

Credit Spreads and Credit Policies*

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Abstract

How should monetary and fiscal policy react to adverse financial shocks? If monetary policy is constrained by the zero lower bound on the nominal interest rate, subsidising the interest rate on loans is the optimal policy. The subsidies can mimic movements in the interest rate and can therefore overcome the zero bound restriction. Credit subsidies are optimal irrespective of how they are financed. If debt is not state contingent, they result in a permanent increase in the level of public debt, in a permanent increase in future taxes and in a permanent reduction in output.

Keywords: Credit policy; credit subsidies; monetary policy; zero-lower bound on nominal interest rates; banks; costly enforcement.

JEL Codes: E31, E40, E44, E52, E58, E62, E63.

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1 Introduction

The financial crisis and the Great Recession have exposed the limitations of conventional monetary policy as a tool for macroeconomic stabilization. Downward movements in the nominal interest rate have become infeasible, because the zero lower bound constraint has been reached in many countries. Additional macroeconomic stimulus has been sought for through quantitative easing measures. Central banks have also developed new policy instruments aimed to address the specific distortions prevailing at any point in time in the financial sector. Weak balance sheet conditions of financial intermediaries have motivated credit policies—i.e. forms of direct credit provision.

While quantitative or credit easing measures have been implemented in large scale, economists are still investigating their theoretical basis. On the one hand, some recent papers have demonstrated the effectiveness of certain sorts of central bank liquidity interventions, when a deterioration in intermediaries' balance-sheets causes disruptions in bank lending.¹ On the other hand, it remains unclear whether such interventions are desirable, or whether the same objectives may be reached more efficiently through different policy tools. The nature of unconventional measures is also controversial, with some authors arguing that they really amount to fiscal policy.²

In this paper we investigate how policy, both monetary and fiscal, should be used to improve allocations in response to financial disruptions.

To do so, we rely on a simple model with costly enforcement, as in Gertler and Karadi (2011) and Gertler and Kiyotaki (2010). The key friction is that bankers can divert part of the bank's assets. In order to be able to attract deposits, they must also capitalise the bank with a sufficient amount of own funds. Internal funds receive a higher return than bank deposits, so lending rates include a spread over and above the deposit rate. The lending spread is a distortion that can be particularly severe when banks' internal funds become too low as a result of exogenous shocks.

In our model, even if we abstract from sticky prices and monopolistic competition, the zero interest rate level is a binding constraint for monetary policy. The central bank would want to set the policy interest rate to a negative level, so as to lower lending rates towards the value which they would reach in the absence of financial distortions. Even if this policy would not

¹Curdia and Woodford, Gertler and Karadi, Gertler and Kiyotaki

²See eg Goodfriend (2011).

reduce lending spreads, it would minimize the effects of the spreads on lending, and therefore on equilibrium allocations.

Given that interest rate policy is restricted by the zero lower bound, how can policy minimize the implications of financial market distortions on the real economy? In spite of the binding constraint on the nominal interest rate, there is still room for policy in flexible-price models. Mean-preserving surprise movements in the price level can in general be very effective in changing the outstanding level of public debt. In our model, they can additionally affect the real level of internal funds of financial intermediaries. How exactly these movements in the price levels can be implemented is a separate issue, which we do not deal with in this paper. One possible implementation is with money supply policy (see also Adao, Correia and Teles (2013) for a discussion of this implementation issue).

In order to restrict policy makers' ability to generate state contingent debt with ex-post volatility of the price level, we look at optimal outcomes when policy is restricted from moving the price level on impact, in response to shocks.

When instantaneous price adjustments are prevented, monetary policy has very little room for manoeuvre in our model. A negative financial shock—i.e. a shock which destroys banks net worth—can have severely adverse consequences on the economy. Even in our stylized model, an idiosyncratic shock to banks' net worth which increases spreads by 1.5 percentage points—an amount comparable to the increase in CDS spreads in the last quarter of 2008—causes a 1.5 percent impact fall in output—again broadly comparable to the almost 2% fall in U.S. GDP in the first quarter of 2009. Additional policy interventions are intuitively desirable.

As in the original Gertler and Karadi (2011) model, policies of direct lending by the central bank would be desirable in our model when banks are balance-sheet constrained. Balance sheet constraints can disrupt lending through the increase in credit spreads. Replacing the "missing" private intermediation with central bank intermediation is intuitively appealing. Nevertheless, central bank intermediation, even if aggressively carried out, cannot isolate the real economy from the consequences of adverse financial shocks.

We show that an ideal response to financial disruption when interest rates are at the zero bound is a fiscal policy involving credit subsidies. Rather than replacing the missing private credit, credit subsidies lower the "effective" borrowing cost for the nonfinancial sector. If lending spreads increase because of a weakening of banks' balance sheets, credit subsidies can potentially completely offset that increase. With lower effective lending rates, lending volumes

will not be depressed. In our model, the real economy can be perfectly shielded from the consequences of the financial disruption.

The exact features of the allocation which can be achieved through credit subsidies depend on how subsidies are financed. If lump sum taxes were feasible, credit subsidies could be used to achieve the first best allocation in the economy. Without lump sum taxes, but with state contingent debt, credit taxes and subsidies will only be used in response to shocks. As in Chari, Christiano and Kehoe (1991), state contingent debt could be replicated through unexpected changes in inflation, which would generate all the desirable variation in the real value of the outstanding nominal public debt. When we restrict policy makers' ability to implement instantaneous price adjustments in reaction to shocks, however, public debt is never state-contingent. In this case, credit taxes and subsidies are still optimal, but they have budgetary implications and the economy cannot be perfectly insulated from the consequences of financial shocks. Indeed adverse shocks result in a permanent increase in the level of public debt, in a permanent increase in future taxes and in a permanent reduction in output.³

A corollary of these results is that credit taxes and subsidies, once available, can also be used to overcome the zero bound constraint on interest rates. Credit subsidies can in general mimic any movements in the nominal interest rate, but have the advantage of not being subject to the zero bound. With credit subsidies it is therefore possible to implement allocations that would be infeasible for monetary policy, because they would require negative interest rates.

Our paper is related to the recent literature studying the effects of financial markets impairments and the desirability of non-standard policy responses (see also Curdia and Woodford, 2011, De Fiore and Tristani, 2012, Eggertsson and Krugman, 2010). This literature explores various forms of direct lending by the central bank, but it does not explicitly allow for fiscal instruments and it does not study the optimal combination of monetary and fiscal policy in reaction to financial distortions.

Optimal fiscal policy when interest rates are at zero has also been studied by Eggertsson and Woodford (2006) and Werning (2012). These papers however rely on the new Keynesian model and therefore abstract from financial market distortions. The key benefit of fiscal policy in those models is related to the large fiscal multipliers which arise in theory when monetary policy

³These results are consistent with those in Barro (1979) and Aiyagari et al (2002) where, in the absence of state contingent debt, innovations in fiscal conditions are spread out over time and the optimal tax rate follows essentially a random walk.

is constrained by the zero bound (see Christiano, Eichenbaum and Rebelo, 2011; Eggertsson, 2011, Woodford, 2011). In contrast, in our environment the fiscal intervention is desirable to cushion the economy from the consequences of an increase in credit spreads.

Our paper is also related to the results in Correia, Farhi, Nicolini and Teles (2013), which shows that consumption and other taxes can be used to overcome the zero bound constraint in models with sticky prices. Our paper differs in the type of frictions and shocks which make the zero bound a restriction for monetary policy, but it confirms the result that standard tax instruments can overcome the zero bound constraint. However, while in the sticky price model it is possible to achieve the first best without lump sum revenues (provided the monopolistic competition mark up is close to zero), in our set up with credit frictions this is no longer true.

The paper is organized as follows. In section 2, we describe the environment. In section 3, we establish an equivalence between nominal interest rates and credit subsidies, irrespective of whether taxes are lump-sum or distortionary. In section 4, we characterize optimal policy. We start by describing properties of the steady state (section 4.1), we then compute numerically the optimal response to shocks in a second best, without lump sum taxes. We consider two cases. In the first, policy can instantaneously change the price level in response to shocks. We show that the real value of all nominal financial assets can be made state contingent in response to technology shocks, but not in response to financial shocks. In the second case, policy is restricted from affecting prices on impact. As a result the real value of nominal financial assets is always noncontingent. Section 5 concludes the paper.

2 A model

2.1 The household

The household is composed of workers and bankers: with probability $1 - \theta$ bankers exit and become workers, and with probability θ they remain bankers. The fraction of bankers is f and workers $1 - f$. Bankers and workers share consumption.

