Fiscal Stimulus of Last Resort

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Abstract

I examine global dynamics in a monetary model with overlapping generations of finite-horizon agents and a binding lower bound on nominal interest rates. Debt targeting rules exacerbate the possibility of self-fulfilling liquidity traps, for agents expect austerity following deflationary slumps. Conversely, activist but sustainable fiscal policy regimes—implementing intertemporally balanced tax cuts and/or transfer increases in response to disinflationary trajectories—are capable of escaping liquidity traps and embarking inflation into a globally stable path that converges to the target. Should fiscal stimulus of last resort be overly aggressive, however, spiral dynamics around the liquidity-trap steady state exist, causing global indeterminacy.

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1 Introduction

The recent observed plunge in global monetary policy rates towards zero or below both as a result of the secular stagnation (Summers, 2016, 2018; Krugman, 2020) and in the attempt to cope with the corona crisis—in a macroeconomic environment featured by effective and expected inflation rates systematically undershooting their targets for an extended period in most major economies following the Great Recession (Bartsch et al., 2019)—poses salient challenges for public policy design. A central question that arguably urges for macroeconomic analysis is how to escape unintended deflationary slumps associated to the existence of a liquidity-trap equilibrium when the economy lies in the vicinity of the effective lower bound policy rate, whereby conventional monetary policy reveals to be impotent in fostering aggregate demand and therefore the level of prices, without triggering other sources of macroeconomic instability—such as unsustainability of fiscal policy or a burst of inflation. The contribution of the present paper is to analyze the issue of aggregate stability in an overlapping generations monetary model that exhibits multiple steady-state equilibria because of the existence of a binding lower bound on nominal interest rates. By departing from the Ricardian debt equivalence (Barro, 1974), due to a finite planning horizon of private agents and to the absence of perfect intergenerational altruism as originally proposed in the Yaari (1965) and Blanchard (1985)’s uncertain lifetime approach, the setup developed in this study enables me to explore in an analytically tractable way the effects of alternative fiscal policy regimes and their interaction with monetary policy from both a local- and a global-dynamics perspective.

The paper establishes policy-relevant results that would not appear in the traditional infinitely-lived single representative agent framework. First I show the dynamic
consequences of a budgetary policy regime in which the fiscal authority gradually adjusts the stock of real government liabilities relative to the size of the economy in order to converge towards a target level in the long run, as assumed by Minea and Villieu (2013), Maebayashi, Hori and Futagami (2017), and Cheron et al. (2019) in non-monetary contexts with endogenous growth to analyze the case of fiscal constraints in the spirit of the Maastricht-Treaty framework prevailing in the European Union. I demonstrate that such a regime of stringent fiscal discipline makes the economic system prone to self-fulfilling deflationary (or disinflationary) trajectories approaching to an unintended steady state that exhibits the features of a liquidity trap, which prevents the monetary authority from uniquely determining inflation along a saddle path passing through the target rate.

In the present setup with dyachronous heterogeneity, deflationary dynamics induce, \textit{per se}, a redistribution of real financial wealth from future to current generations, because the implied increase in the real value of government liabilities rises the burden of future fiscal restrictions. Such an intergenerational redistribution of wealth in favor of currently alive generations would provide, \textit{ceteris paribus}, a stimulus to aggregate demand and thus to prices, tending as a consequence to counter-react to the initial deflationary pressures. In other words, a stabilizing role of wealth effects, potentially capable of making liquidity traps implausible along the lines of the traditional theory of Pigou (1943, 1947) and Patinkin (1965), is operative in my optimizing framework.

However, in a condition of general equilibrium that takes also into account the design of fiscal policy, if the government is engaged in making the stock of real government liabilities relative to the size of the economy converge to a target level to comply constraints of the Maastricht-type, following deflation primary surpluses must increase
in order to avoid escalation of real debt. Under these circumstances, the resulting fiscal austerity measures generate a negative wealth effect on current cohorts’ consumption and turn to reinforce the initial deflationary pressures, hence leading the economic system to a liquidity-trap steady state, whereby monetary policy loses control over the inflation rate. Global indeterminacy arises. Specifically, any inflation trajectory originating below the saddle path passing through the target steady state can be sustained as an equilibrium outcome, bringing about macroeconomic instability.

