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Abstract

This paper explores global dynamics in a monetary model with limited asset market participation and the zero lower bound on nominal interest rates. It is shown that a rise in government transfers to 'non-Ricardian' consumers financed by debt-based taxes to 'Ricardian' consumers is capable of escaping disinflationary paths typically convergent to a liquidity trap. Fiscal policy does not need to be unsustainable at the low inflation steady state to avoid liquidity traps, as argued in the context of the standard single representative agent setup.

JEL Classification: E31; E62; E63.

Keywords: Fiscal Policy; Multiple Equilibria; Global Dynamics; Liquidity Traps; Non-Ricardian Consumers.

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1 Introduction

We explore the dynamic effects of budgetary policies in a monetary model with limited asset market participation. Multiplicity of steady state equilibria, due to the zero lower bound on nominal interest rates, affects global dynamics. We demonstrate that a rise in government transfers to 'non-Ricardian' consumers, financed by debt-based taxes to 'Ricardian' consumers, is capable of escaping disinflationary paths typically convergent to a liquidity trap. This result radically differs from what is commonly argued in the context of the single representative agent paradigm, *i.e.*, that fiscal policy needs to be unsustainable at the low inflation steady state to rule out the liquidity trap equilibrium (Benhabib *et al.*, 2002; Woodford, 2003). In a setting with heterogeneous consumers, by contrast, we show that *intertemporally balanced* fiscal expansions—globally satisfying the Ricardian agents' transversality condition—do suffice to avoid liquidity traps.

The present paper is connected to both empirical and theoretical literature. Empirically, the share of non-Ricardian agents—intended as non-optimizing individuals who employ the 'rule-of-thumb' of consuming their current disposable income, without smoothing consumption overtime by recourse to financial markets—range from 26 to 40 percent in industrialized countries (Campbell and Mankiw, 1989; Coenen and Straub, 2005; Forni *et al.*, 2009; Di Bartolomeo *et al.*, 2011; Albonico *et al.*, 2014). A systematic incorporation of non-Ricardian households within macroeconomic models for policy evaluation is therefore often advocated, at least since the seminal paper by Mankiw (2000).

Indeed, research in macroeconomics increasingly employs frameworks whereby non-Ricardian agents coexist with Ricardian agents, in order to examine the effects and the design of both monetary policy (Galí *et al.*, 2004; Di Bartolomeo and Rossi, 2007; Bilbiie, 2008; Colciago, 2011; Ascari *et al.*, 2017) and fiscal policy (Galí *et al.*, 2007), as well as the issue of monetary-fiscal interrelationships (Motta and Tirelli, 2012, 2015; Rossi, 2014).[1]

[1] An alternative strand of literature departing from Ricardian equivalence studies monetary-fiscal policy interactions in the presence of distortionary taxation. See, for example, Correia *et al.* (2013), who examine

Consistently with the business cycle literature, nevertheless, the foregoing 'New Keynesian' studies by construction rely on local dynamics, hence abstracting from global nonlinearities.[2] Our central focus, on the other hand, is to depart from local analysis, and concentrate on global nonlinear dynamics and possible multiplicities of steady-state equilibria.

In the traditional infinite-horizon representative agent setup, Benhabib *et al.* (2002) show that, once global dynamics are taken into account, interest rate rules locally ensuring inflation control typically give rise to multiple self-fulfilling decelerating inflation paths converging to a liquidity trap equilibrium. They demonstrate that avoiding liquidity traps requires 'making the low-inflation steady state fiscally unsustainable', that is, violating the intertemporal budget constraint of the government and thus the transversality condition should the economy embark on decelerating inflation trajectories. Our main contribution, on the other hand, is to show that *sustainable* fiscal expansions, respecting the government's intertemporal budget constraint for *any* inflation path, may well escape liquidity traps when the economy is populated by both Ricardian and non-Ricardian individuals, as widely documented by the empirical evidence.

The paper proceeds as follows. Section 2 develops the model. Section 3 investigates the interaction between inflation and public deficits dynamics from a global perspective. Section 4 summarizes the conclusions.

2 The Model

There is a continuum of infinitely lived households $[0, 1]$. A $1 - \lambda$ share consists of 'Ricardian' households, who are forward looking and smooth consumption by having access to financial markets. The remaining λ share consists of 'non-Ricardian' households

the issue of optimal unconventional fiscal policy at the zero lower bound, following a temporary discount factor shock.

[2]See Cochrane (2011, 2016) for a critique to the standard local determinacy results emphasized in the New Keynesian literature under the conventional Taylor-rule-framework.

à la Mankiw (2000), who cannot accumulate any assets nor have any liabilities, hence fully consuming their current labor income net of taxes.

