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Fiscal policy and optimal monetary rules in a non-Ricardian economy

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Abstract

We study in this article how the conduct of fiscal policy interacts with the choice of optimal monetary rules by a central bank. We consider a non-Ricardian model with nondistortionary fiscal policies, and compare two policy packages, one where fiscal and monetary policies are simultaneously optimized, and one where monetary policy is optimized under a given fiscal policy. We find a number of results that would not appear in the traditional Ricardian framework: (a) the optimal monetary rule may be activist when fiscal policy is kept inactive, whereas it is not when combined with optimal fiscal policy; (b) combining optimally fiscal and monetary policies may lead to far superior outcomes, even when, following Sargent and Wallace (1975, Journal of Political Economy 83, 241–254), government is allowed to react to much less information.

JEL classification: E52; E63

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1. Introduction

The study of optimal interest rate rules for monetary authorities has recently been the object of a renewed and vigorous interest (for a panorama of recent work, see, for example, McCallum, 1999; Taylor, 1999a). In line with the recent trends in macroeconomics, several authors quite naturally investigated and characterized optimal interest rate policies in rigorous dynamic general equilibrium RBC type models.[1]

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[1] See, for example, Clarida et al. (1999), Collard (1999), Erceg et al. (2000), Woodford (1999), and the contributions in the book edited by Taylor (1999b).

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A related important line of literature has studied the joint determination of monetary and fiscal policies in a rigorous intertemporal framework, quite often including distortionary taxes.[2]

A majority of these studies is set in the framework of the traditional infinitely lived consumer model. This is a "Ricardian" framework and therefore, if we consider lump-sum fiscal policy (which we will), the study of optimal interest rules can be conducted independently from that of fiscal policy.

What we want to do in this article is to consider a non-Ricardian framework, and study how the conduct of fiscal policy interacts with the choice of the optimal monetary rules by the central bank. In order to make the results of this interaction more clearcut, we shall compare two policy packages, one where the fiscal and monetary authorities coordinate to jointly optimize their policies, the other where the monetary authority chooses its policy on the basis of a given fiscal policy. Comparison of the two will yield a number of interesting results:

- First, we find that setting optimal monetary policy without a simultaneous optimization of fiscal policy is likely to lead to major distortions in the design of policy. For example, we shall find below that, although monetary policy should be activist under a "passive" fiscal policy, it can become nonactivist once combined with optimal fiscal policies in the same model.
- Secondly, we shall find out that the fiscal–monetary combination allows to reach much better outcomes. If no further qualification was made, this would be a trivial statement since one more policy instrument is added. But it will not be: indeed, considering monetary policy alone we allow, as in the recent literature on optimal monetary rules, for monetary policy to respond to any shock, including the current ones. This clearly gives a strong informational bias in favor of monetary policy effectiveness, as was pointed out long ago by Sargent and Wallace (1975, 1976). So, following them, we shall impose on the fiscal–monetary mix the restriction that both policies can be based on past shocks only. In spite of these much more stringent informational constraints, we find that the fiscal–monetary mix performs better.

2. The model

As we indicated above, we want a non-Ricardian framework; so we shall consider a monetary overlapping generations model (Samuelson, 1958) with production. The economy includes representative firms, households, and the government.

Households of generation t live for two periods. They work an amount L_t for a wage W_t, consume C_t in period t, and C'_{t+1} in period $t+1$. They maximize the expected value of their utility U_t according to

$$U_t = \alpha_t \log C_t + \log C'_{t+1} - \frac{(1+\alpha_t)L_t}{\nu_t}, \tag{1}$$

[2] See, for example, Adao et al. (2000), Chari et al. (1991), Lucas and Stokey (1983).

where α_t is a positive stochastic variable whose variations represent demand shocks and ν_t is a shock on the supply of labor (see Eq. (13)). Households are submitted in each period of their life to a "cash in advance" constraint:

$$m_t \geqslant \theta_t P_t C_t, \qquad m'_{t+1} \geqslant P_{t+1} C'_{t+1}, \tag{2}$$

where θ_t is a stochastic shock representing the inverse of the "velocity of money." Note that the old household, who is in the last period of his life, has to pay hundred percent cash. The total quantity of money is $M_t = m_t + m'_t$. We see that the young household, who starts life without any financial asset, will need to borrow money from the central bank in order to satisfy this cash-in-advance constraint. He can do so at the interest rate i_t set by the government. He borrows $\theta_t P_t C_t$, so that the central bank profit is

$$\Phi_t = i_t \theta_t P_t C_t. \tag{3}$$

We assume that the central bank redistributes these profits to the young households.[3]

The representative firm has a production function

$$Y_t = Z_t L_t, \tag{4}$$

where Y_t is output, L_t labor input, and Z_t a technology shock common to all firms. We assume that the firms belong to the young households, to which they distribute their profits, if any.

