann et al. (2011) while Mendoza and Quadrini (2010) work with a value of .1. We explore the impact of varying this parameter which governs the adjustment cost of deviating from the steady state capital to loan ratio.

The parameters of the preferences of the bank are $\beta_b = 0.98$ and $\sigma_b = 1$. The spread between the risk free rate paid on deposits and the rate charged on loans by banks are mainly governed by β_b and γ. Related studies work with lower discount factors for the less patient agent (in our case the bank). Guerrieri et al. (2012) use .96

while Gerali et al. (2010) use .975. This allows the steady state spread (the loan rate) to be a bit higher but it does not have a major impact on the quantitative properties of the model so we do not show sensitivity to varying this parameter.

4 Results

In this section we explore the impulse responses of the calibrated model to shocks to the default parameter θ_t. To help illustrate the mechanics of the model, we first begin with a contemporaneous shock to θ before moving on to look at anticipated default using news shocks about θ.

4.1 Contemporaneous shock to θ_t

Figures 4 and 5 show the response of the model economy to a 25% fall in θ_t in period 1, representing an unanticipated 25% drop in the return recieved by government bond-holders in period 1. The shock process has zero persistence, so as indicated in the last panel of Figure 4, θ_t returns to its steady value in period 2. As can be seen from the figure, in response to this one-time shock, consumption, investment, hours-worked and output all drop immediately, and then gradually rise towards steady-state well into the future. Moreover, the loan rate rises and the deposit rate falls, indicating an immediately rise in the credit spread. Interestingly, the price of government bonds q^g rises immediately, implying a *drop* in the implied interest rate on government bonds.

The initial impact effect of the shock works through the bank's budget constraint as an unanticipated drop in the the bank's period t return on its government bond portfolio. Faced with this unanticipated drop in period t income, the bank reduces its consumption in the present, but by an amount less than the drop in income. This consumption-smoothing motive entices it to spread the impact through time, willingly reducing its end-of-period equity in order to pull future consumption into the present.

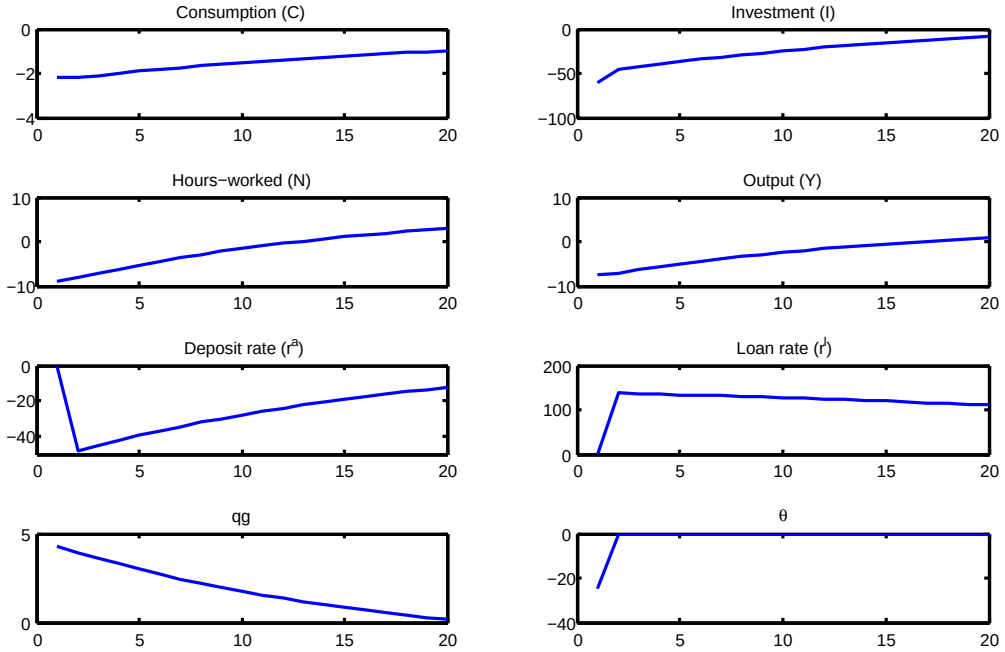
To reduce its end-of-period equity the bank can either increase deposits or decrease loans in the present, yet since a given rise in loans reduces its excess capital by a factor of $1-\gamma$ less than a rise in deposits, to remain indifferent at the margin, in equilibrium the loan rate r^l must rise relative to the deposit rate r^d. As a result, the credit spread $r^l_{t+1} - r^d_{t+1}$ rises immediately.

Taking (13) from the firm's problem and combining with (5) we obtain

$$1 + q^{lf}_t = \frac{(1 + r^L_{t+1})}{(1 + r^d_{t+1})}, \tag{34}$$

which makes clear that the shadow price of borrowing to invest rises with the credit spread. Since the firm's capital Euler equation indicates that the firm's optimal investment schedule is a function of the credit spread (via q^{lf}_t) as well as the level of the risk-free rate, in the face of rising spreads, firms reduce their demand for new investment at the given risk-free rate, which consequently reduces their demand for bank loans. This overall reduction in the demand for credit forces the bank to reduce its overall liabilities, implying that in equilibrium the deposit rate r^d_t falls such that