The household preferences are

$$\text{Max } E_t \sum_{t=0}^{\infty} \beta^t \left[\log C_t - \frac{\chi}{1 + \phi} N_t^{1+\phi} \right]$$

The household starts period t with nominal wealth \mathbb{W}_t . At the beginning of period t , in an assets market, the household purchases $E_t Q_{t,t+1} B_{t,t+1}$ in state contingent nominal claims

where $Q_{t,t+1}$ is the price in period t of a unit of money in period $t+1$, in some state, normalized by the probability of occurrence of the state. It also purchases noncontingent public debt B_t^g , and deposits D_t^h . In the beginning of the following period the nominal wealth \mathbb{W}_{t+1} includes the state contingent bonds $B_{t,t+1}$, the gross return on noncontingent public debt, $R_t B_t^g$, and deposits, $R_t D_t^h$, the dividends received from the banks Π_t^b . It also includes the wage income $W_t N_t$, which is received in units of money in a goods/labor market at the end of period t . The household pays for consumption expenditures $P_t C_t$, and lump sum taxes T_t . The flow of funds constraints of the households are therefore

$$E_t Q_{t,t+1} B_{t,t+1} + B_t^g + D_t^h \leq \mathbb{W}_t, \quad (1)$$

$$\mathbb{W}_{t+1} = B_{t,t+1} + R_t B_t^g + R_t D_t^h + \Pi_t^b + W_t N_t - P_t C_t - T_t$$

These budget constraints are written under the assumption that $R_t \geq 1$. Otherwise, the households would actually borrow an arbitrarily large amount and hold cash. Unless the profits from that activity were fully taxed this would not be an equilibrium. This is the zero bound on interest rates as an equilibrium restriction.

The first order conditions of the households problem include

$$-\frac{u_C(t)}{u_N(t)} = \frac{P_t}{W_t}, \quad (2)$$

$$\frac{u_C(t)}{\beta u_C(t+1)} = Q_{t,t+1}^{-1} \frac{P_t}{P_{t+1}}, \quad (3)$$

$$\frac{u_C(t)}{P_t} = R_t E_t \frac{\beta u_C(t+1)}{P_{t+1}}, \quad (4)$$

2.2 Firms

In the economy there is a representative firm endowed with a stochastic technology that transforms N_t units of labor into $Y_t = A_t N_t$ units of output. In the beginning of the period, the firm needs to borrow nominal funds S_t in order to pay the wage bill. We assume the firms hold money, $M_t^f = S_t$, that is not remunerated.⁴ The borrowing constraint is

$$W_t N_t \leq S_t \quad (5)$$

⁴One way to think about the timing of transactions is with an assets market in the beginning of the period where firms borrow the money and a goods/labor market at the end where they use the money to pay wages.

The profits in each period t can be written as⁵

$$\pi_t^f = P_t Y_t - W_t N_t - \left(R_t^l (1 - \tau_t^l) - 1 \right) S_t,$$

where P_t is the price level, R_t^l is the gross interest rate on the loans to the firms, and τ_t^l is a government subsidy on the gross loan rate.

Using the borrowing constraint (5), we can write profits as

$$\pi_t^f = P_t Y_t - R_t^l (1 - \tau_t^l) W_t N_t.$$

Profit maximization implies

$$P_t A_t = R_t^l (1 - \tau_t^l) W_t.$$

which, together with the borrowing constraint (5), implies

$$A_t N_t = R_t^l (1 - \tau_t^l) \frac{S_t}{P_t}$$

2.3 Banks

Each bank j channels funds from depositors to the firms. Because of a costly enforcement problem, each bank must have internal funds, $Z_{j,t}$. The bank borrows $D_{j,t}$ from households and firms and lends $S_{j,t}^b$. It follows that

$$S_{j,t}^b = D_{j,t} + Z_{j,t}$$

The net worth of the bank evolves according to

$$Z_{j,t+1} = R_t^l S_{j,t}^b - R_t D_{j,t}.$$

Combining the two conditions above, we can write

$$Z_{j,t+1} = \left(R_t^l - R_t \right) S_{j,t}^b + R_t Z_{j,t}$$

Note that individual banks' profits are given by

$$\bar{\Pi}_{j,t+1}^b = \left(R_t^l - 1 \right) S_{j,t}^b - (R_t - 1) D_{j,t}$$

⁵It is an equilibrium restriction that $R_t^l (1 - \tau_t^l) \geq R_t$, otherwise firms could make infinite profits borrowing at $R_t^l (1 - \tau_t^l)$ and holding deposits that would pay R_t .

so that

$$Z_{j,t+1} = \bar{\Pi}_{j,t+1}^b + Z_{j,t}$$

Bankers maximize terminal wealth, $V_{j,t}$, where

$$V_{j,t} = E_t \sum_{s=0}^{\infty} (1-\theta) \theta^s Q_{t,t+1+s} Z_{j,t+1+s} = E_t \sum_{s=0}^{\infty} (1-\theta) \theta^s Q_{t,t+1+s} \left[(R_{t+s}^l - R_{t+s}) S_{j,t+s}^b + R_{t+s} Z_{j,t+s} \right]$$

As in Gertler and Kiyotaki (2010), bankers can appropriate a fraction λ of assets $S_{j,t}$. The incentive compatibility constraint is

$$V_{j,t} \geq \lambda S_{j,t}^b.$$

As shown in appendix A, the value $V_{j,t}$ can be written as:

$$V_{j,t} = v_t S_{j,t}^b + \eta_t Z_{j,t}$$

where

$$v_t = E_t \left\{ (1-\theta) Q_{t,t+1} (R_t^l - R_t) + Q_{t,t+1} \theta \frac{S_{j,t+1}^b}{S_{j,t}^b} v_{t+1} \right\}$$

and

$$\eta_t = E_t \left\{ (1-\theta) + Q_{t,t+1} \theta \frac{Z_{j,t+1}}{Z_{j,t}} \eta_{t+1} \right\}.$$

The incentive constraint can then be written as

$$v_t S_{j,t}^b + \eta_t Z_{j,t} \geq \lambda S_{j,t}^b \tag{6}$$

For $Z_{j,t} > 0$, the constraint will bind only if $v_t < \lambda$, which we assume to be the case. Then

$$S_{j,t}^b = \frac{\eta_t}{(\lambda - v_t)} Z_{j,t} \equiv \phi_t Z_{j,t}.$$

This is the private assets to equity ratio, which we refer to as leverage ratio. More specifically the debt to equity ratio is

$$\frac{S_{j,t}^b - Z_{j,t}}{Z_{j,t}} = \phi_t - 1 > 0.$$

The evolution of net worth can now be simplified to

$$Z_{j,t+1} = \left[(R_t^l - R_t) \phi_t + R_t \right] Z_{j,t}$$

The growth rates of Z_j and S_j^b are given by

$$\zeta_{t,t+1} = \frac{Z_{j,t+1}}{Z_{j,t}} = (R_t^l - R_t) \phi_t + R_t$$

$$\varkappa_{t,t+1} = \frac{S_{jt+1}^b}{S_{jt}^b} = \frac{\phi_{t+1}}{\phi_t} \left[(R_t^l - R_t) \phi_t + R_t \right]$$

We can now write the expressions for v_t and η_t as

$$v_t = (1 - \theta) \frac{R_t^l - R_t}{R_t} + E_t [Q_{t,t+1} \theta \varkappa_{t,t+1} v_{t+1}]$$

and

$$\eta_t = E_t \{ (1 - \theta) + Q_{t,t+1} \theta \zeta_{t,t+1} \eta_{t+1} \}$$

The internal funds of bankers are the sum of the funds of surviving bankers Z_{et+1} and entering bankers Z_{nt+1} . Since a fraction θ of bankers survive,

$$Z_{et} = \theta \left[(R_{t-1}^l - R_{t-1}) \phi_{t-1} + R_{t-1} \right] Z_{t-1}.$$

The remaining fraction, $1 - \theta$, die and transfer back the internal funds to the households at the end of the period. The households then transfer to the entering banks the fraction $\frac{\omega}{1-\theta}$ of these assets at t ,

$$Z_{nt} = \omega \left[(R_{t-1}^l - R_{t-1}) \phi_{t-1} + R_{t-1} \right] Z_{t-1}.$$

We can then write

$$Z_t = Z_{et} + Z_{nt} = (\theta + \omega) \left[(R_{t-1}^l - R_{t-1}) \phi_{t-1} + R_{t-1} \right] Z_{t-1}$$

Note that the internal funds are not a separate asset. They are simply a balance sheet item defined as the difference between banks' assets–loans and liabilities–deposits.