Then I explore the issue of how to lift the economy out of liquidity traps. I demonstrate that a large class of ‘activist’ but sustainable fiscal policy regimes—decreasing taxes and/or increasing public transfers in response to decelerating inflation under the respect of the government’s solvency condition—enable the economic system to escape liquidity traps and, at the same time, embark inflation into a globally stable path converging to the target rate. My results indicate that to sustain global determinacy and thus ensure macroeconomic stability, there is no need for the government to render the liquidity-trap steady state fiscally unsustainable as predicted in the context of the traditional Ramsey-type single representative agent paradigm.

Should deflationary spirals take place, a sequence of fiscal expansions financed by issuance of bonds and future taxes net of transfers enlarges both human and financial wealth for currently alive households, thereby sustaining aggregate consumption and exerting a powerful stimulus to aggregate demand despite the expected increase in real interest rates in the vicinity of the trapping equilibrium, for government debt is net wealth for living generations. This course of sustainable policy action, which partly shifts the sequence of future net taxes to future generations thereby inducing current generations to dissave, is shown to be capable of offsetting self-fulfilling falls in prices,
restoring in general equilibrium convergence of inflation towards the intended steady state.

However, I demonstrate that not all types of expansionary budgetary policies that are able to eradicate liquidity traps are compatible with global determinacy. In particular, I find that when fiscal stimulus is overly aggressive, (unstable) spiral dynamics around the liquidity-trap steady state exist. In this case, even though convergence of inflation towards the target rate along a saddle connection is ensured, global indeterminacy prevails. In addition, the inflation rate may fluctuate for relatively long periods of time in a region whereby monetary policy is necessarily ‘passive’—in the sense of Leeper (1991)—because of the effective lower bound on the nominal interest rate, away from the intended steady state. These results cast doubts on the stabilizing properties of excessively lax fiscal boosts expected to be backed by large future net taxes required to redeem the government debt eventually.

Two clear-cut policy implications stem from my analytical findings. First, strict fiscal discipline does not support price stability, contrary to conventional wisdom, at least since Sargent and Wallace (1981). Rather, it is a potential source of macroeconomic imbalances, for it dampens aggregate demand following deflationary slumps, thus exacerbating expectations-driven instabilities in prices. A self-fulfilling ‘austerity-deflation’ nexus does amplify the possibility of undesired liquidity traps. Second, enforcing an intertemporally balanced and moderately aggressive bond-financed fiscal stimulus at a time of out-of-equilibrium deflationary trajectories plays an essential role, complementary to inflation-targeting-oriented interest rate feedback rules (e.g., Taylor, 1999, 2012; Woodford, 2003; Galí, 2015; Walsh, 2017), in order to guarantee price and macroeconomic stability. Central banks can determine equilibrium inflation globally under the
rules-based approach to monetary policy (Taylor, 2021), but only if supported by feedback budgetary policy actions of ‘last resort’.

The paper is organized as follows. Section 2 points out the paper’s connections with the literature and elucidates the novel contribution of the present study. Section 3 develops the optimizing continuous time overlapping generations model and specifies the monetary policy regime. Section 4 examines global dynamics under a debt targeting fiscal policy regime. Section 5 examines global dynamics under an activist fiscal policy regime compatible with the respect of the government’s intertemporal budget constraint. The concluding Section 6 sums up the main results.