Figure 4: Contemporaneous fall in θ - plot 1

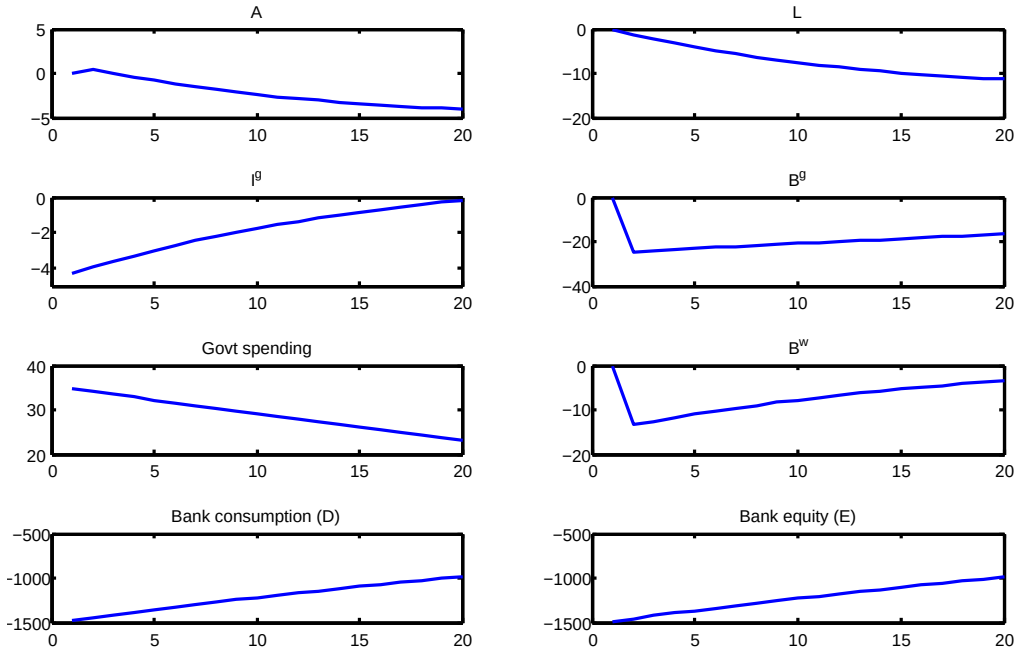


the household is willing to reduce its supply of deposits, signifying an overall reduction in the household's risk-free rate.

This drop in the risk-free rate, r^d, causes the household to reduce its labour supply, which manifests itself as a rise in the real wage (not shown in figure) and a drop in hours-worked. Over time this effect is combined with a drop in labour demand due to the falling capital stock.

While the model response to the contemporaneous shock exhibits some patterns which are consistent with the ongoing Euro-area sovereign debt crisis episode, a few aspects are inconsistent. The government's debt *falls* when the shock hits since the default allows it to fund its obligations with less borrowing. Moreover, the implied interest rate on government debt $1/q^g$ *falls*. The rise in government borrowing and sudden rise in the interest rate on government debt are important features of the sovereign debt crisis which the contemporaneous shock model fails to deliver. Perhaps more fundamentally, while we have eventually observed a realized sovereign default, it did not occur until March 2012, nearly two years after many economies began exhibiting the features of the crisis discussed in the introduction. To address these issues we now turn to the illustrating the response of the model to anticipated rather than unanticipated default.

Figure 5: Contemporaneous fall in θ - plot 2



4.2 Anticipated increase in government default

We now consider the case of anticipated default where agents receive news in advance about a future default. To illustrate the importance of long-bonds in the model, we first consider the case where the government only issues 1-period bonds, corroborating the result of Kollmann et al. (2011) that anticipated default has no real impact in a 1-period bond model economy. We then subsequently consider the full case where the government issues the infinite coupon long-bond.

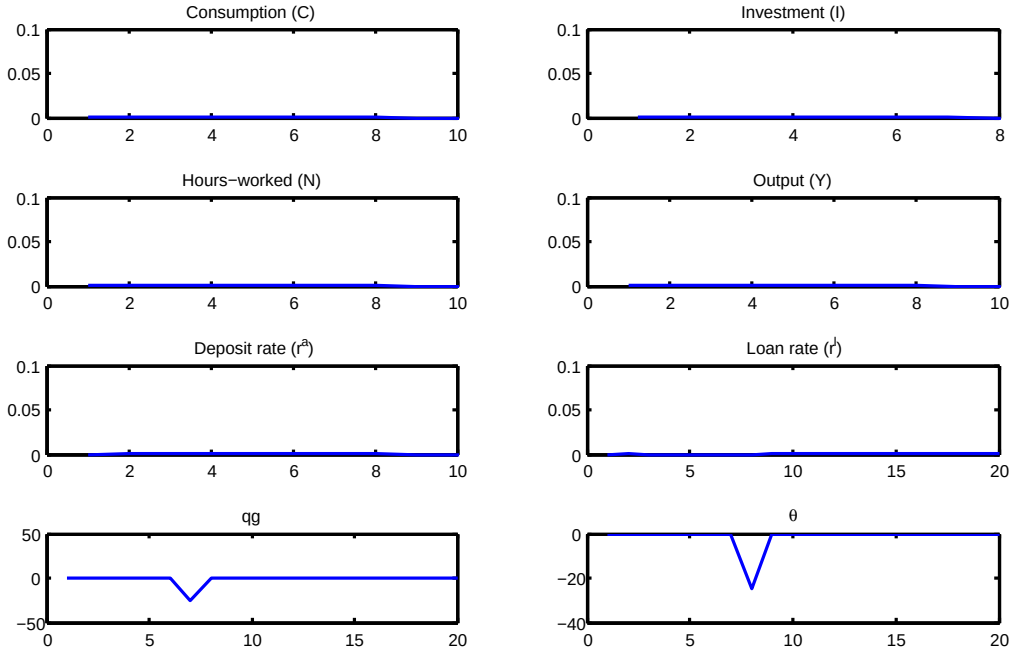
4.2.1 Anticipated increase in government default with 1-period bonds

Figures 6 and 7 show the response to an anticipated default in the 1-period bond model economy which receives a news shock in period 1 that θ will fall by 25% in period 8, and then in period 8 θ does actually falls by 25% [12]. Note that consumption, investment, hours-worked and output fail to move away from steady state in response to either the news shock in period 1 or the realization of of the shock in period 8. In period 7 before the realization, the price of government bonds, q^g, falls for a single period (ie the interest rate on government bonds rises), and as well, the government increases new debt issues I_g, temporarily increasing its stock of outstanding debt B^g.