In order to simplify the exposition, we shall assume that the shocks α_t, ν_t, θ_t, and Z_t are stochastic i.i.d. variables.

2.1. Information sets and the equilibrium concept

The economy we consider is hit in each period by four stochastic shocks (α_t, ν_t, θ_t, and Z_t). Let us denote by s_t the current realization of these shocks, and by s^t the history of these shocks up to time t included.

A competitive equilibrium consists of allocations and prices $C_t(s^t)$, $C'_t(s^t)$, $L_t(s^t)$, $Y_t(s^t)$, $P_t(s^t)$, and $W_t(s^t)$ such that: (a) all usual optimality conditions for firms and households apply; (b) goods and labor markets clear.

In the case of preset prices, all above variables will be still function of s^t, except for the price which will be preset on the basis of the previous period's information s^{t-1}, and symmetrically for preset wages.

In what follows, in order to have a more compact notation, we shall not make explicit the dependance of allocations on s^t, by writing, for example, C_t instead of $C_t(s^t)$, unless this is useful for the comprehension. But the above structure is clearly implicit in all that follows.

2.2. Government policies and the comparison

Government has two potential policy instruments: It sets the interest rate i_t (monetary policy). It can also give lump-sum monetary transfers T_t to the old households (fiscal

[3] This assumption is only made to simplify calculations below.

policy). The counterpart of these monetary transfers is monetary creation, so we should note that our fiscal policy is different from "traditional" fiscal policy, where these transfers are financed by bond creation.[4]

We shall compare, for various assumptions on price and wage rigidity, two different sets of policies:

- In the first one, we derive the optimal monetary rule assuming a "passive" fiscal policy; more precisely, we set fiscal transfers to zero. On the other hand, we assume, following the recent literature on monetary rules, that the central bank is allowed to react to the *current* shocks. So this policy package, denoted "passive fiscal policy," is characterized by

$$i_t = i_t(s^t), \qquad T_t = 0. \tag{5}$$

- In the second one, we assume that the government can freely use both fiscal and monetary policies, but can react to past shocks only, and not to any contemporaneous shocks. This takes into account the famous Sargent and Wallace (1975) critique, who blamed Keynesian models for deriving policy activism from an informational advantage on the side of government. So this policy package, denoted "optimized fiscal policy," is characterized by

$$i_t = i_t(s^{t-1}), \qquad T_t = T_t(s^{t-1}). \tag{6}$$

We see that it is not clear *a priori* which will lead to better results. On the one hand, the "optimized fiscal policy" package uses one more instrument. On the other hand, the "passive fiscal policy" package uses full information on the current shocks, which clearly gives a strong informational advantage to the central bank.

2.3. *The criterion*

In order to assess the optimality properties of the two sets of policies, we shall use the criterion proposed by Samuelson for the overlapping generations model (Samuelson, 1967, 1968; Abel, 1987) and assume that in period t the government maximizes the function V_t:

$$V_t = E_t \sum_{s=t-1}^{\infty} \beta^{s-t} U_s. \tag{7}$$

The sum starts at $s = t - 1$ because the household born in $t - 1$ is still alive in t. Rearranging the terms in the infinite sum (7), we find that, up to a constant, the criterion V_t can be rewritten in the more convenient form:

$$V_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} \Delta_s \tag{8}$$

[4] This fiscal policy is thus somehow a hybrid of standard fiscal policy and monetary policy. We call it fiscal policy in order to have a simple terminology.

with

$$\Delta_t = \alpha_t \log C_t + \frac{\log C'_t}{\beta} - \frac{(1+\alpha_t)L_t}{\nu_t}. \tag{9}$$

3. General equilibrium relations

For the policy evaluations that will follow, we will need to know the equilibrium values of a number of macroeconomic variables.