2 Related Literature

The macroeconomic framework set forth in this paper and the results that emerge from the present analysis are markedly different than those prevailing in most of the literature on ‘confidence-driven’ liquidity traps (see Bilbie, 2018, and Nakata and Schmidt, 2019). The seminal works by Benhabib, Schmitt-Grohé and Uribe (2001, 2002) and Schmitt-Grohé and Uribe (2009) employ an infinitely-lived single representative agent setup with real balance effects à la Sidrauski (1967)-Brock (1974, 1975), thereby overlooking intergenerational heterogeneity and the associated wealth effects on aggregate demand dynamics. The analysis developed in this paper is an effort to fill this gap. In particular, Benhabib, Schmitt-Grohé and Uribe (2002) show that fiscal policy requires to be unsustainable at the steady state exhibiting deflation or relatively low inflation in order to avoid the liquidity trap equilibrium, for the agents’ transversality condition turns to be violated. In contrast, in the present setting with overlapping generations of finitely-lived agents, which brings the advantage of encompassing the Ramsey-type
framework as a limiting case, I demonstrate that fiscal boosts satisfying both the individuals’ transversality condition and the government’s solvency constraint do suffice to escape liquidity traps and, at the same time, sustain global determinacy. Stabilizing budgetary policies need not be intertemporally unbalanced. In addition, however, I prove that fiscal stimulus of last resort should not be overly aggressive, in order to avoid that the liquidity-trap steady state is an unstable spiral point—which would give rise to global indeterminacy.

Performing a thorough numerical analysis of a nonlinear New Keynesian model with distortionary taxation, Mertens and Ravn (2014) show that supply-side policies such as cuts marginal labour tax rates—as opposed of demand-side policies such as increases in government spending—are necessary to properly offset expectations-driven liquidity traps. My paper differs in three relevant dimensions. First, I present an alternative way to analyze the implications of confidence-driven liquidity traps for fiscal policy design, since I employ an overlapping generations model whereby demographic heterogeneity matters—contrary to the standard New Keynesian setup. Taxes/transfers are lump sum, prices are flexible and time is continuous, in order to make my analysis directly comparable to Benhabib, Schmitt-Grohé and Uribe (2002) and reconsider transparently the role of demand stimulating budgetary policies in a model where private agents have finite horizons, without unnecessary complications. Combining distortionary taxes and sticky prices with an overlapping generations setting and analyzing the implied global dynamics are important considerations for future research. The present modeling approach to monetary-fiscal interactions in the presence of multiple steady-state equilibria could then constitute a fruitful benchmark for more complex investigations along these lines. Second, in my simple and tractable continuous-time model I am enabled
to explore analytically the scope for the existence—under a particular type of fiscal policy—of a saddle connection among different steady states, leading to global determinacy under the Taylor-rule monetary framework and escaping the liquidity-trap equilibrium. Third, differently from Mertens and Ravn (2014), I do find a positive role of demand-side-oriented fiscal stimulus respecting the government’s intertemporal budget constraint in order to restore an inflationary path uniquely converging to the central bank’s target rate. The view that fiscal intervention stimulating aggregate demand, financed by bond issues and future higher taxes and/or lower expenditures to avoid public insolvency, is a powerful tool to reverse downward pressure on inflation linked to the existence of a liquidity-trap equilibrium appears to have sound microfoundations.

Using a standard New Keynesian model à la Woodford (2003), Schmidt (2016) shows that Ricardian government spending rules that prevent a decline in real marginal costs following a confidence shock protect the economy from falling into expectations-driven liquidity traps. My paper is complementary in three important dimensions. First, my contribution is to demonstrate that sustainable fiscal actions can be justified even in the most innocuous monetary framework with flexible prices, once intergenerational heterogeneity is accounted for. The stabilizing dynamic effect of Ricardian budgetary policies does not require pricing frictions. Second, in the present model with overlapping-generations demographics I show that out-of-target deflationary slumps are typically escaped not by making the liquidity-trap steady state incompatible with agents’ optimizing conditions in general equilibrium, as in Schmidt (2016), but by making it locally unstable. Under these circumstances, I prove that there exists a heteroclinic orbit connecting the unintended steady state with the intended one, along which global determinacy of equilibrium applies should fiscal policy design ensure that
the undesired steady state is an unstable node. Third, I analyze the dynamic implications of a Ricardian experiment concerning an intertemporal reallocation of taxes and transfers, in order to elucidate the consequences of intergenerational wealth effects in an otherwise conventional model exhibiting the presence of Ricardian equivalence and the existence of liquidity traps. Importantly, from an empirical perspective, such a policy focus is justifiable from the fact that fiscal stimulus packages in the aftermath of both the Great Recession and the corona crisis have largely consisted of increases in public transfers (e.g., Taylor, 2018; Bayer et al., 2020). Remarkably, the first fiscal plan decided by the Biden administration in the United States—The American Rescue Plan Act of 2021—consists for approximately three quarters of transfers.