Unlike in the case of the contemporaneous shock, when the expected default occurs

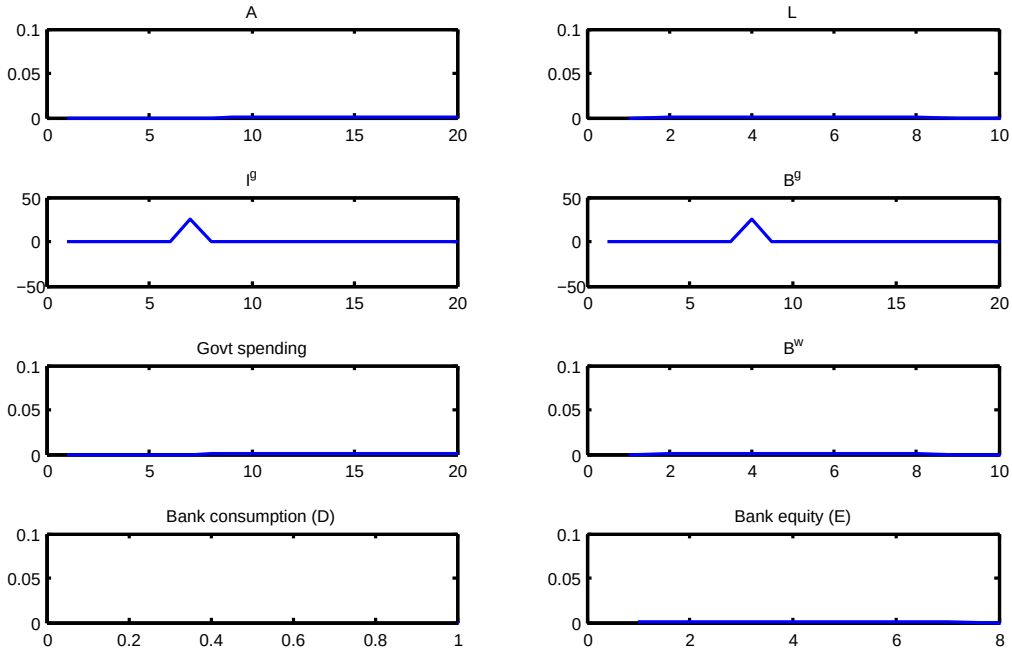
[12] As we discussed earlier, it is straightforward to show that setting $\delta^b = 1$ reduces the infinite-coupon bond to a standard 1-period bond.

Figure 6: News about fall in θ - shock realized: 1-period bond - plot 1



7 periods in the future, the bank experiences no income loss in the current period. More importantly, the bank experiences no income loss even in the default period 8. Since the 1-period bonds are priced each period based on the expected return the following period, when agents receive news in period 1 about the expected fall in θ_t in period 8, they have full knowledge of the drop in expected return, such that when period 7 arrives, the value of a 1-period bond falls in order to reflect the expected loss next period. As a consequence, the change in the bond price has no impact on the bank's equity since the 1-period bonds only sit on the bank's balance sheet for a single period, and the bank trades the bonds at the same time that they are priced. Thus with no impact to the bank, the anticipated default has no impact on the household or the firm. It does, however, impact the government's budget constraint. In period 7 when q^g falls, the government must effectively issue more debt than normal to cover the higher interest rates on bonds that agents believe it will default on. While this temporarily increases the government's outstanding debt, when period 8 arrives, the government defaults on a fraction θ_t of its debt, thus reducing its outstanding stock back to the steady state level. Thus while the anticipated default in this 1-period bond economy does have an effect on the variables associated with the government, there is no impact on the remainder of the real economy.