Consider first the problem of the old households in period t, and denote by Ω_t the financial wealth that the old households own at the beginning of period t, *including* the period t transfer T_t. With a hundred percent cash-in-advance constraint, their consumption C'_t is simply given by

$$P_t C'_t = \Omega_t. \tag{10}$$

Now let us write the maximization program of the young household born in t. When young, the representative household receives wages $W_t L_t$, firms' profits $\Pi_t = P_t Y_t - W_t L_t$, and central bank profits denoted as Φ_t. He will receive a transfer T_{t+1} from the government when old. If he consumes C_t in the first period of his life, he will end up in the second period with a financial wealth:

$$\Omega_{t+1} = (W_t L_t + \Pi_t + \Phi_t + T_{t+1}) - (1 + \theta_t i_t) P_t C_t. \tag{11}$$

In view of (10), the expected value of $\log C'_{t+1}$ is, up to a constant, equal to $\log \Omega_{t+1}$, so that the household in the first period of his life solves the following program:

$$\begin{aligned} \text{Maximize} \quad & \alpha_t \log C_t + \log \Omega_{t+1} - \frac{(1+\alpha_t)L_t}{\nu_t} \\ \text{s.t.} \quad & \Omega_{t+1} = (W_t L_t + \Pi_t + \Phi_t + T_{t+1}) - (1 + \theta_t i_t) P_t C_t. \end{aligned}$$

Note that, since $T_{t+1} = T_{t+1}(s^t)$ is a function of variables up to period t, it is known to the household when deciding on quantities supplied and demanded, so that the above program is deterministic. The first-order conditions for this program yield:

$$P_t C_t = \frac{\alpha_t}{1+\alpha_t} \frac{W_t L_t + \Pi_t + \Phi_t + T_{t+1}}{1 + \theta_t i_t} = \frac{\alpha_t}{1+\alpha_t} \frac{P_t Y_t + \Phi_t + T_{t+1}}{1 + \theta_t i_t}, \tag{12}$$

$$L_t^s = \nu_t - \frac{\Pi_t + \Phi_t + T_{t+1}}{W_t}. \tag{13}$$

Equation (12) is the usual consumption function, while Eq. (13) gives the Walrasian supply of labor. We also have the balance equation for the goods market:

$$C_t + C'_t = Y_t = Z_t L_t. \tag{14}$$

Equations (3), (4), (10)–(12), and (14) are valid in all circumstances, whether markets clear or not. Combining them we obtain the following relations, also valid in all cases:

$$P_t Y_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{1 + \theta_t i_t} + \Omega_t, \tag{15}$$

$$P_t C_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{1 + \theta_t i_t}, \tag{16}$$

$$\Omega_{t+1} = \Omega_t + T_{t+1}. \tag{17}$$

Now, if the labor market clears, Eq. (13) is valid. Combining it with relations (3), (10), (14), and (16), we obtain

$$W_t = \frac{1 + \alpha_t}{\nu_t}(\Omega_t + T_{t+1}). \tag{18}$$

Finally, if the goods market clears, price is equal to marginal cost, so that

$$P_t = \frac{W_t}{Z_t}. \tag{19}$$

Before moving to the study of optimal fiscal–monetary policies under preset prices and wages, we may already point out an important difference between our non-Ricardian model and the traditional model with a single dynasty of consumers. In the latter, as is well known, some interest rate rules give rise to price indeterminacy. For example, a nominal interest rate peg will result in nominal price indeterminacy.[5] On the contrary, Eqs. (18) and (19) show that in this model the Walrasian price and wage are fully determinate whatever the interest rate rule. As a result, we will not have to worry about price determinacy when studying optimal policies below.

4. Preset prices

We shall begin our study of nominal rigidities with preset prices and make the assumption, traditional in the literature,[6] that the preset price is equal to the expected value of the Walrasian price, i.e.:

$$P_t = E_{t-1} P_t^* = E\left(P_t^* \mid s^{t-1}\right). \tag{20}$$

Combining (18) and (19), we find that the Walrasian price is equal to

$$P_t^* = \frac{(1 + \alpha_t)(\Omega_t + T_{t+1})}{\nu_t Z_t}. \tag{21}$$

So the preset price is equal to

$$P_t = E_{t-1}\left[\frac{(1 + \alpha_t)(\Omega_t + T_{t+1})}{\nu_t Z_t}\right]. \tag{22}$$

[5] This issue was first raised by Sargent and Wallace (1975).