3 The Model

For the objectives of this work, I model intergenerational heterogeneity within a monetary economy in continuous time by setting forth a modified version of the Yaari (1965)-Blanchard (1985)-Weil (1989) overlapping generations framework, whereby forward looking agents have finite horizons, extended to incorporate money in the agents’ asset menu and embed the more general case of non-separable preferences over consumption and real cash balances. The resulting framework will permit me to remain close to the literature on global perspectives of macroeconomic policy rules that originates at least since the seminal contributions by Benhabib, Schmitt-Grohé and Uribe (2001, 2002), based on the other hand upon the infinite-horizon single representative agent setup.

1https://www.congress.gov/bill/117th-congress/house-bill/1319/text.
3.1 The Individual’s Consumption Behavior

Agents face uncertainty about the duration of their lives. Each individual, in particular, is assumed to be subject to a common and constant instantaneous probability of death, \( \mu > 0 \). At each instant of time \( t \) a new generation is born and total population is assumed to grow at a constant rate \( n \). Therefore, the birth rate is \( \beta = n + \mu \). Denote by \( N(t) \) total population at time \( t \), with \( N(0) = 1 \) for simplicity. Hence, the size of the generation born at time \( t \) is \( \beta N(t) = \beta e^{nt} \), while the size of the surviving cohort born at time \( s \leq t \) is \( \beta N(s) e^{-\mu(t-s)} = \beta e^{-\mu t} e^{\beta s} \). Population at time \( t \) is consequently given by \( N(t) = \beta e^{-\mu t} \int_{-\infty}^{t} e^{\beta s} ds \).

There is no intergenerational operative bequest motive, following Blanchard (1985). Newly born agents have no assets. Individuals have identical preferences and are assumed to supply one unit of labor inelastically, which is transformed one-for-one into output, for analytical convenience. Each agent belonging to the generation born at time \( s \leq 0 \) chooses the time path of consumption, \( \overline{c}(s,t) \), and real money balances, \( \overline{m}(s,t) \), in order to maximize the expected discounted value of the utility function given by

\[
E_0 \int_0^\infty \log \Upsilon (\overline{c}(s,t), \overline{m}(s,t)) e^{-\rho t} dt,
\]

where \( E_0 \) denotes the expectation operator conditional on period 0 information, \( \rho > 0 \) is the pure rate of time preference, and the subutility function \( \Upsilon (\cdot) \) is strictly increasing, concave, and linearly homogenous. According to Reis (2007), consumption and real money balances are Edgeworth complements, that is, \( \Upsilon_{cm} > 0 \). Following Cushing (1999), the elasticity of substitution between the two is lower than unity.

Using the fact that the probability at time 0 of surviving at time \( t \geq 0 \) is \( e^{-\mu t} \), the
expected lifetime utility function (1) can be rewritten as

\[
\int_0^\infty \log \mathcal{U}(c(s, t), m(s, t)) e^{-(\mu + \rho)t} dt,
\]

implying that the effective subjective discount rate with lifetime uncertainty is \(\mu + \rho\).

Individuals accumulate their real assets, \(\bar{a}(s, t)\), in the form of interest bearing public bonds, \(\bar{b}(s, t)\), and real money balances, so that \(\pi(s, t) = \bar{b}(s, t) + \bar{m}(s, t)\). The instantaneous budget constraint in real terms takes the form

\[
\dot{\bar{a}}(s, t) = (R(t) - \pi(t) + \mu) \bar{a}(s, t) + \bar{y}(s, t) - \bar{c}(s, t) - R(t)\bar{m}(s, t),
\]

where \(R(t)\) denotes the nominal interest rate, \(\pi(t)\) the inflation rate, \(\bar{y}(s, t)\) output, and \(\bar{c}(s, t)\) real lump-sum taxes net of public transfers. Following Yaari (1965), the budget constraint incorporates the hypothesis that in each period consumers of generation \(s\) receive an actuarial fair premium, given by \(\mu \bar{a}(s, t)\), from perfectly competitive life insurance companies in exchange for their total financial wealth at the time of death. The life insurance market avoids the possibility for individuals of passing away leaving undesired bequests to their heirs. As emphasized by Blanchard (1985), under the alternative hypothesis of actuarial bonds issued by financial intermediaries, results would be equivalent.