Figure 7: News about fall in θ - shock realized: 1 period bond - plot 2

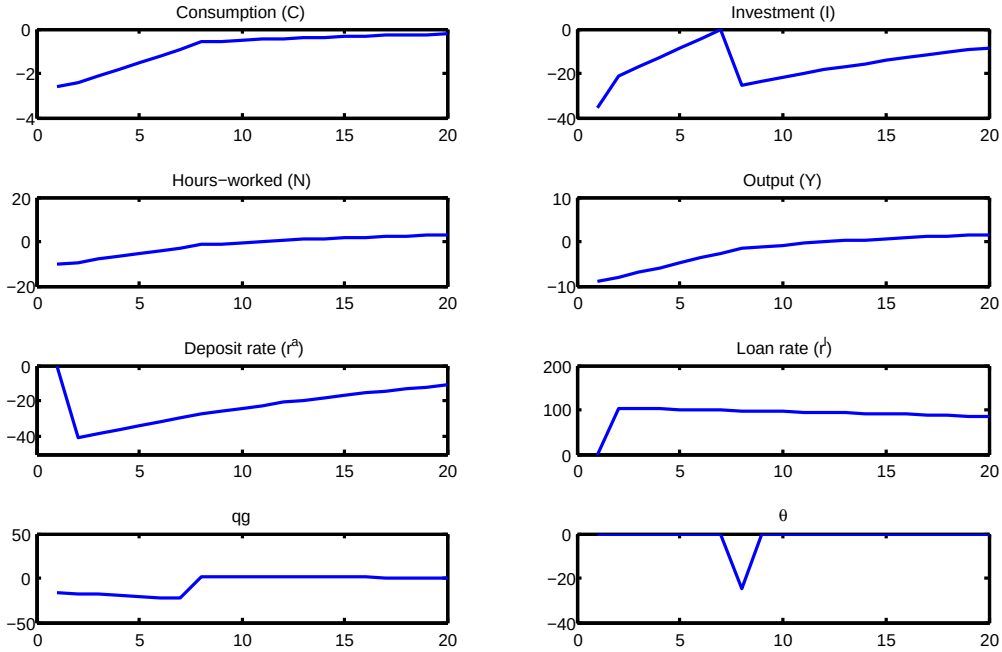


4.2.2 Anticipated increase in government default with long-bonds

Figures 8 and 9 show the response of the long-bond model economy to an anticipated default whereby agents receive a news shock in period 1 that θ will fall by 25% in period 8, and then in period 8 θ falls by 25%. As can be seen from the figure, in response to the news shock, consumption, investment, hours-worked and output all drop immediately, and persistently stay below steady state for all periods shown in the figure. As in the case of the contemporaneous shock, the loan rate rises and the deposit rate falls, indicating an immediately rise in the credit spread. In contrast to that case, now the price of government bonds, q^g, falls immediately, implying a *rise* in the yield on government bonds which is consistent with observations from the Eurozone. Bank equity and bank consumption also drop immediately, and deposits and loans begin a gradual fall and remain persistently below steady state for all periods shown in the figure.

Unlike in the case of the one-period bond, the news shock now has a direct impact on the price of the long-bond in period 1. Note that in the bank's government bond first-order condition (28), the price of the bond next period q^g_{t+1} is on the right hand side of the equation, reflecting the positive market value of the bond next period since the bond will continue to pay coupons into the future. Iterating this equation into the future 8 periods then reveals that the price today depends on the expected value of θ for all periods leading up to and including period 8. Thus news that θ_t will decrease in period 8 immediately reduces the price of the long bond in period 1 as

Figure 8: News about fall in θ - shock realized: - plot 1



compensation to the potential investor for this expected loss [13].

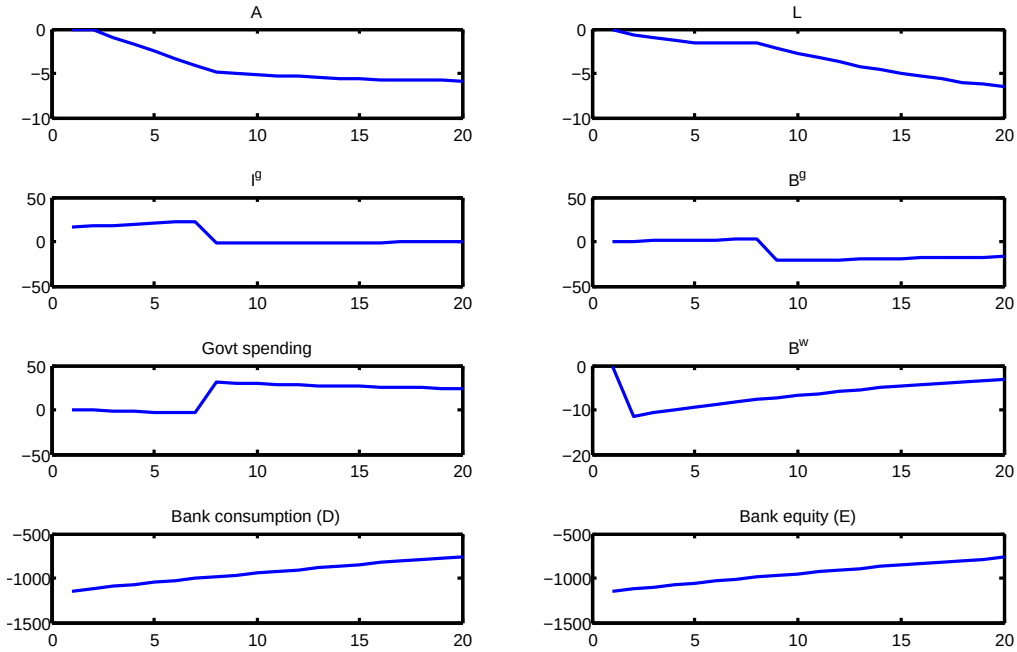
Since the bank's equity depends on the value of its stock of government debt on its balance sheet, $q_t^g B g_{t+1}^g$, the drop in q_{t+1}^g causes an immediately drop in the bank's equity, thereby reducing its excess capital, forcing the bank to incur costs for deviating from the legislated (or desired) capital ratio. The bank, as a result, tries to increase its excess capital by reducing consumption, reducing deposits or increasing loans, however, since loans contribute to excess capital by a factor of $1-\gamma$ less than deposits, deposits respond by more, pulling the amount of loans down with it and the loan rate r_{t+1}^l rises relative to r_{t+1}^d, increasing the credit spread immediately.

Then, as in the case of the contemporaneous shock, the rise in the credit spread causes a drop in investment and therefore a fall in demand for loans by firms, and a consequent fall in the deposit rate, r_{t+1}^a, as banks work to discourage deposits hence lowering their liabilities. The drop in the household's risk-free rate then reduces labour supply, which combined with the drop in labour demand in future periods due to the declining capital stock, produces a persistent drop in hours-worked and output.

Note, in addition, that unlike the contemporaneous case, government debt now rises in response to the shock as the increase in interest rate on government bonds forces the government to borrow more to finance its existing obligations.

[13] Note that for $\delta^g = 1$, which corresponds to the 1-period bond case, q_{t+1}^g drops out of the right hand side of equation (28), severing any relation of the current price to values of θ more than one period in the future, illustrating in a compact way why news has no effect in the 1-period bond version of the model.