[6] Of course, it would be preferable to assume that firms set their prices at the beginning of the period by maximizing expected profits weighted by the marginal utility of income in the corresponding state of the world. Although the resulting pricing formula looks qualitatively similar, it is unfortunately impossible to obtain closed form solutions such as the ones we will obtain here, notably because the constraint that the interest rate is always nonnegative creates two regimes, and prevents a simple solution.

4.1. The equilibrium

Since the labor market clears, Eqs. (10), (14)–(16), and (18) hold. Combining them, we obtain the values of the preset price equilibrium quantities:

$$C_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{(1+\theta_t i_t)P_t}, \tag{23}$$

$$C'_t = \frac{\Omega_t}{P_t}, \tag{24}$$

$$L_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{(1+\theta_t i_t)P_t Z_t} + \frac{\Omega_t}{P_t Z_t}. \tag{25}$$

4.2. Passive fiscal policy

We shall now study the optimal monetary rule, assuming that the monetary authority sets interest rates under full knowledge of all shocks, and that the fiscal policy is passive, this last assumption being formalized by having zero fiscal transfers all the time:

$$T_t = 0, \quad \forall t. \tag{26}$$

Proposition 1. *Under preset prices and the passive fiscal policy* (26), *the optimal interest rate rule is*

$$i_t = \frac{1}{\theta_t} \max\left[0, \frac{\nu_a(1+\alpha_t)Z_a}{\nu_t(1+\alpha_a)Z_t} - 1\right], \tag{27}$$

where

$$\alpha_a = E(\alpha_t), \qquad \frac{1}{Z_a} = E\left(\frac{1}{Z_t}\right), \qquad \frac{1}{\nu_a} = E\left(\frac{1}{\nu_t}\right). \tag{28}$$

Proof. Combining (22) and (26), the preset price is equal to

$$P_t = E_{t-1}\left[\frac{(1+\alpha_t)(\Omega_t + T_{t+1})}{\nu_t Z_t}\right] = \frac{(1+\alpha_a)\Omega_t}{\nu_a Z_a} \tag{29}$$

and the equilibrium quantities are:

$$C_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{(1+\theta_t i_t)P_t} = \frac{\nu_a \alpha_t Z_a}{(1+\theta_t i_t)(1+\alpha_a)}, \tag{30}$$

$$C'_t = \frac{\Omega_t}{P_t} = \frac{\nu_a Z_a}{1+\alpha_a}, \tag{31}$$

$$L_t = \frac{\nu_a Z_a}{(1+\alpha_a)Z_t}\left(\frac{\alpha_t}{1+\theta_t i_t} + 1\right). \tag{32}$$

So we have to maximize in i_t, for each value of the shocks:

$$\begin{aligned}\Delta_t &= \alpha_t \log\left[\frac{\nu_a \alpha_t Z_a}{(1+\alpha_a)(1+\theta_t i_t)}\right] + \frac{1}{\beta}\log\left(\frac{\nu_a Z_a}{1+\alpha_a}\right) \\ &\quad - \frac{\nu_a(1+\alpha_t)Z_a}{\nu_t(1+\alpha_a)Z_t}\left(\frac{\alpha_t}{1+\theta_t i_t} + 1\right),\end{aligned} \tag{33}$$

subject to the constraint $i_t \geqslant 0$. The solution is Eq. (27). □

To discuss the above results, let us define the "composite shock" Λ_t as

$$\Lambda_t = \frac{1+\alpha_t}{\nu_t Z_t}, \qquad \Lambda_a = \frac{1+\alpha_a}{\nu_a Z_a}. \tag{34}$$

Rule (27) can be rewritten as

$$i_t = \frac{1}{\theta_t} \max\left[0, \frac{\Lambda_t}{\Lambda_a} - 1\right]. \tag{35}$$

We may first note that this optimal interest rule is highly nonlinear. It dampens the effects of the shock Λ_t when it is above average, i.e., when $\Lambda_t > \Lambda_a$. But it is totally inactive for low values of this shock because of the constraint $i_t \geqslant 0$.