Subscript R denotes the Ricardian representative agent, whose lifetime utility function is given by

$$\int_0^\infty e^{-\rho t} \log \Omega(c_R(t), m_R(t))dt, \tag{1}$$

where $\rho > 0$ indicates the rate of time preference, $c_R(t)$ consumption, and $m_R(t)$ real money balances at instant of time t. Function $\Omega(\cdot\,,\cdot)$ is strictly increasing, strictly concave and linearly homogeneous. Consumption and real money balances are Edgeworth complements (Reis, 2007), $\Omega_{cm} > 0$, and the elasticity of substitution between the two is lower than unity (Cushing, 1999). The flow budget constraint is

$$\dot{a}_R(t) = (i(t) - \pi(t))\, a_R(t) + y_R(t) - \tau_R(t) - c_R(t) - i(t)\, m_R(t), \tag{2}$$

where $a_R(t)$ denotes real financial wealth, consisting of interest-bearing government bonds and money balances, $y_R(t)$ an endowment of perishable goods, $\tau_R(t)$ real lump-sum taxes net of public transfers, $i(t)$ the nominal interest rate on bonds, and $\pi(t) = \dot{P}(t)/P(t)$ the inflation rate. Ponzi's games are precluded, implying

$$\lim_{t\to\infty} e^{-\int_0^t [i(j)-\pi(j)]dj} a_R(t) \geq 0. \tag{3}$$

Letting $z_R(t)$ denote total consumption, defined as physical consumption plus the interest forgone on real money holdings,

$$z_R(t) = c_R(t) + i(t)\, m_R(t), \tag{4}$$

the optimizing problem can be solved using a two-stage procedure (Marini and van der Ploeg, 1988). In the first stage, consumers solve an intratemporal problem of choosing the efficient allocation between consumption and real money balances to maximize function $\Omega(\cdot\,,\cdot)$, for a given level of total consumption, $z_R(t)$. Optimality implies that the marginal rate of substitution between consumption and real balances equals the nominal interest rate, $\Omega_m\left(c_R\left(t\right), m_R\left(t\right)\right) / \ \Omega_c\left(c_R\left(t\right), m_R\left(t\right)\right) = i(t)$. Because preferences are linearly homogeneous, this optimality condition is of form

$$c_R\left(t\right) = \Gamma(i(t)) m_R\left(t\right), \tag{5}$$

where $\Gamma'(\cdot) > 0$. In the second stage, Ricardian households solve an intertemporal problem of choosing the optimal time path of total consumption, $z_R(t)$, to maximize the lifetime utility function (1), given (5) and the constraints (2) and (3). Using (4) and (5) yields $\log\Omega(c_R\left(t\right), m_R\left(t\right)) = \log q(t) + \log z_R(t)$, where $q(t) = \Omega\left(\frac{\Gamma(i(t))}{\Gamma(i(t))+i(t)}, \frac{1}{\Gamma(i(t))+i(t)}\right)$. Consequently, at the optimum

$$\dot{z}_R(t) = (i(t) - \pi(t) - \rho) z_R(t), \tag{6}$$

$$\lim_{t\to\infty} e^{-\int_0^t [i(j)-\pi(j)]dj} a_R\left(t\right) = 0. \tag{7}$$

From (5),

$$z_R(t) = \Theta(i(t)) c_R\left(t\right), \tag{8}$$

where $\Theta(i(t)) = 1 + i(t)/\Gamma\left(i(t)\right)$. Combining (6) and (8) yields the optimal time path of Ricardian households' consumption:

$$\dot{c}_R\left(t\right) = \left(i(t) - \pi(t) - \rho\right) c_R\left(t\right) - \frac{\Theta'(i(t))\dot{i}(t)}{\Theta(i(t))} c_R\left(t\right). \tag{9}$$

where $\Theta'(\cdot) > 0$.

Households in the $[0, \lambda]$ interval, denoted by subscript NR, neither save nor borrow, thereby behaving in a "hand-to-mouth" fashion, along the lines of Mankiw (2000):[3]

$$c_{NR}(t) = y_{NR}(t) - \tau_{NR}(t). \tag{10}$$

As in Galí *et al.* (2007), taxes paid by non-Ricardian households may differ from those of Ricardian households.

The government finances deficits by printing money, M, and issuing bonds, B. Assuming that public consumption is zero, for simplicity, the government's budget constraint in real terms is thus

$$\dot{a}(t) = (i(t) - \pi(t))\, a(t) - \lambda \tau_{NR}(t) - (1-\lambda)\, \tau_R(t) - i(t)\, m(t), \tag{11}$$

where $a(t) = (B(t) + M(t))/P(t)$ and $m(t) = M(t)/P(t)$. For the argument developed in this paper, we shall assume that the fiscal policy regime is globally 'Ricardian', *i.e.*, guarantees that the present discounted value of government liabilities converges to zero for any path of the endogenous variables:

$$\lim_{t\to\infty} e^{-\int_0^t [i(j)-\pi(j)]dj} a(t) = 0. \tag{12}$$

Following Benhabib *et al.* (2002), the monetary authority adopts an interest rate policy described by the feedback rule

$$i(t) = \Phi(\pi(t)), \tag{13}$$

where function $\Phi(\cdot)$ is continuous, increasing, positive, and at the target inflation rate,

[3]Reasons behind such a behavior notably include lack of access to financial markets, binding borrowing constraints, myopia, extreme hyperbolic discounting, or limited information.