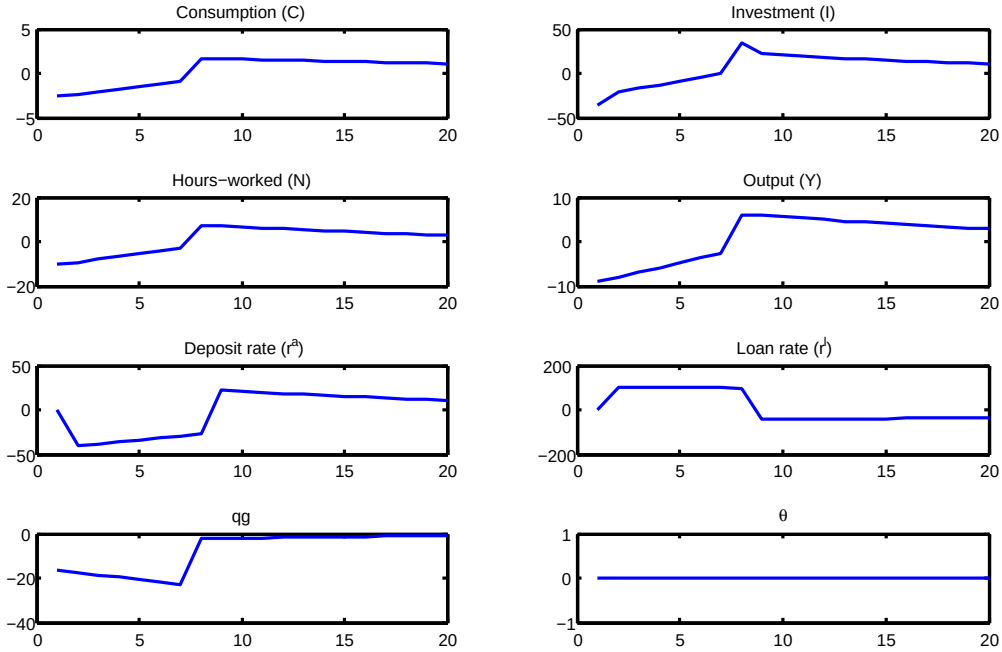
Figure 9: News about fall in θ - shock realized: - plot 2



4.2.3 Unrealized fears

While we have witnessed an actual default by the government of Greece, many other nations caught up in sovereign default fears have yet to default, and may never do so. The news shock methodology is interesting in this situation because it allows us to analyze the macroeconomic implications of news that fails to materialize. While too stark to be realistic, we find the following exercise to be quite helpful in interpreting current events in Europe. In period 1 agents recieve news that θ will fall in period 8 by 25 percent. In period 8, an exactly off-setting contemporaneous shock to θ renders the news false. As a result, all the actions taken by agents in fear of a sovereign default need to be reversed and the economy slowly recovers from the recession. Figures 10 and 11 show the response of the long-bond model economy for the unrealized news-shock case. Much of what was discussed in the previous section is true here as well. Since agents receive the same news in period 1 as in the realized shock case, their responses are exactly the same up until period 7 : the immediate rise in the yield on government debt and consequent loss of bank capital causes the credit spread to rise as well. This leads to less credit in the banking system, a fall in loans and investment as well as in output, consumption and hours worked. Once again the fear of a future default unleashes strong movement in prices that trigger a recession. In period 8 those fears prove to be unfounded and there is an immediate spike in government bond prices which then slowly recover to steady state values. The spike in bond prices causes an immediate increase in bank capital which allows the bank

Figure 10: News about fall in θ - shock **unrealized**: - plot 1



to increase consumption. Lending rates fall back while deposit rates rise quickly and slowly recover to their steady state levels and bank deposits and total quantity of loans slowly recover. The fall in the credit spread encourages the firm to borrow and invest in physical capital and to hire more labor so that output and consumption also rise. We find this exercise particularly interesting because it helps shed light on the recessions experienced by many Euro-zone nations in the absence of any sovereign defaults based purely on changes in expectations.