Recall that $\bar{\Pi}_{j,t}^b = Z_{j,t} - Z_{j,t-1}$. Each bank accumulates profits $\bar{\Pi}_{j,t}^b$ as net worth until the banker dies, at which point the remaining net worth is transferred to the households as dividends. Aggregate profits transferred by dying banks to households are

$$\bar{\Pi}_{n,t}^b = (1 - \theta) \left[(R_{t-1}^l - R_{t-1}) \phi_{t-1} + R_{t-1} - 1 \right] Z_{t-1}.$$

Dividends to households net of the transfer to entering banks are therefore

$$\Pi_t^b = (1 - \theta - \omega) \left[(R_{t-1}^l - R_{t-1}) \phi_{t-1} + R_{t-1} - 1 \right] Z_{t-1}$$

which can be rewritten as

$$\Pi_t^b = \left(\frac{1}{\theta + \omega} - 1 \right) Z_t \tag{7}$$

2.4 Government

The government spends G_t , issues money M_t , issues state noncontingent debt \bar{B}_{t+1}^g , also remunerated at rate R_t , gives credit subsidies $\tau_t^l R_t^l S_t$, provides intermediation S_t^g directly to non-financial firms at the market rate R_t^l and raises lump sum taxes T_t . In its intermediation activity the government is not subject to the incentive constraint, but it has an intermediation (deadweight) cost τ per unit of real lending. The aggregate deadweight cost is $\tau \frac{S_t^g}{P_t}$. One way to think about this resource cost is as a direct enforcement cost.

The question here is whether the central bank lends directly the money to the firms, or alternatively lends it to the banks that in turn make those loans, or, which is equivalent, lends it to households that deposit it with the banks that lend it to the firms.

As in Gertler and Karadi (2011), we write the government intermediation as a fraction of total intermediation $S_t^g = \psi_t S_t$. Gertler and Karadi assume that policy is an arbitrary rule for ψ_t as a function of credit spreads. We, instead look at policies where ψ_t is determined optimally.

The government budget constraint is given by

$$\bar{B}_t^g + M_t - \psi_t S_t \leq -\mathbb{W}_t^g, \quad (8)$$

where $-\mathbb{W}_{t+1}^g$ are government liabilities

$$-\mathbb{W}_{t+1}^g = R_t \bar{B}_t^g + M_t + \tau_t^l R_t^l S_t + \tau \psi_t S_t - \psi_t S_t R_t^l + P_t G_t - T_t \quad (9)$$

The government budget constraint can therefore be written as

$$B_t^g + M_t - \psi_t S_t \leq R_{t-1} B_{t-1}^g + M_{t-1} + \tau_{t-1}^l R_{t-1}^l S_{t-1} + \tau \psi_{t-1} S_{t-1} - \psi_{t-1} S_{t-1} R_{t-1}^l + P_{t-1} G_{t-1} - T_{t-1}$$

2.5 Market clearing

The resource constraint is

$$C_t + G_t + \tau \psi_t \frac{S_t}{P_t} = A_t N_t$$

The market clearing condition for deposits is

$$D_t = D_t^b + D_t^f$$

and for loans,

$$S_t = S_t^b + \psi_t S_t.$$

2.6 Equilibrium conditions

The equilibrium conditions can be summarized as

$$\frac{u_C(t)}{u_N(t)} = \frac{R_t^l(1 - \tau_t^l)}{A_t} \quad (10)$$

$$C_t + G_t + \tau\psi_t \frac{S_t}{P_t} = A_t N_t \quad (11)$$

$$A_t N_t = R_t^l (1 - \tau_t^l) \frac{S_t}{P_t}$$

$$S_t = \frac{\phi_t}{1 - \psi_t} Z_t \quad (12)$$

$$\phi_t = \frac{\eta_t}{\lambda - v_t} \quad (13)$$

$$Z_t = (\theta + \omega) R_{t-1} \left[\left(\frac{R_{t-1}^l}{R_{t-1}} - 1 \right) \phi_{t-1} + 1 \right] Z_{t-1} \quad (14)$$

$$\frac{u_C(t)}{P_t} = R_t E_t \frac{\beta u_C(t+1)}{P_{t+1}}, \quad (15)$$

$$Q_{t,t+1} = \frac{u_C(t) P_{t+1}}{\beta u_C(t+1) P_t}. \quad (16)$$

and

$$\zeta_{t,t+1} = R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \quad (17)$$

$$\varkappa_{t,t+1} = \frac{\phi_{t+1}}{\phi_t} R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \quad (18)$$

$$v_t = E_t \left\{ (1 - \theta) Q_{t,t+1} R_t \left(\frac{R_t^l}{R_t} - 1 \right) + Q_{t,t+1} \theta \frac{\phi_{t+1}}{\phi_t} R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] v_{t+1} \right\} \quad (19)$$

$$\eta_t = E_t \left\{ (1 - \theta) + Q_{t,t+1} \theta R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \eta_{t+1} \right\} \quad (20)$$

Note that we can also introduce a leverage shock like Gertler and Karadi's capital quality shock. Define such shock as ξ_t . We can then assume that the shock destroys net worth at the beginning of the period. The only equations which would be affected here are

$$\frac{A_t}{R_t^l(1 - \tau_t^l)} N_t = \frac{\phi_t}{1 - \psi_t} \frac{Z_t}{P_t} \quad (21)$$

and

$$Z_t = \xi_t (\theta + \omega) R_{t-1} \left[\left(\frac{R_{t-1}^l}{R_{t-1}} - 1 \right) \phi_{t-1} + 1 \right] Z_{t-1} \quad (22)$$

Notice that the price level can adjust so that the equilibrium is not affected by the destruction of internal funds. This can indeed be part of optimal policy as will be seen later.

We will also consider an exogenous shock to λ .

The nominal quantity of money is not neutral in this economy, the reason being that internal funds are predetermined. If it was possible to increase Z_0 , together with all price levels and nominal quantities by the same percentage, this would keep interest rates and allocations unchanged. Because Z is predetermined, however, increasing all nominal quantities and price levels would not be possible without changing the real allocation. Equation (14) shows that, for a given Z_{t-1} , an increase in Z_t would not be consistent with the observed levels of the policy rate R_{t-1} , the credit spread, R_{t-1}^l/R_{t-1} , and leverage, ϕ_{t-1} . The level of prices is not irrelevant in this economy.

It is useful to compare the equilibrium allocation with the one that would arise in the absence of distortions. The first-best allocation can be obtained as the solution to the maximization of households' preferences subject to the resource constraint. The efficiency conditions are given by

$$-\frac{u_C(t)}{u_N(t)} = \frac{1}{A_t}, \quad (23)$$

$$C_t + G_t = A_t N_t. \quad (24)$$

Comparison of condition (23) with (10) shows that the distortion introduced by costly enforcement and by the death probability of bankers, which limit their ability to accumulate internal funds, shows up as a positive spread $R_t^l(1 - \tau_t^l) - 1$. Only when this is one, it is possible to achieve the first best allocation in our economy. In order for that to be attained it is also necessary that $\psi_t = 0$.

3 Credit subsidies and interest rates: An equivalence result

The role of the policy rate in this economy is the same as the role of credit taxes and subsidies, with one difference: the zero bound constraint on interest rates. This constraint does not apply to the credit taxes, which can become subsidies. In this section we show the following equivalence result: the interest rate policy that is relaxed of the zero bound constraint implements the same allocations as a policy of credit taxes and subsidies. This result holds irrespective of whether taxes are lump-sum or distortionary. It follows from this that the zero bound constraint is irrelevant when policy also includes those credit taxes and subsidies.

We proceed as follows: We first allow for negative policy rates, without having the agents act on the arbitrage opportunity. We take into account the effect that lower (negative) rates would have on the lending rates and on the government financing. We then take the allocations as given and show that for any path for the policy rate, corresponding to a particular path of credit taxes, there is an alternative implementation with the policy rate set at zero and alternative paths of credit taxes. That alternative implementation will produce the same wedges and raise the same tax revenues. This means that if nominal interest rates taxes could be negative, the credit taxes would be redundant policy instruments. It also means that the fiscal policies can overcome the nonnegativity constraint on the nominal interest rate allowing to achieve better allocations.

More precisely, we allow for nominal interest rates, $R_t - 1$, to be negative. When that is the case, households could borrow and hold cash, and make arbitrarily large profits. Banks could also do the same arbitrage. We assume that households and banks are prevented from doing this. Banks can give cash to the firms, but they cannot hold it. Subject to these restrictions, there is an equilibrium with negative rates. We consider the extended set of equilibria where the nominal interest rate is not restricted to be positive. We show that the set of equilibria with negative interest rates can be implemented with positive rates and with credit subsidies. We first proceed assuming that lump sum taxes are available.