We may further inquire how much this policy stabilizes imbalances on the goods market. These imbalances are well represented by the deviations from unity of the ratio $W_t/P_t Z_t$. We have already computed the value of P_t (Eq. (29)). Now from Eq. (18), since the labor market clears in this case

$$W_t = \frac{(1+\alpha_t)\Omega_{t+1}}{\nu_t} = \frac{(1+\alpha_t)\Omega_t}{\nu_t}, \tag{36}$$

so that

$$\frac{W_t}{P_t Z_t} = \frac{\nu_a(1+\alpha_t)Z_a}{\nu_t(1+\alpha_a)Z_t} = \frac{\Lambda_t}{\Lambda_a}. \tag{37}$$

We see that the interest rate policy is powerless against imbalances on the goods markets, whether they are provoked by demand, productivity or labor supply shocks.

We may note also, looking at Eq. (37), that for some values of the shocks we may have $W_t/P_t Z_t < 1$. In such a case firms would rather shut down than serving demand, as we have assumed so far. We show in Appendix A that introducing imperfect competition allows to reconcile profit maximization with the assumption that demand is always served, provided that shocks are not too big.

4.3. *Optimized fiscal policy*

We shall now see that a combination of optimal monetary and fiscal policies, even under quite more stringent informational constraints, allows to solve some of the above problems. We first characterize the optimal fiscal and monetary policies through the following proposition.

Proposition 2. *Under preset prices, the optimal monetary and fiscal policies are given by*

$$i_t = 0, \tag{38}$$

$$\frac{\Omega_t + T_{t+1}}{\Omega_t} = \frac{\beta \nu_t (1+\alpha_a) Z_t}{\nu_a(1+\alpha_t)Z_a} = \frac{\beta \Lambda_a}{\Lambda_t}. \tag{39}$$

Proof. In order to find the optimal policy in a simple manner, we shall use a slightly roundabout method, which uses essentially the fact that the value of C'_t in (24) is independent of all shocks. So we shall proceed in two steps: (a) we shall compute the best possible situation attainable under the constraint that C'_t is independent of all shocks; (b) we shall show that the policy defined by (38) and (39) actually leads to this best situation, so that it is indeed the optimal policy.

Let us now carry out step (a). For that we shall maximize the expected value of the "period t utility" Δ_t:

$$\Delta_t = \alpha_t \log C_t + \frac{1}{\beta} \log C'_t - \frac{(1+\alpha_t) L_t}{\nu_t}, \tag{40}$$

subject to the feasibility constraint $C_t + C'_t = Z_t L_t$ and the condition that C'_t be independent of all shocks. Let us first insert the feasibility constraint into (40). The maximand Δ_t becomes

$$\alpha_t \log C_t + \frac{1}{\beta} \log C'_t - \frac{(1+\alpha_t)(C_t + C'_t)}{\nu_t Z_t}. \tag{41}$$

So we have to maximize the expected value of (41) under the constraint that C'_t is independent of α_t, ν_t, and Z_t. Since there is no constraint on C_t, we immediately find:

$$C_t = \frac{\alpha_t \nu_t Z_t}{1+\alpha_t}. \tag{42}$$

As for C'_t, this amounts to maximizing the following quantity:

$$\frac{1}{\beta} \log C'_t - \frac{(1+\alpha_a) C'_t}{\nu_a Z_a}, \tag{43}$$

which yields

$$C'_t = \frac{\nu_a Z_a}{\beta(1+\alpha_a)}. \tag{44}$$

We shall now move to step (b), and show that policies (38) and (39) allow indeed to reach the allocation defined by (42) and (44). In order to show this, we equalize the values in (23) and (24) to those in (42) and (44):

$$C_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{(1+\theta_t i_t) P_t} = \frac{\alpha_t \nu_t Z_t}{1+\alpha_t}, \tag{45}$$

$$C'_t = \frac{\Omega_t}{P_t} = \frac{\nu_a Z_a}{\beta(1+\alpha_a)}. \tag{46}$$

Using first Eq. (45), and comparing the resulting value of P_t with the value of the Walrasian price P_t^* in Eq. (21), we obtain

$$P_t = \frac{(1+\alpha_t)(\Omega_t + T_{t+1})}{(1+\theta_t i_t)\nu_t Z_t} = \frac{P_t^*}{1+\theta_t i_t}. \tag{47}$$