Figure 11: News about fall in θ - shock **unrealized**: - plot 2

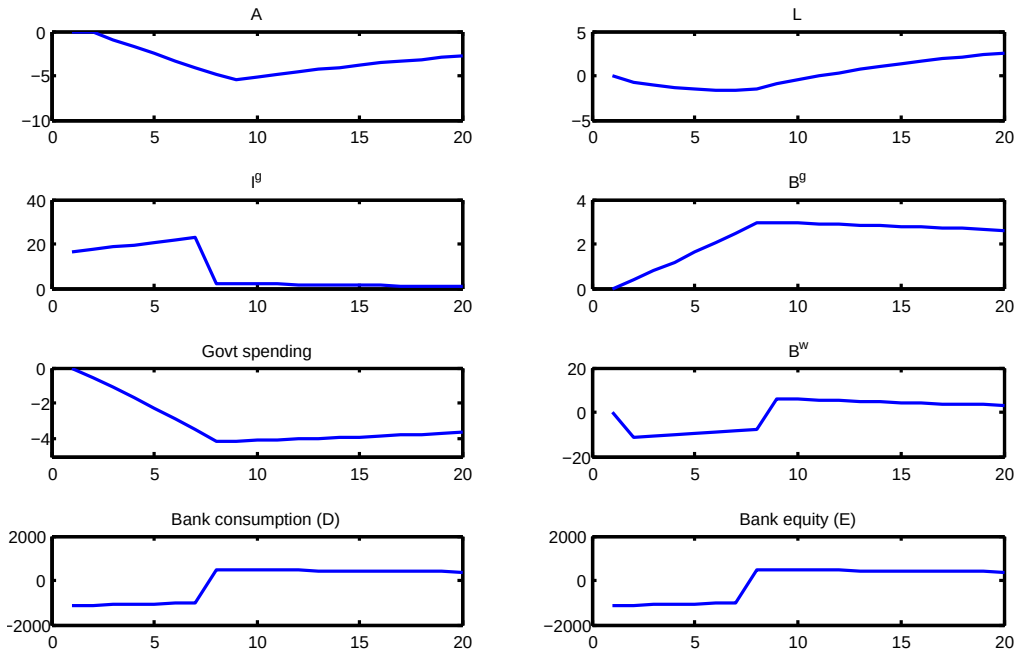
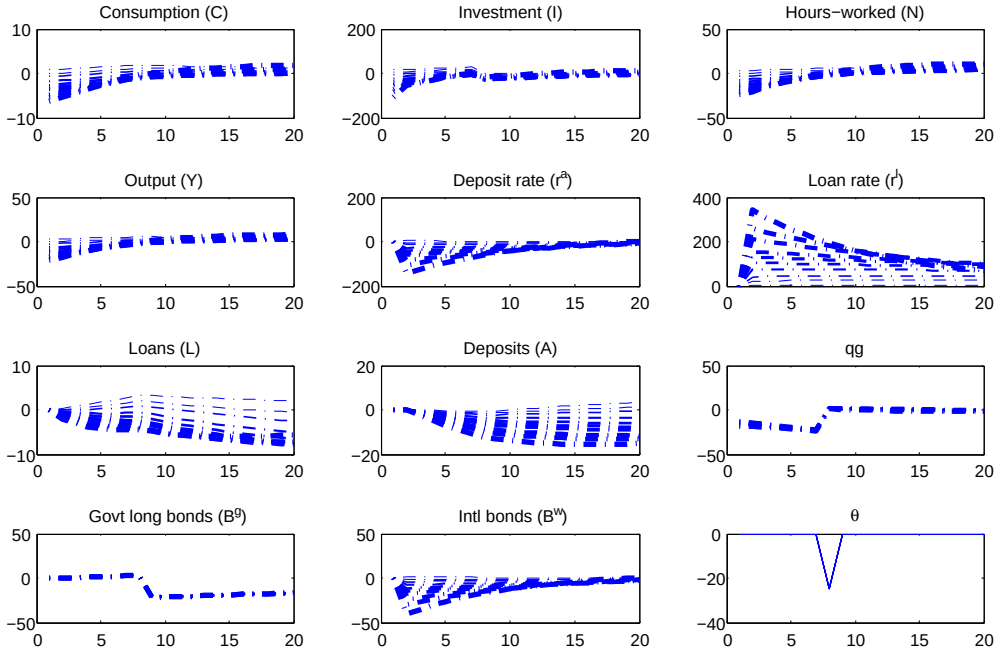


Figure 12: News about fall in θ - shock realized: γ sensitivity

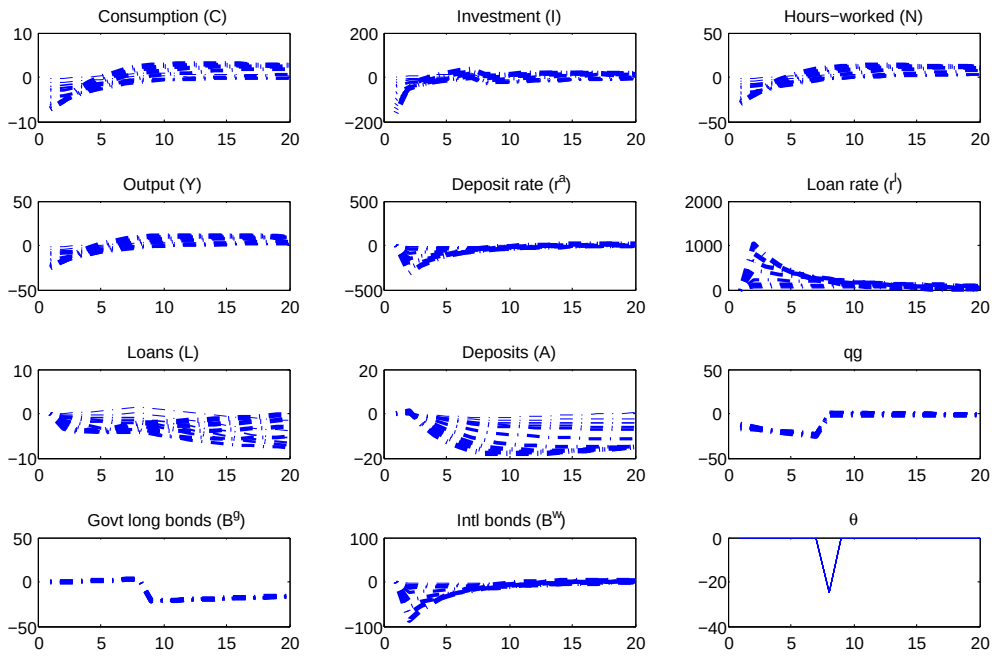


Notes: The figure above shows impulse responses to a fulfilled news-shock for different values of γ. Each line corresponds to a different value of γ, ranging from 0.0001 (thinner) to 0.3 (thicker).