For simplicity we assume away direct credit policy by the government so that $\psi_t = 0$. The equilibrium conditions for the economy are then given by equations (10)-(20) and can be written with $\psi_t = 0$ as

$$\begin{aligned}
-\frac{u_C(t)}{u_N(t)} &= \frac{R_t^l (1 - \tau_t^l)}{A_t}, & (25) \\
C_t + G_t &= A_t N_t \\
\frac{A_t}{R_t^l (1 - \tau_t^l)} N_t &= \phi_t \frac{Z_t}{P_t} \\
\phi_t &= \frac{\eta_t}{\lambda - v_t} \\
Z_t &= (\theta + \omega) R_{t-1} \left[\left(\frac{R_{t-1}^l}{R_{t-1}} - 1 \right) \phi_{t-1} + 1 \right] Z_{t-1} \\
\frac{u_C(t)}{P_t} &= R_t E_t \frac{\beta u_C(t+1)}{P_{t+1}},
\end{aligned}$$

and

$$\zeta_{t,t+1} = R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right]$$

$$\begin{aligned}
z_{t,t+1} &= \frac{\phi_{t+1}}{\phi_t} R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \\
v_t &= E_t \left\{ (1 - \theta) Q_{t,t+1} R_t \left(\frac{R_t^l}{R_t} - 1 \right) + Q_{t,t+1} \theta \frac{\phi_{t+1}}{\phi_t} R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] v_{t+1} \right\} \\
\eta_t &= E_t \left\{ (1 - \theta) + Q_{t,t+1} \theta R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \eta_{t+1} \right\} \\
Q_{t,t+1} &= \frac{u_C(t) P_{t+1}}{\beta u_C(t+1) P_t}.
\end{aligned}$$

To show the equivalence result, take an allocation, $\{C_t, N_t\}$ and $\left\{ \phi_t, \frac{R_t^l}{R_t}, \eta_t, v_t \right\}$, where $R_t^l \geq 1$. R_t can be less than one. Take a path for $\{\tau_t^l = 0\}$, and an alternative path $\{\tilde{\tau}_t^l\}$ such that

$$R_t^l (1 - \tau_t^l) = \tilde{R}_t^l (1 - \tilde{\tau}_t^l), \quad (26)$$

$$\frac{R_t^l}{R_t} = \frac{\tilde{R}_t^l}{\tilde{R}_t}, \quad (27)$$

$$\tilde{Q}_{t,t+1} \tilde{R}_t = Q_{t,t+1} R_t, \quad (28)$$

and

$$\tilde{R}_t \geq 1,$$

for all t . Notice that it is always possible to find a $\{\tilde{\tau}_t^l\}$, such that restrictions (26)-(28) are satisfied and $\tilde{R}_t \geq 1$.

Since Z_0 cannot move, P_0 should not move either, so $P_0 = \tilde{P}_0$. Under the alternative path, the spreads, leverage, weights are all invariant. Only the nominal variables grow at a different rate, keeping the real variables constant.

This shows the equivalence result between two alternative instruments, a policy interest rate that is not restricted to be positive and the credit subsidy.

Equivalence without lump sum taxes If lump sum taxes are not available, the budget constraint of the households (or the government) is also an equilibrium condition that must be satisfied, other than by the lump sum taxes. Here we assume that the government can issue state-contingent debt.⁶ The budget constraint of the households can be written as the single constraint

$$\sum_{t=0}^{\infty} \sum_{s^t} \frac{Q_t}{R_t} P_t C_{1t} \leq \sum_{t=0}^{\infty} \sum_{s^t} \frac{Q_t}{R_t} W_t N_t + \sum_{t=0}^{\infty} \sum_{s^t} \frac{Q_t}{R_t} \Pi_t^b + \mathbb{W}_0$$

⁶If that debt was noncontingent, there would also be other fiscal instruments, namely consumption taxes, that would replicate the state contingency.

From the firms problem

$$W_t = \frac{A_t P_t}{R_t^l (1 - \tau_t^l)}.$$

It follows that, the budget constraint of the households, with equality, is

$$\sum_{t=0}^{\infty} \sum_{s^t} \frac{Q_t}{R_t} P_t C_t = \sum_{t=0}^{\infty} \sum_{s^t} \frac{Q_t}{R_t} \frac{A_t P_t}{R_t^l (1 - \tau_t^l)} N_t + \sum_{t=0}^{\infty} \sum_{s^t} \frac{Q_t}{R_t} \Pi_t^b + \mathbb{W}_0$$

Using the marginal conditions of the households

$$\frac{\beta^t \pi_t u_C(t)}{u_C(0)} = \frac{\frac{Q_t}{R_t} P_t}{\frac{1}{R_0} P_0}$$

$$-\frac{u_C(t)}{u_N(t)} = \frac{R_t^l (1 - \tau_t^l)}{A_t}$$

it follows

$$\sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t u_C(t) C_t + \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t u_N(t) N_t - \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t u_C(t) \frac{\Pi_t^b}{P_t} = R_0 u_C(0) \frac{\mathbb{W}_0}{P_0}$$

The net profits of the banks can be written, from (7), as

$$\Pi_t^b = \left(\frac{1}{\theta + \omega} - 1 \right) \frac{S_t^b}{\phi_t}$$

As before we are assuming that $S_t^g = 0$,⁷ so that it follows that the constraint can be written as

$$\sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t u_C(t) C_t + \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t u_N(t) N_t + \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t u_N(t) \left(\frac{1}{\theta + \omega} - 1 \right) \frac{N_t}{\phi_t} = R_0 u_C(0) \frac{\mathbb{W}_0}{P_0}$$

The condition depends on the allocations only, except for the term on the initial wealth. For $\mathbb{W}_0 = 0$, the condition only depends on the allocations, and therefore the equivalence between interest rates or credit subsidies as a form of implementing the equilibrium set of allocations follows through also without lump sum taxes. The equivalence is established for interest rates that are not restricted to be positive. It follows that the zero bound constraint on interest rates is not a relevant constraint to police, also in this context.

4 Credit policies

We first describe the first best policy in this environment. This would be achieved if there could be lump sum revenues to finance negative interest rates or credit subsidies to firms. We

⁷We could also have assumed a full profit tax.

then exclude lump sum taxes and compute the optimal response of policy to shocks. Because of the equivalence between tax and interest rate policy, we set the nominal interest rate to zero and determine the optimal credit subsidy policy, in particular, in response to a financial shock.

4.1 The first best allocation with lump sum taxes

With lump sum taxes it is possible to achieve the first best by using credit subsidies rather than setting negative interest rates and $R_t^l = 1$.

The first best allocation requires

$$R_t^l (1 - \tau_t^l) = 1$$

Let's also set $R_t = 1$. It is possible to satisfy the other equilibrium conditions and achieve the first-best allocation:

$$A_0 N_0 = \phi_0 \frac{Z_0}{P_0}$$

is satisfied with P_0 ,

$$\frac{u_C(t)}{P_t} = E_t \frac{\beta u_C(t+1)}{P_{t+1}}, \quad (29)$$

is satisfied with P_{t+1} , $t \geq 0$,

$$A_t N_t = \phi_t \frac{Z_t}{P_t}, \quad t \geq 1,$$

is satisfied by Z_t ,

$$Z_t = (\theta + \omega) R_{t-1} \left[\left(\frac{R_{t-1}^l}{R_{t-1}} - 1 \right) \phi_{t-1} + 1 \right] Z_{t-1}, \quad t \geq 1$$

is satisfied by R_{t-1}^l , $t \geq 1$,

$$\phi_t = \frac{\eta_t}{\lambda - v_t}$$

is satisfied by ϕ_t , and the following conditions restrict the variables v_t , η_t , $\zeta_{t,t+1}$, $\varkappa_{t,t+1}$, $Q_{t,t+1}$

$$\begin{aligned} \zeta_{t,t+1} &= R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \\ \varkappa_{t,t+1} &= \frac{\phi_{t+1}}{\phi_t} R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \\ v_t &= E_t \left\{ (1 - \theta) Q_{t,t+1} R_t \left(\frac{R_t^l}{R_t} - 1 \right) + Q_{t,t+1} \theta \frac{\phi_{t+1}}{\phi_t} R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] v_{t+1} \right\} \\ \eta_t &= E_t \left\{ (1 - \theta) + Q_{t,t+1} \theta R_t \left[\left(\frac{R_t^l}{R_t} - 1 \right) \phi_t + 1 \right] \eta_{t+1} \right\} \end{aligned}$$

$$Q_{t,t+1} = \frac{u_C(t) P_{t+1}}{\beta u_C(t+1) P_t}.$$

Optimal policy can achieve the first-best by setting $R_t = 1$ and $R_t^l (1 - \tau_t^l) = 1$. The same allocation can also be achieved with a path for the policy rate that is higher than zero, $R_t > 1$, and with a higher subsidy τ_t^l that compensates not only the spread but also the policy rate.