Agents are precluded from engaging in Ponzi’s games, implying

\[
\lim_{t \to \infty} \bar{a}(s, t) e^{-\int_0^t (R(j) - \pi(j) + \mu) dj} \geq 0.
\]

Let \(\pi(s, t)\) denote total consumption, defined as physical consumption plus the
interest forgone on real money holdings. That is,

$$\overline{x}(s, t) \equiv \overline{c}(s, t) + R(t)\overline{m}(s, t).$$  \hspace{1cm} (5)

Hence, the agent’s optimizing problem can be solved using a two-stage budgeting procedure (Deaton and Muellbauer, 1980; Marini and van der Ploeg, 1988).

In the first stage, consumers solve an intratemporal maximizing problem of choosing the efficient allocation between consumption and real money balances, in order to maximize the instantaneous subutility function \( \Upsilon(\cdot) \) for a given level of total consumption. Optimality implies that the marginal rate of substitution between consumption and real money balances must equal the nominal interest rate:

$$\frac{\Upsilon_m(\overline{x}(s, t), \overline{m}(s, t))}{\Upsilon_c(\overline{x}(s, t), \overline{m}(s, t))} = R(t).$$  \hspace{1cm} (6)

Because preferences are linearly homogenous, condition (6) takes the form

$$\overline{c}(s, t) = \Omega(R(t))\overline{m}(s, t),$$  \hspace{1cm} (7)

where \( \Omega'(R(t)) > 0 \). This sign restriction follows from \( \Upsilon_{cc} - \Upsilon_{cm}\Upsilon_c/\Upsilon_m < 0 \) and \( \Upsilon_{mm} - \Upsilon_{cm}\Upsilon_m/\Upsilon_c < 0 \).

In the second stage, agents solve an intertemporal maximizing problem of choosing the time path of total consumption, \( \overline{x}(s, t) \), in order to maximize their lifetime utility function (2) given the constraints (3)-(4) and the optimal static condition (7). At optimum\(^2\)

$$\hat{x}(s, t) = (R(t) - \pi(t) - \rho)\overline{x}(s, t),$$  \hspace{1cm} (8)

\(^2\)See Appendix A for analytical details.
\[
\lim_{t \to \infty} \pi(s, t) e^{-\int_0^t (R(j) - \pi(j) + \mu) dj} = 0. \tag{9}
\]

Integrating forward the instantaneous budget constraint (3) after using definition (5), applying the transversality condition (9) and employing the dynamic equation (8), total consumption can be expressed as a linear function of total wealth:

\[
\pi(s, t) = (\mu + \rho) \left( \overline{a}(s, t) + \overline{h}(s, t) \right), \tag{10}
\]

where

\[
\overline{h}(s, t) \equiv \int_t^\infty \left( \overline{y}(s, v) - \tau(s, v) \right) e^{-\int_v^t (R(j) - \pi(j) + \mu) dj} dv \tag{11}
\]

quantifies human wealth, that is, the present discounted value of after-tax/transfers labor income.

Using (5), (7), and (10), it also follows that individual physical consumption is a function of total wealth:

\[
\overline{c}(s, t) = \frac{(\mu + \rho)}{\Lambda(R(t))} \left( \overline{a}(s, t) + \overline{h}(s, t) \right). \tag{12}
\]

where \( \Lambda(R(t)) \equiv 1 + R(t)/\Omega(R(t)) \). Combining (5), (7) and (8) yields the optimal time path of individual consumption:

\[
\dot{\overline{c}}(s, t) = \left[ (R(t) - \pi(t) - \rho) - \frac{\Lambda'(R(t))}{\Lambda(R(t))} \dot{R}(t) \right] \overline{c}(s, t), \tag{13}
\]

where \( \Lambda'(R(t)) > 0 \). This sign restriction follows from \( \Omega(R(t)) - R(t) \Omega'(R(t)) > 0 \), which in turn depends on the elasticity of substitution between real money balances and consumption, \( \Omega'(R(t)) R(t)/\Omega(R(t)) \), assumed to be lower than unity. Notice that, according to (13), the growth rate of optimal consumption is identical across all
generations, for it is independent of s.