π^*, monetary policy obeys the Taylor (1993) principle. Specifically,

$$\exists \pi^* > -\rho : \Phi\left(\pi^*\right) = \rho + \pi^*,\ \Phi'\left(\pi^*\right) > 1. \tag{14}$$

In the aggregate, equilibrium in the goods and the assets markets requires $c(t) = y(t)$, where

$$c\left(t\right) = \lambda c_{NR}\left(t\right) + (1-\lambda)c_{R}\left(t\right) \tag{15}$$

and $y\left(t\right) = \lambda y_{NR}\left(t\right) + (1-\lambda)y_{R}\left(t\right)$, $a\left(t\right) = (1-\lambda)a_{R}\left(t\right)$, and $m\left(t\right) = (1-\lambda)m_{R}\left(t\right)$. Assuming constant endowments, consistently with Benhabib *et al.* (2002), equations (9), (10), (13) and (15) yield

$$\dot{\pi}_t = H(\pi\left(t\right))\left[\left(\Phi(\pi\left(t\right)) - \pi\left(t\right) - \rho\right) - \lambda\frac{\dot{\tau}_{NR}\left(t\right)}{y - \lambda\left(y_{NR} - \tau_{NR}\left(t\right)\right)}\right], \tag{16}$$

where $y - \lambda\left(y_{NR} - \tau_{NR}\left(t\right)\right) > 0$ and

$$H(\pi\left(t\right)) = \frac{\Theta(\Phi(\pi\left(t\right)))}{\Phi'(\pi\left(t\right))\Theta'(\Phi(\pi\left(t\right)))} > 0. \tag{17}$$

3 Fiscal Policy and Inflation Dynamics

According to (16), in the present framework inflation dynamics not only depend on real interest rates but also on the time profile of taxes (net of transfers). Only in the limiting case in which $\lambda = 0$, Ricardian equivalence holds and inflation dynamics evolve consistently with the single infinitely lived representative agent paradigm. In this polar case, $\dot{\pi}_t = H(\pi\left(t\right))\left(\Phi(\pi\left(t\right)) - \pi\left(t\right) - \rho\right)$, and the results obtained by Benhabib *et al.* (2002) apply. Specifically, if fiscal policy is globally Ricardian, the presence of a zero bound on nominal interest rates combined with an interest rate rule increasing in inflation and such that $\Phi'\left(\pi^*\right) > 1$ must imply the existence of a low, and possibly negative, alternative steady-state inflation rate, $\pi^L < \pi^*$, at which monetary policy is 'passive', $\Phi'\left(\pi^L\right) < 1$. Multiple steady-state equilibria occur, and, because $H(\pi(t)) > 0$, global dynamics exhibit self-fulfilling decelerating inflation paths converging to the unintended liquidity trap steady state π^L, as shown in Figure 1.

Nevertheless, in the presence of non-Ricardian households ($\lambda > 0$), even if budgetary policies are expected to always satisfy the government's intertemporal budget constraint, inflation dynamics depend on *both* monetary *and* fiscal policies.

Can liquidity traps be avoided through sustainable fiscal policies? Consider the case in which the fiscal authority implements increases in public transfers (or taxes cuts) to non-Ricardian households financed by debt-based taxes to Ricardian households, should the economy embark on a self-fulfilling decelerating inflation path. Formally,

$$\lambda \tau_{NR}(t) = \Psi\left(\Phi(\pi(t)) - \pi(t)\right), \tag{18}$$

$$(1-\lambda)\,\tau_R(t) + i(t)\,m(t) = \psi(t)\,a(t), \tag{19}$$

where function $\Psi(\cdot)$ is positive and increasing, and $\psi(t)$ is positive and assumed to obey $\psi(t) > \Psi\left(\Phi(\pi(t)) - \pi(t)\right)/a(t)$. Thus, the fiscal stimulus that occurs when the central bank decreases the real interest rate in the attempt to reverse dynamics is intertemporally balanced, for it satisfies (12). Using (18), equation (16) becomes

$$\dot{\pi}(t) = \frac{H(\pi(t))}{K(\pi(t))}\left(\Phi(\pi(t)) - \pi(t) - \rho\right). \tag{20}$$

where

$$K(\pi(t)) = 1 + \frac{\Psi'\left(\Phi(\pi(t) - \pi(t)\right)\left(\Phi'(\pi(t)) - 1\right)H(\pi(t))}{y - \lambda y_{NR} + \Psi\left(\Phi(\pi(t)) - \pi(t)\right)} \lesseqgtr 0. \tag{21}$$