A special feature of the first best equilibrium is that the dynamic response to shocks of all nominal variables are indeterminate. Real allocations are pinned down, but different impact movements in the initial price level would be accompanied by different subsidies τ_t^l and different values of real net worth, leverage, and credit spreads. However, lending rates net of the subsidy would remain fixed at zero, i.e. $R_t^l (1 - \tau_t^l) = 1$. The Ramsey planner would therefore be indifferent between the different adjustment paths of spreads, net worth and leverage in reaction to shocks. As it turns out, this is also a feature of an economy where the first best cannot be achieved but there is state contingent debt.

We proceed now by describing properties of the steady state.

4.2 The steady state

In a steady state with constant gross inflation Π , we have $\frac{P_{t+1}}{P_t} = \frac{W_{t+1}}{W_t} = \frac{S_{t+1}}{S_t} = \frac{Z_{t+1}}{Z_t} = \Pi$. The steady state conditions, with $\psi_t = 0$ are given by

$$\begin{aligned} \frac{1}{\chi C N^\varphi} &= \frac{R^l (1 - \tau^l)}{A} \\ C + G &= AN \\ R \frac{\beta}{\Pi} &= 1 \\ \frac{A}{R^l (1 - \tau^l)} N &= \phi \frac{Z_t}{P_t} \\ \Pi &= (\theta + \omega) \left[(R^l - R) \phi + R \right] \end{aligned} \tag{30}$$

where

$$\begin{aligned} \phi &= \frac{\eta}{\lambda - v} \\ v &= (1 - \theta) \frac{\beta}{\Pi} (R^l - R) + \frac{\beta}{\Pi} \theta \varkappa v \end{aligned} \tag{31}$$

$$\eta = (1 - \theta) + \frac{\beta}{\Pi} \theta \zeta \eta \tag{32}$$

$$\varkappa = \zeta = (R^l - R) \phi + R \tag{33}$$

Manipulating the conditions (31) with (33) above, we get

$$\eta = \frac{1 - \theta}{1 - \theta \left[\left(\frac{R^l}{R} - 1 \right) \phi + 1 \right]} \quad (34)$$

and

$$v = \frac{(1 - \theta) \left(\frac{R^l}{R} - 1 \right)}{1 - \theta \left[\left(\frac{R^l}{R} - 1 \right) \phi + 1 \right]}. \quad (35)$$

It follows that

$$\phi = \frac{\eta}{\lambda - v} = \frac{1 - \theta}{\lambda \left[1 - \theta \left[1 + \left(\frac{R^l}{R} - 1 \right) \phi \right] \right] - (1 - \theta) \left(\frac{R^l}{R} - 1 \right)}$$

implying that

$$1 - \theta - (1 - \theta) \left[\lambda - \left(\frac{R^l}{R} - 1 \right) \right] \phi + \theta \lambda \left(\frac{R^l}{R} - 1 \right) \phi^2 = 0. \quad (36)$$

Notice that equation (30) can be written as

$$\frac{\beta - \omega - \theta}{\theta + \omega} = \left(\frac{R^l}{R} - 1 \right) \phi,$$

where it must be that $\frac{\beta}{\theta + \omega} > 1$, or $\beta > \theta + \omega$. This expression together with equation (36) can be used to obtain an expression for leverage

$$\phi = \frac{\beta (1 - \theta)}{\lambda [\theta (1 - \beta) + \omega]}. \quad (37)$$

The spread is given by

$$\frac{R^l}{R} - 1 = \frac{\lambda (\beta - \theta - \omega) [\theta (1 - \beta) + \omega]}{(\theta + \omega) \beta (1 - \theta)} \quad (38)$$

and is thus independent of inflation.

With lump sum taxes, if the nominal interest could be negative, the Ramsey planner could implement the first best with monetary policy only, i.e. by setting $\tau^l = 0$. The optimal policy is to set $R^l = 1$. There is always a $R < 1$ that can satisfy the remaining equilibrium conditions, for a given P :

$$R \frac{\beta}{\Pi} = 1$$

$$AN = \phi \frac{Z}{P}$$

$$\Pi = (\theta + \omega) [(1 - R) \phi + R]$$

where

$$\phi = \frac{\beta (1 - \theta)}{\lambda [\theta (1 - \beta) + \omega]}.$$

The solution requires $R < 1$ because otherwise the bank would not be willing to lend.

As seen above, the same allocation could be achieved when the zero-lower bound on nominal interest rates is imposed, $R \geq 1$, with an appropriate choice of credit subsidy τ^l . In this case, the first-best allocation can be achieved through a combination of $R^l > 1$, $R = 1$ and τ^l such that $R^l(1 - \tau^l) = 1$. The optimal subsidy can be obtained using equation (38) and is given by

$$\frac{\tau^l}{1 - \tau^l} = \frac{\lambda(\beta - \theta - \omega)[\theta(1 - \beta) + \omega]}{(\theta + \omega)\beta(1 - \theta)} > 0.$$

4.3 Credit subsidies vs credit easing

Credit subsidies are not conventional policy, but they affect the economy in a very similar fashion to interest rate policy, except when the interest rate ought to be negative. Instead, the unconventional credit easing policies, such as the direct central bank lending to firms explored in Gertler and Karadi (2011), act in a very different way. While interest rate policy, or credit subsidies, in this economy aim at minimizing the costs of ensuring the private incentives to the financial intermediaries, direct lending by the central banks directly overcomes the need for those incentives, at a cost in terms of resources. The rationale for the resource cost can be a direct enforcement cost.

Whether a credit subsidy or direct central bank intermediation are preferable will depend on how severe is the financial friction relative to the resource cost. If the resource loss is deemed to be large, credit subsidies will be preferable in reaction to severe financial impairments. If the resource loss is small, central bank intermediation is preferable, because credit subsidies have budgetary implications, increasing public deficit and debt at times of crisis.

[To be completed]

4.4 Numerical analysis

This section illustrates the quantitative features of the model described in section 2 through an impulse response analysis.

We only have five parameters to calibrate. We use standard values for utility parameters: $\beta = 0.99$ and $\varphi = 0$. Concerning the financial sector parameters, we rely on Gertler and Karadi (2011). Specifically we use the same value as in that paper for the fraction of funds that can be diverted from the bank, λ , bankers' survival probability, θ , and the proportional transfer to entering bankers, ω . In the steady state of our model, these parameters imply an annualized

spread of 1.1 percent and a leverage ratio of 6. These values are roughly comparable to those in Gertler and Karadi (2011), where the annualized spread and leverage are 100 basis points and 4, respectively.

Government expenditure is set to zero in the figures.

We assume that the economy starts from the optimal steady state—that is, the steady state in which government debt and the fiscal subsidy are at their optimal level—and then look at impulse responses to i.i.d. shocks. The level of government debt must then be negative in the optimal steady state. The government holds positive assets in order to finance the optimal subsidy.

The impulse responses are the ones that would be obtained under commitment at an arbitrarily distant date in the future – assuming commitment is at time zero. We first abstract from fiscal policy, so that τ^l is kept constant at its optimal level. The policy interest rate is set at zero, but there is still room for price level policy. How this price level policy can actually be directly implemented is beyond the scope of this paper.

In this economy, the price level can move on impact and thus affect the real value of both banks' internal funds and government debt. This policy is extremely powerful since it can make real government debt and real internal funds effectively state contingent. In general, mimicking both state contingent government debt and state contingent internal funds through a single change in the price level is infeasible. For the particular example with a technology shocks that we compute, the optimal response of the price level achieves both goals.

In order to restrict the possibility of replicating state contingent debt (or money) and because, in practice, central banks are not able to change the price level on impact in response to shocks, we move on to study the case in which policy is exogenously prevented from changing prices on impact after the shock. In this case, fiscal policy can still improve allocations through credit subsidies and taxes.

All impulse responses are computed after solving the fully nonlinear, deterministic version of the model.

4.4.1 Optimal response to shocks at the ZLB

The impulse responses in Figures 1 through 5 are all under the assumption that lump sum taxes cannot be levied. The differences are between the case where only monetary and price level policy are considered (Figures 1 and 2), and the case when credit taxes and subsidies are

also considered (Figures 3-5). In the exercises in Figures 4 and 5 policy is restricted not to move the price level on impact.