5 Sensitivity to key parameters

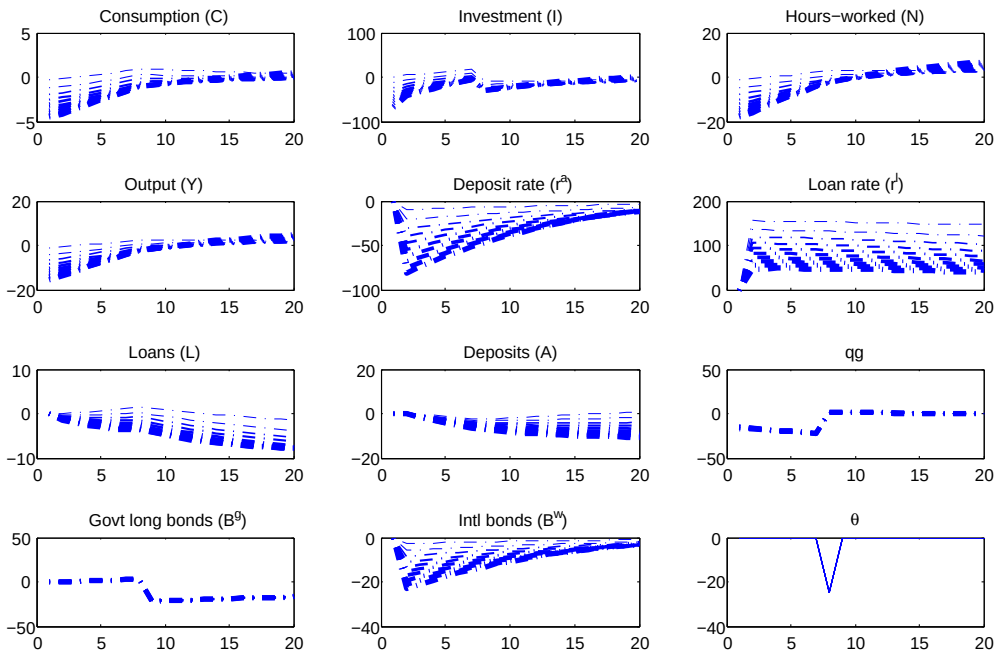
In this section we explore the sensitivity of our model results to variations in key parameters. As can be seen from Figures 12 - 15, while the results do change with the parameters, the story told in the previous section remains intact. Not surprisingly, both γ, the capital requirements ratio, and ϕ_2, the adjustment cost parameter on excess capital, are key parameters for transmitting the news shock about government default into real activity, and in general the depth of the recession falls as these two parameters are reduced. As γ approaches zero, given some change in equity, altering either loans or deposits offers equal marginal impact for the bank on restoring its capital ratio, and thus there is no rise in the credit spread, $r^l - r^d$ and consequently no impact on demand for new capital. As ϕ_2 approaches zero, the bank faces no penalty for deviating from the capital requirement, and thus again there is no rise in the credit spread and no impact on the demand for new capital.

Figure 13: News about fall in θ - shock realized: ϕ_2 sensitivity



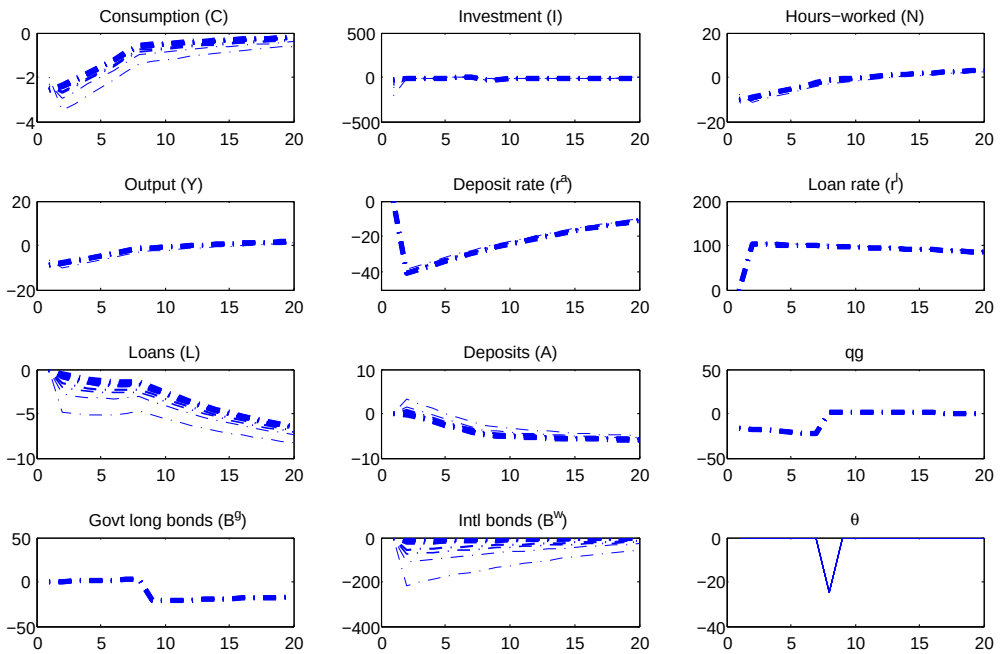
Notes: The figure above shows impulse responses to a fulfilled news-shock for different values of ϕ_2. Each line corresponds to a different value of ϕ_2, ranging from 0.05 (thinner) to 2.5 (thicker).

Figure 14: News about fall in θ - shock realized: τ sensitivity



Notes: The figure above shows impulse responses to a fulfilled news-shock for different values of τ. Each line corresponds to a different value of τ, ranging from 0.05 (thinner) to 0.5 (thicker).

Figure 15: News about fall in θ - shock realized: ψ_w sensitivity



Notes: The figure above shows impulse responses to a fulfilled news-shock for different values of ψ_w. Each line corresponds to a different value of ψ_w, ranging from 0.01 (thinner) to 1 (thicker).