Since $P_t = E_{t-1} P_t^*$, the only way to make these consistent is to have $i_t = 0$ (Eq. (38)). Inserting $i_t = 0$ into Eqs. (45) and (46), we obtain:

Table 1
A comparison of the two policy packages

	Optimized fiscal policy	Passive fiscal policy
Fiscal policy	$\frac{\Omega_t + T_{t+1}}{\Omega_t} = \frac{\beta \Lambda_a}{\Lambda_t}$	$T_{t+1} = 0$
Monetary rule	$i_t = 0$	$i_t = \frac{1}{\theta_t} \max\left[0, \frac{\Lambda_t}{\Lambda_a} - 1\right]$
$\frac{W_t}{P_t Z_t}$	$\frac{W_t}{P_t Z_t} = 1$	$\frac{W_t}{P_t Z_t} = \frac{\Lambda_t}{\Lambda_a}$

$$\Omega_t + T_{t+1} = \frac{\nu_t P_t Z_t}{1 + \alpha_t}, \tag{48}$$

$$P_t = \frac{\beta(1 + \alpha_a)\Omega_t}{\nu_a Z_a}. \tag{49}$$

Combining (48) and (49), we obtain the optimal fiscal policy (Eq. (39)). □

The optimal policy mix consists of Eqs. (38) and (39). The optimal interest rate rule is a passive one ($i_t = 0$). Optimal fiscal policy (39) reacts countercyclically to demand shocks α_t. Moreover, it reacts positively to productivity shocks Z_t and labor supply shocks ν_t.

This policy further has a remarkable feature: indeed, with $i_t = 0$ Eq. (47) becomes

$$P_t = P_t^*. \tag{50}$$

Even though the price is preset before the shocks are revealed, the goods market is always cleared under our optimal policy!

4.4. A comparison

We can now compare the optimal monetary rules under passive and optimized fiscal policies. The most salient features of the two policy packages are compared in Table 1, where the composite shock Λ_t has been defined in Eq. (34).

On this we see particularly well the two points outlined in the introduction:

(a) The nature of the optimal monetary rule changes completely from one experiment to the other: when combined with an optimized fiscal policy, the monetary policy is “nonactivist” (although the zero interest rate plays a central role in neutralizing monetary shocks), and the fiscal policy is activist. When combined with a passive fiscal policy, in the contrary, the optimal interest rate policy becomes activist (although in an asymmetrical manner).

(b) As far as the goods market is concerned, the performances of the two policies are quite unequal. The combination of optimal fiscal and monetary policies completely eliminates imbalances in the goods market, even though it uses information from previous periods only. Under a passive fiscal policy, the optimal monetary rule cannot prevent shocks to create goods market imbalances, even though it makes full use of all current information.

5. Preset wages

We shall now assume that, instead of prices, it is the wages that are preset according to the formula

$$W_t = E_{t-1} W_t^* = E\left(W_t^* \mid s^{t-1}\right). \tag{51}$$

The value of W_t^* is given in Eq. (18), so that the preset wage is equal to

$$W_t = E_{t-1}\left[\frac{1+\alpha_t}{\nu_t}(\Omega_t + T_{t+1})\right]. \tag{52}$$

The study of the preset wages case is actually quite similar to that of preset prices. So, rather than going through all the steps, we shall limit ourselves to the main results.[7] Let us start with the optimal monetary rule under passive fiscal policy, which is characterized by the following proposition.

Proposition 3. *Under preset wages and the fiscal policy $T_t = 0$, the optimal interest rate rule is*

$$i_t = \frac{1}{\theta_t} \max\left[0, \frac{\nu_a(1+\alpha_t)}{\nu_t(1+\alpha_a)} - 1\right]. \tag{53}$$

This time the optimal interest rate rule is function of the composite shock $(1+\alpha_t)/\nu_t$. We note that, as in the preset prices case, this optimal interest rule is nonlinear: it dampens the effects of the composite shock when it is above average, i.e., when $(1+\alpha_t)/\nu_t > (1+\alpha_a)/\nu_a$. But it is totally inactive for deflationary shocks because of the constraint $i_t \geqslant 0$.