Figure 1 shows the impulse responses to a 1% innovation in technology—the shock is assumed to be serially uncorrelated—when optimal policy is constrained by the zero bound on nominal interest rates. All variables are in deviation from the steady state.

As seen in figure 1, output responds to the shock exactly as it would in the first best. It increases one-to-one with the shock, while hours (not reported in the figure) remain constant. To deliver this outcome, optimal policy must ensure that leverage, hence spreads, do not change in reaction to the shock. In turn, this requires that the increase in the real value of loans necessary to finance the increase in production, $s_t = S_t/P_t$, is accompanied by a one-to-one increase in real value of net worth $z_t = Z_t/P_t$. This can be achieved through an impact fall in the price level, which must be reversed after one period to ensure that s_t and z_t return to their steady state values once the shock is reabsorbed. In the third period after the shock, all variables are back to steady state. In this exercise the movements in the price level needed to adjust the real value of internal funds is the same as the movement needed to adjust the real value of debt.

Figure 2 shows responses to a financial shock ξ_t , which causes a 1% exogenous fall in the value of banks' nominal internal funds—this shock is also assumed to be serially uncorrelated. As in Figure 1, optimal policy is constrained by the zero bound on nominal interest rates. Ceteris paribus, the shock would lead to a one-to-one reduction in real internal funds z_t and, for given amount of loans, an increase in banks' leverage ϕ_t . If lump sum taxes were available, policy would respond through a cut in the price level equal to the size of the shock. This response would completely stabilise the real value of internal funds, leverage and output. The same response would be optimal without lump sum taxes if credit subsidies could be used. Instead, when only price level policy can be used, the change in the price level that would be needed to adjust both the value of internal funds and debt, results in the price level actually increasing, reinforcing the drop in the real value of internal funds. That way, output drops, and in spite of the increase in the increase in the lending rate, the expenditure in the subsidy goes down. With lower outlays, the outstanding real value of government assets must go down, which is indeed the case when the price level goes up. In other words, to ensure a stationary level of government debt in steady state, the price level must increase slightly on impact. In real terms, the government debt increases and banks' net worth falls a bit more than implied

by the size of the shock. Leverage and credit spreads must increase, so that banks profits increase and net worth can be slowly rebuilt. Along the adjustment path, lending volumes and output remain below the steady state. This exercise also shows that the effects on the price level depend on the calibration that has the economy start from the efficient steady state where the government has enough assets to pay for the steady state level of the subsidy. Still, the general result that price level policy is not sufficient to deal with the effect of the shock, at the zero lower bound, is there, independently of the particular calibration.

When only price level policy is used, the impulse responses to a net worth shock are third best. The second best responses, which coincide with the first best responses in this economy, will have allocations not vary with the net worth shock. Figure 3 shows that the first best responses are implemented when we allow for time-varying fiscal subsidies (the impulse responses of figure 2 are also shown for comparison). Following the shock, the price level falls which cushions the reduction in net worth (by almost 50% compared to the case shown in Figure 2). However lending is kept unchanged in real terms. Net worth and leverage must increase and so do lending rates, but output is insulated from these financial developments through an impact increase in the credit subsidy. The increase in bank profits is such that net worth can be rebuilt in one quarter. After one quarter, prices return to steady state and so does the real value of government debt. The adjustment process is complete.

One way to understand the impulse responses with a time-varying credit subsidy in Figure 3 is to note that in this case price level policy can be used to guarantee that government bonds are state contingent, without other conflicting objectives such as guaranteeing also that real internal funds are adjusted optimally. The role of the credit subsidy is to ensure that real allocations are optimal, irrespective of the real value of banks' internal funds and leverage. Changes in the initial price level can thus be targeted to ensure that real government debt is state-contingent, and thus ensure the necessary financing of the credit subsidy.

Figures 4 and 5 show how this outcome is altered when government bonds cannot be made state-contingent because of a restriction to policy that does not allow for the price level to be moved on impact. They focus on the case in which policy is prevented from changing the price level on impact.

Following a technology shock, shown in Figure 4, the real value of banks' net worth cannot be changed on impact. To allow for an increase in production, leverage must increase. The ensuing increase in loan rates, however, has almost no effect on the real economy, thanks to

a parallel increase in the subsidy τ_t^l . Real allocations are similar to the first best, but the economy does not return to the original steady state. The increase in the subsidy ultimately leads to a small, permanent increase in the real value of government debt. The economy settles on a new steady state, where the higher debt is financed through a slightly lower level of the subsidy. Output also falls permanently to a marginally lower level.

Qualitatively similar results are obtained in response to a shock to the value of internal funds—see Figure 5. The impulse response of output is relatively close to the first best, but this requires an initial increase in the credit subsidy which leads to a permanent increase in real government debt. A 12% shock to internal funds, which in our model would cause an increase in spreads by 1.5% as in the last quarter of 2008, would lead to a 1.4% increase in real government debt in the new steady state.

5 Concluding remarks

We have analyzed optimal monetary and fiscal policy in reaction to financial shocks in an economy where the nonnegativity of the policy rate is a binding constraint to monetary policy.

We have shown that credit subsidies and taxes can be employed to shield the economy from the adverse consequences of financial shocks on credit spreads. The subsidy can implement the first best when monetary policy is constrained if it can be financed in a lump sum fashion. However, without lump sum taxes, or without state contingent debt, a policy of credit subsidies and taxes is not fully effective. When debt cannot be made state contingent, the financing of the credit subsidy induces permanent effects on taxes, government debt, and output.

Credit subsidies are not conventional policy, but they affect the economy in a very similar fashion to interest rate policy, except when the interest rate ought to be negative. Instead, the unconventional credit easing policies, such as the direct central bank lending to firms explored in Gertler and Karadi (2011), act in a very different way. While interest rate policy, or credit subsidies, in this economy aim at minimizing the costs of ensuring the private incentives to the financial intermediaries, direct lending by the central banks directly overcomes the need for those incentives, at a cost in terms of resources. The rationale for the resource cost can be a direct enforcement cost.

Whether a credit subsidy or direct central bank intermediation are preferable will depend on how severe is the financial friction relative to the resource cost. If the resource loss is deemed

to be large, credit subsidies will be preferable in reaction to severe financial impairments. If the resource loss is small, central bank intermediation is preferable, because credit subsidies have budgetary implications, increasing public deficit and debt at times of crisis.

Appendix

[To be written]

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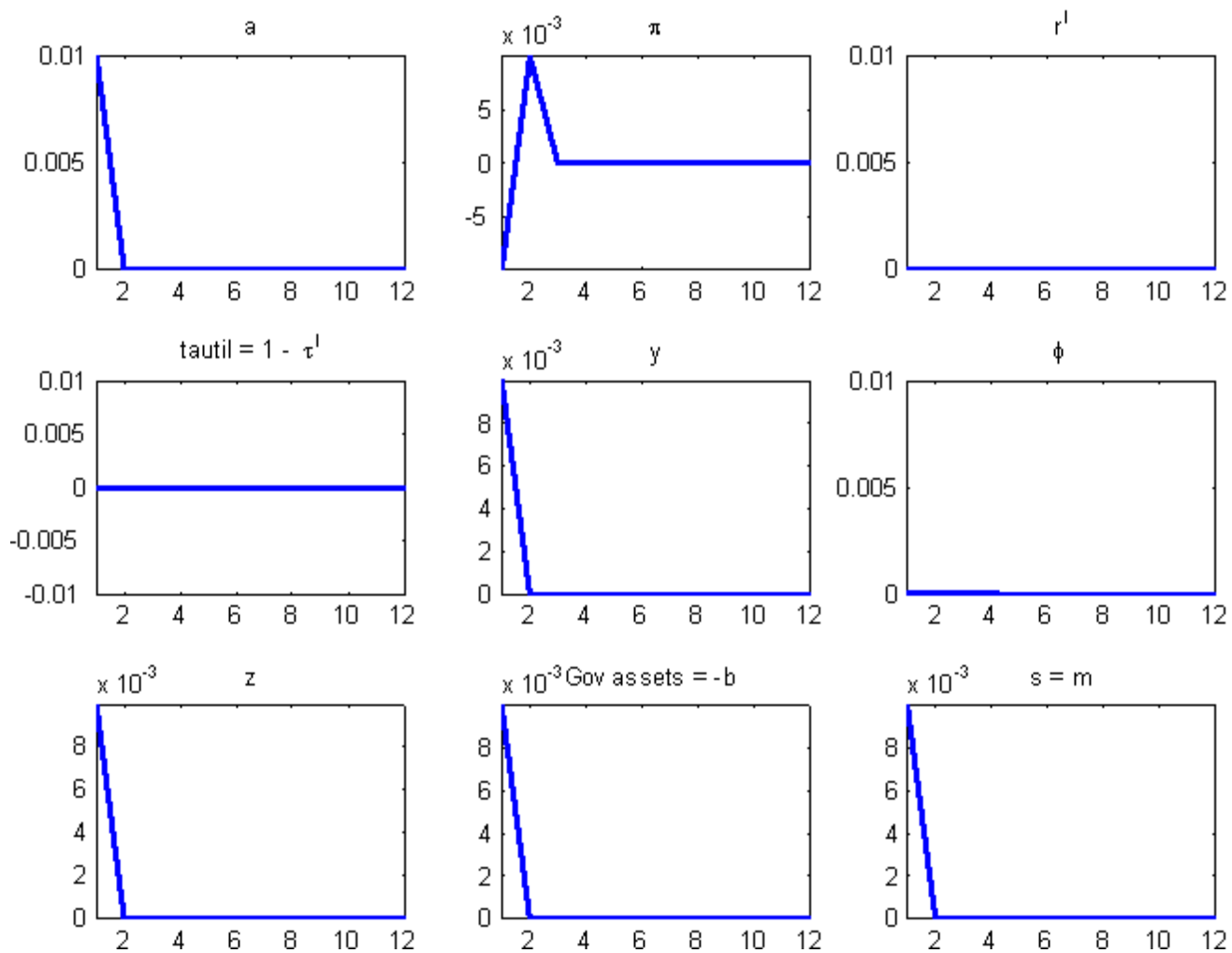