6 Conclusion

Can the mere fear of future sovereign default in itself lead to a recession ? We build a model which answers the question in the affirmative. Our small open economy model delivers a fall in output, consumption, investment and hours as well as in the amount of credit flowing through the banking system in conjunction with a rise in the spread between loan and deposit rates purely in anticipation of a future default by the government on its debt. These features are consistent with recent observations from the Euro-zone periphery nations such as Greece, Spain, Italy, Portugal and Ireland. Our paper contributes to several recent literatures including studies that emphasise the role of banking capital in economic fluctuations as well as the news shock literature. While most studies of news shocks focus on news about total factor productivity or fiscal policy, we extend these ideas to the financial sphere and study the impact of news about the expected return on sovereign bonds due to a default. Relative to the business cycle literature with a banking system, the presence of long maturity bonds is unusual and essential to the story. In addition to the transmission of financial shocks to the real sector, a contribution of the model is the link between sovereign yields and credit spreads created by the interaction of long bonds on the balance sheet of banks with a capital sufficiency requirement.

References

Arellano, Cristina, "Default Risk and Income Fluctuations in Emerging Economies," *American Economic Review*, June 2008, *98* (3), 690–712.

Beaudry, Paul and Franck Portier, "An exploration into Pigou's theory of cycles," *Journal of Monetary Economics*, September 2004, *51* (6), 1183–1216.

_ **and** _ , "Stock Prices, News, and Economic Fluctuations," *American Economic Review*, September 2006, *96* (4), 1293–1307.

_ **, Martial Dupaigne, and Franck Portier**, "Modeling News-Driven International Business Cycles," *Review of Economic Dynamics*, January 2011, *14* (1), 72–91.

Christiano, Lawrence, Cosmin Ilut, Roberto Motto, and Massimo Rostagno, "Monetary policy and stock market boom-bust cycles," Working Paper Series 955, European Central Bank October 2008.

Contessi, Silvio, "An application of conventional sovereign debt sustainability analysis to the current debt crises," *Review*, 2012, (May), 197–220.

Duffie, Darrell and Kenneth J Singleton, "Modeling Term Structures of Defaultable Bonds," *Review of Financial Studies*, 1999, *12* (4), 687–720.

Durdu, Ceyhun Bora, Ricardo Nunes, and Horacio Sapriza, "News and sovereign default risk in small open economies," Technical Report 2010.

Garcia-Cicco, Javier, Roberto Pancrazi, and Martin Uribe, "Real Business Cycles in Emerging Countries?," *American Economic Review*, December 2010, *100* (5), 2510–31.

Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti, "Credit and Banking in a DSGE Model of the Euro Area," *Journal of Money, Credit and Banking*, 09 2010, *42* (s1), 107–141.

Guerrieri, Luca, Matteo Iacoviello, and Raoul Minetti, "Banks, Sovereign Debt and the International Transmission of Business Cycles," in "NBER International Seminar on Macroeconomics 2012" NBER Chapters, National Bureau of Economic Research, Inc, May 2012.

Gunn, Christopher and Alok Johri, "News and knowledge capital," *Review of Economic Dynamics*, January 2011, *14* (1), 92–101.

Gunn, Christopher M. and Alok Johri, "News, Intermediation Efficiency and Expectations-driven Boom-bust Cycles," Department of Economics Working Papers 2011-02, McMaster University March 2011.

_ **and** _ , "News, Credit Spreads and Default Costs: An expectations-driven interpretation of the recent boom-bust cycle in the U.S," Department of Economics Working Papers 2012-04, McMaster University May 2012.

_ **and** _ , "An expectations-driven interpretation of the Great Recession," *Journal of Monetary Economics*, 2013, *60* (4), 391 – 407.

Hatchondo, Juan Carlos and Leonardo Martinez, "Long-duration bonds and sovereign defaults," *Journal of International Economics*, September 2009, *79* (1), 117–125.

Iacoviello, Matteo, "Financial Business Cycles," Technical Report 2010.

Jaimovich, Nir and Sergio Rebelo, "News and Business Cycles in Open Economies," *Journal of Money, Credit and Banking*, December 2008, *40* (8), 1699–1711.

_ **and** _ , "Can News about the Future Drive the Business Cycle?," *American Economic Review*, September 2009, *99* (4), 1097–1118.

King, Robert G. and Sergio T. Rebelo, "Resuscitating Real Business Cycles," NBER Working Papers 7534, National Bureau of Economic Research, Inc February 2000.

_ **, Charles I. Plosser, and Sergio T. Rebelo**, "Production, growth and business cycles : I. The basic neoclassical model," *Journal of Monetary Economics*, 1988, *21* (2-3), 195–232.

Kollmann, Robert, "Global Banks, Financial Shocks and International Business Cycles: Evidence from an Estimated Model," CEPR Discussion Papers 8985, C.E.P.R. Discussion Papers May 2012.

_ **, Zeno Enders, and Gernot J. Mller**, "Global banking and international business cycles," *European Economic Review*, April 2011, *55* (3), 407–426.

Leeper, Eric and Todd Walker, "Information Flows and News Driven Business Cycles," *Review of Economic Dynamics*, January 2011, *14* (1), 55–71.

Mendoza, Enrique G. and Vincenzo Quadrini, "Financial globalization, financial crises and contagion," *Journal of Monetary Economics*, January 2010, *57* (1), 24–39.

_ **and Vivian Z. Yue**, "A General Equilibrium Model of Sovereign Default and Business Cycles," *The Quarterly Journal of Economics*, 2012, *127* (2), 889–946.

Neumeyer, Pablo A. and Fabrizio Perri, "Business cycles in emerging economies: the role of interest rates," *Journal of Monetary Economics*, March 2005, *52* (2), 345–380.

Sosa-Padilla, Cesar, "Sovereign Defaults and Banking Crises," Department of Economics Working Papers 2012-09, McMaster University September 2012.

Uribe, Martin and Vivian Z. Yue, "Country spreads and emerging countries: Who drives whom?," *Journal of International Economics*, June 2006, *69* (1), 6–36.

Yue, Vivian Z., "Sovereign default and debt renegotiation," *Journal of International Economics*, March 2010, *80* (2), 176–187.