Suppose that the fiscal expansion is sufficiently aggressive, such that

$$\Psi'(\rho) > \frac{y - \lambda y_{NR} + \Psi(\rho)}{(1 - \Phi'(\pi^L))\, H(\pi^L)}, \tag{22}$$

implying $K(\pi(t)) < (>)\, 0$ for $\pi(t) < (>)\, \bar{\pi}$, where $\pi^L < \bar{\pi} < \pi^*$ satisfies $K(\bar{\pi}) = 0$. The phase diagram associated with equation (20) is shown in Figure 2. Under condition (22), the fiscal stimulus is capable of escaping the liquidity trap equilibrium, making the economy converge asymptotically to $\bar{\pi} > \pi^L$. The baseline economic mechanism at work is as follows. The rise in transfers (or the cut in taxes) to non-Ricardian consumers stimulates aggregate demand for goods. The increase in aggregate demand occurs without affecting the intertemporal budget constraint of the government, as Ricardian equivalence does not apply. The associated excess demand in the goods market induces an increase in inflation to restore equilibrium, thereby preventing the economy from falling into the liquidity-trap steady state π^L.

Therefore, our analytical results support the view that it is feasible to escape liquidity traps through expansionary fiscal policies without the 'threat' of generating unsustainable budgetary deficits.

4 Conclusions

The aim of this paper is to analyze the scope for avoiding liquidity traps through intertemporally balanced fiscal policies in a monetary model with agents' heterogeneity, due to limited asset market participation. The main result is that an increase in government transfers to 'non-Ricardian' consumers, financed by debt-based taxes to 'Ricardian' consumers, succeeds in offsetting self-fulfilling disinflationary paths *per se* converging to a low inflation—possibly deflation—liquidity trap steady state. Expansionary government budgetary policies do not need to violate the transversality condition to rule out liquidity traps, as it emerges within the single infinitely lived representative agent framework.

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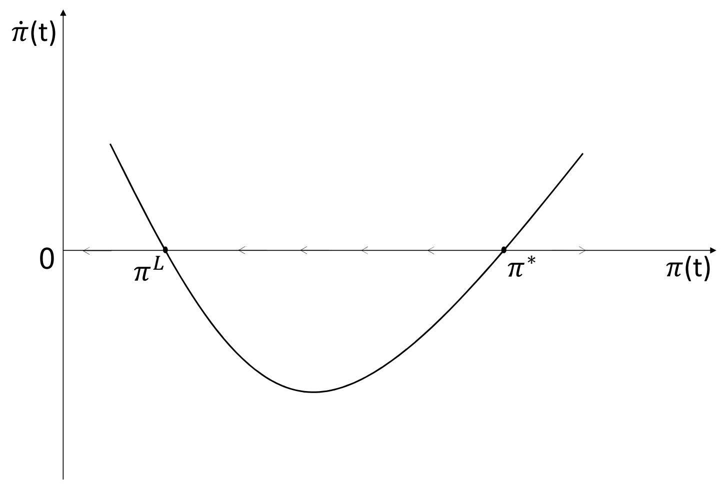

Figure 1: Phase diagram of $\pi(t)$ under the single infinitely lived representative agent limiting case, equations (16)-(17) with $\lambda = 0$

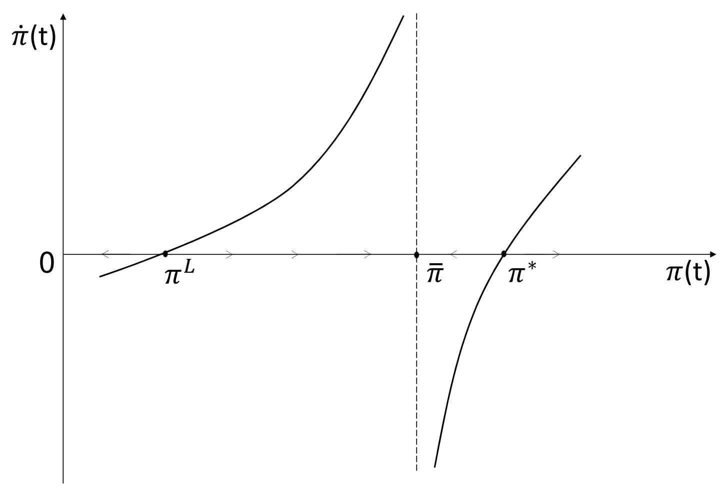

Figure 2: Phase diagram of $\pi(t)$ with Ricardian and non-Ricardian consumers, equations (20)-(22) with $\lambda > 0$