Figure 1: Impulse responses to a technology shock: optimal price level policy

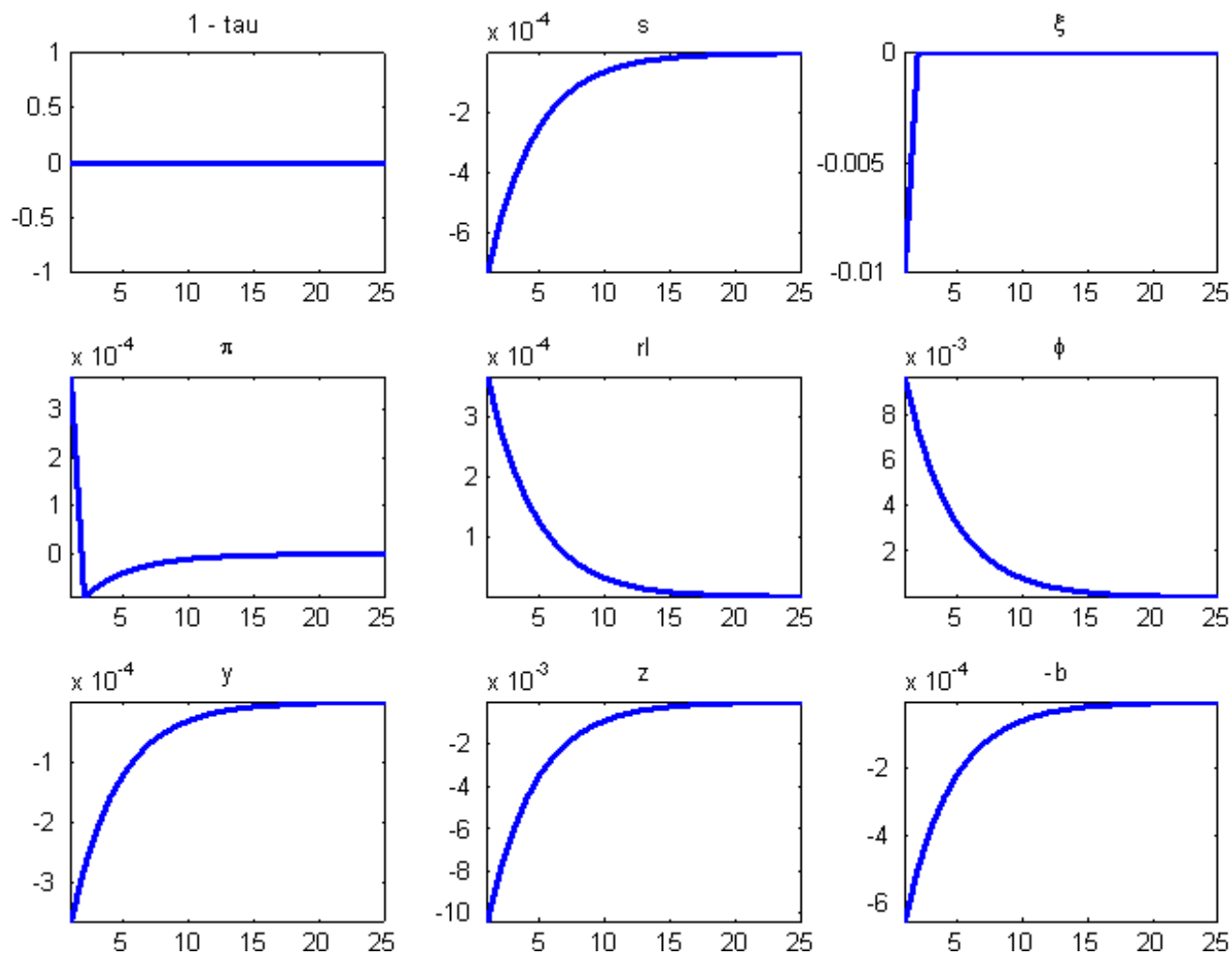


Figure 2: Impulse responses to a net worth shock: optimal price level policy

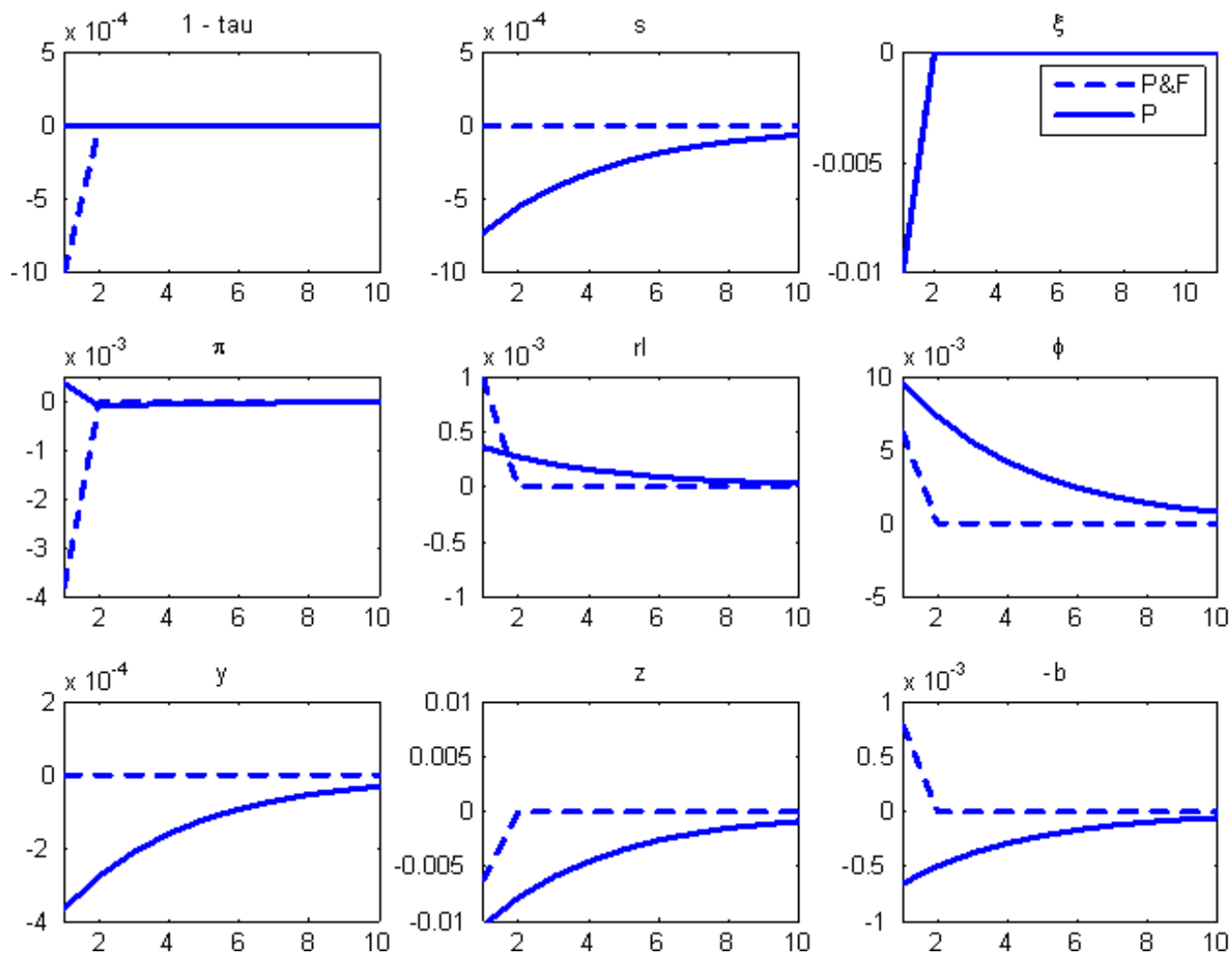


Figure 3: Impulse responses to a technology shock: optimal price level (P) vs. price level and fiscal (P&F) policy