We may also inquire how well the labor market is stabilized through this rule. Here a good indicator is the discrepancy between labor demand and labor supply, which can be computed as

$$L_t - L_t^s = \nu_t\left[\frac{\nu_a(1+\alpha_t)}{\nu_t(1+\alpha_a)} - 1\right]. \tag{54}$$

We see that the interest rate policy is powerless to cure employment imbalances. It turns out that optimizing on both the fiscal and monetary policies allows to solve that problem. The optimal policy is characterized in the preset wages case through the following proposition.

Proposition 4. *Under preset wages, the optimal fiscal–monetary policy mix is given by*

$$i_t = 0, \tag{55}$$

$$\frac{\Omega_t + T_{t+1}}{\Omega_t} = \frac{\beta\nu_t(1+\alpha_a)}{\nu_a(1+\alpha_t)}. \tag{56}$$

[7] A full version with proofs is available from the author.

The optimal policy mix combines a passive monetary policy ($i_t = 0$) to an activist countercyclical fiscal policy. Similarly to the preset prices case, the preset wage is equal in all circumstances to the Walrasian wage:

$$W_t = W_t^*. \tag{57}$$

This means that, whatever the value of the shocks, the labor market will be cleared at all times in spite of the preset wages!

6. Conclusions

We studied in this paper the interaction between fiscal policy and optimal monetary rules in a non-Ricardian economy, and obtained results that would not hold in the traditional Ricardian framework.

First, we saw that different fiscal policies can lead to dramatically different results in terms of the resulting optimal monetary rule: in our example, the monetary rule is activist when fiscal policy is passive, whereas it becomes non-activist when fiscal policy is optimized.

Secondly, we saw that the optimal combination of monetary and fiscal policies leads to better outcomes, even though we constrain much more the information available to the policymakers. In our example, the goods (or labor) market is cleared when the optimal mix of fiscal and monetary policies is used. On the contrary, under a passive fiscal policy, the optimal interest rule can stabilize neither the goods nor the labor market.

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Appendix A

We saw in deriving the optimal monetary rule in the preset prices case (Section 4.2) that for some values of the shocks firms would make negative profits by serving demand, and therefore that they would rather shut down in the corresponding states of the world.

In this appendix we shall introduce imperfect competition à la Dixit–Stiglitz (1977), and show that, provided that shocks are not too big (in a way that will be made precise in Eq. (77)), firms will always be willing to satisfy the demand for goods.

A.1. The model

We shall thus consider the preset prices case. The households are exactly the same. Production is now carried in two steps. Monopolistically competitive intermediate firms indexed by $j \in [0,1]$ produce intermediate goods j with labor according to the production functions

$$Y_{jt} = Z_t L_{jt}, \tag{58}$$

where Z_t is a common productivity shock. These intermediate goods are assembled by competitive firms endowed with the technology

$$Y_t = \left(\int_0^1 Y_{jt}^{\sigma} \right)^{1/\sigma}, \quad 0 < \sigma \leqslant 1. \tag{59}$$

We further assume that each firm j sees its production subsidized at a rate $1/\sigma \geqslant 1$, so that the profits of firm j are equal to

$$\Pi_{jt} = \frac{1}{\sigma} P_{jt} Y_{jt} - W_t L_{jt}. \tag{60}$$

Such subsidies are traditionally introduced in order to counteract some negative welfare effects of imperfect competition. The subsidy rate is equal to the "monopolistic markup" $1/\sigma$ derived from the function (59).

A.2. Price setting

From (59), the demand for each intermediate j is given by

$$Y_{jt} = Y_t \left(\frac{P_{jt}}{P_t} \right)^{-1/(1-\sigma)} \tag{61}$$

with

$$P_t = \left(\int_0^1 P_{jt}^{-\sigma/(1-\sigma)} \, \mathrm{d}j \right)^{-(1-\sigma)/\sigma}. \tag{62}$$

Accordingly, the profits of firm j are equal to

$$\Pi_{jt} = \frac{1}{\sigma} P_t Y_t \left(\frac{P_{jt}}{P_t} \right)^{-\sigma/(1-\sigma)} - \frac{W_t Y_t}{Z_t} \left(\frac{P_{jt}}{P_t} \right)^{-1/(1-\sigma)}. \tag{63}$$