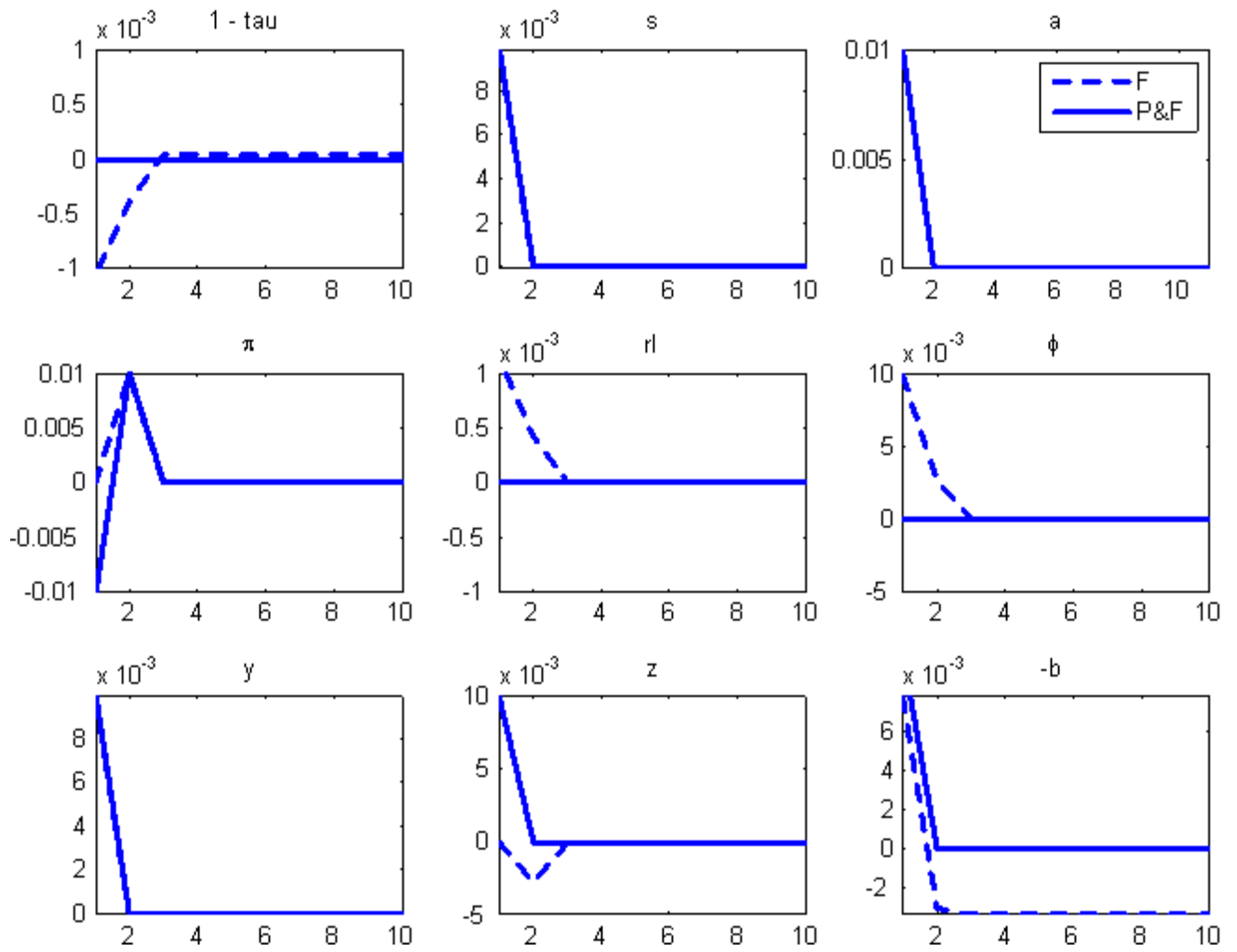


Figure 4: impulse responses to a technology shock: optimal price level and fiscal (P&F) vs. fiscal policy (F).

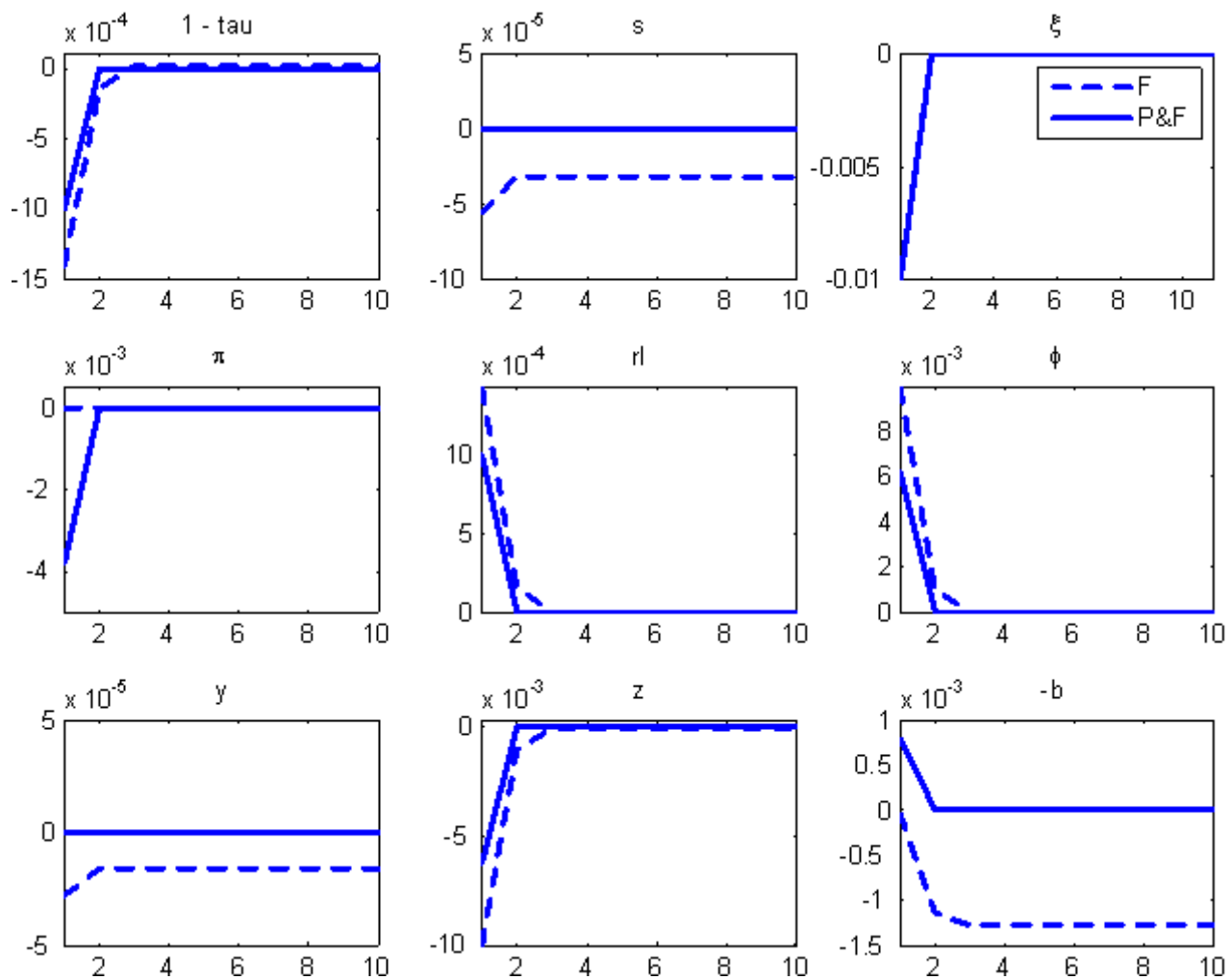


Figure 5: impulse responses to a net worth shock: optimal price level and fiscal (P&F) vs. fiscal policy (F).