Maximization in P_{jt} yields the following first-order condition:

$$P_{jt} = P_t^m = \frac{W_t}{Z_t}. \tag{64}$$

Now we shall assume that the preset price is equal to the expected value of this "monopolistically competitive price" P_t^m:

$$P_t = E_{t-1} P_t^m = E_{t-1} \left(\frac{W_t}{Z_t} \right) = E_{t-1} \left[\frac{(1+\alpha_t)(\Omega_t + T_{t+1})}{\nu_t Z_t} \right]. \tag{65}$$

A.3. The optimal interest rate rule under passive fiscal policy

Again, we assume that the monetary authority sets interest rates under full knowledge of all shocks and that the fiscal policy is passive:

$$T_t = 0, \quad \forall t. \tag{66}$$

Proposition 5. *The optimal interest rate rule under preset prices and fiscal policy* (66) *is*

$$i_t = \frac{1}{\theta_t} \max\left[0, \frac{\nu_a(1+\alpha_t)Z_a}{\nu_t(1+\alpha_a)Z_t} - 1\right] = \frac{1}{\theta_t} \max\left[0, \frac{\Lambda_t}{\Lambda_a} - 1\right]. \tag{67}$$

Proof. Combining (65) and (66), we find that the preset price is equal to

$$P_t = E_{t-1} P_t^m = E_{t-1}\left[\frac{(1+\alpha_t)(\Omega_t + T_{t+1})}{\nu_t Z_t}\right] = \frac{(1+\alpha_a)\Omega_t}{\nu_a Z_a}, \tag{68}$$

and the preset price equilibrium quantities are

$$C_t = \frac{\alpha_t(\Omega_t + T_{t+1})}{(1+\theta_t i_t)P_t} = \frac{\alpha_t \nu_a Z_a}{(1+\theta_t i_t)(1+\alpha_a)}, \tag{69}$$

$$C_t' = \frac{\Omega_t}{P_t} = \frac{\nu_a Z_a}{1+\alpha_a}, \tag{70}$$

$$L_t = \frac{\nu_a Z_a}{(1+\alpha_a)Z_t}\left(\frac{\alpha_t}{1+\theta_t i_t} + 1\right). \tag{71}$$

So we have to maximize in i_t, for each value of the shocks:

$$\begin{aligned} \Delta_t &= \alpha_t \log\left[\frac{\alpha_t \nu_a Z_a}{(1+\alpha_a)(1+\theta_t i_t)}\right] + \frac{1}{\beta}\log\left[\frac{\nu_a Z_a}{1+\alpha_a}\right] \\ &\quad - \frac{\nu_a(1+\alpha_t)Z_a}{\nu_t(1+\alpha_a)Z_t}\left(\frac{\alpha_t}{1+\theta_t i_t} + 1\right), \end{aligned} \tag{72}$$

subject to the constraint $i_t \geqslant 0$. The solution is Eq. (67). □

We may note that the policy rule is the same as the one we found in Proposition 1.

Now let us compute in which circumstances firms will be actually willing to serve all demand forthcoming to them. Taking into account the subsidy, the profit of a firm j is (Eqs. (58) and (60)):

$$\Pi_{jt} = \frac{1}{\sigma} P_t Y_{jt} - W_t L_{jt} = \left(\frac{1}{\sigma} P_t - \frac{W_t}{Z_t}\right) Y_{jt}. \tag{73}$$

We have already computed the value of P_t (Eq. (68)):

$$P_t = \frac{(1+\alpha_a)\Omega_t}{\nu_a Z_a}. \tag{74}$$

From Eq. (18), since the labor market clears in this case,

$$W_t = \frac{1+\alpha_t}{\nu_t}(\Omega_t + T_{t+1}) = \frac{1+\alpha_t}{\nu_t}\Omega_t, \tag{75}$$

so that profits can be rewritten:

$$\Pi_{jt} = \left[\frac{1}{\sigma} - \frac{(1+\alpha_t)\nu_a Z_a}{(1+\alpha_a)\nu_t Z_t}\right] P_t Y_{jt} = \left[\frac{1}{\sigma} - \frac{\Lambda_t}{\Lambda_a}\right] P_t Y_{jt}. \tag{76}$$

We see that profits will be positive if shocks are sufficiently small in the precise sense that the shocks are such that, in all circumstances,

$$\frac{\Lambda_t}{\Lambda_a} = \frac{(1+\alpha_t)\nu_a Z_a}{(1+\alpha_a)\nu_t Z_t} < \frac{1}{\sigma}. \tag{77}$$

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