3.2 Time Paths of Aggregate Variables

I can now derive the evolution of aggregate variables. The population aggregate for a generic variable at individual level \( z(s, t) \) can be obtained by integrating over all generations, so that

\[ \bar{Z}(t) \equiv \beta e^{-\mu t} \int_{-\infty}^{t} z(s, t) e^{\beta s} ds, \]  

(14)

where the upper case letter indicates the aggregate value at the population level. The corresponding variable in per capita terms is denoted as

\[ \bar{z}(t) \equiv \bar{Z}(t) e^{-nt} = \beta \int_{-\infty}^{t} z(s, t) e^{\beta(s-t)} ds. \]  

(15)

For analytical convenience, assume that each agent faces identical age-independent income and net tax flows, so that \( \bar{y}(s, t) = \bar{y}(t) \) and \( \bar{\tau}(s, t) = \bar{\tau}(t) \), as in Blanchard (1985). Then, using \( \bar{a}(t, t) = 0 \) and consequently \( \dot{c}(t, t) = [\alpha(\mu + \rho)/\Lambda(\bar{R}(t))] \bar{h}(t, t) \), the budget constraint and the optimal time path of consumption expressed in per capita terms are given by, respectively:

\[ \dot{\bar{a}}(t) = (\bar{R}(t) - \pi(t) - R(t)\bar{m}(t)), \]  

(16)

\[ \dot{\bar{c}}(t) = \left[ (\bar{R}(t) - \pi(t) - \rho) - \frac{\Lambda'(\bar{R}(t))}{\Lambda(\bar{R}(t))} \bar{R}(t) \right] \bar{c}(t) - \frac{\beta(\rho + \mu)}{\Lambda(\bar{R}(t))} \bar{a}(t), \]  

(17)

Equation (17) stipulates that evolution over time of per capita consumption also depends upon the level of per capita real financial wealth \( \bar{a}(t) \). A higher real wealth

\[ \text{See Appendix B for analytical details.} \]
brings about a stimulus to current consumption at expense of future consumption. This is because the absence of perfect intergenerational altruism implies that future cohorts’ consumption is not valued by agents alive today. Government liabilities are net wealth for living generations, for agents may not be alive to pay future taxes required to guarantee public solvency. Intergenerational heterogeneity prevails: older generations are wealthier than younger generations, and therefore consume more and save less. Only in the special case in which the birth rate $\beta$ is equal to zero, the law of motion of per capita consumption collapses to the traditional Euler equation characterizing the infinitely-lived single representative agent monetary framework (e.g., Benhabib, Schmitt-Grohé and Uribe, 2002), whereby solely interest-rate movements affect consumption dynamics.

### 3.3 The Public Sector

The monetary authority controls the nominal interest rate $R(t)$ and is subject to the zero lower bound on policy rates, which prevents to set a negative value of $R(t)$. As pointed out by Buiter (2020), the effective lower bound that the monetary authority has to satisfy must equal the zero nominal interest rate on currency minus the carry cost of currency, due for instance to storage or insurance. In my model, I have abstracted from the carry cost of currency, for analytical convenience. So the effective lower bound must be zero. Modifying the model to account for the possibility of a negative nominal interest rate, which is consistent with the recent behavior of some central banks, would not alter the results of the present analysis in any essential dimension. All that is necessary for my findings to hold is that there exists some binding lower bound on policy rates. Whether such a bound is negative, zero, or positive is inconsequential.
Having said this, let me assume that monetary policy is described by a feedback policy rule of the form

\[ R(t) = \Psi(\pi(t)), \]  

(18)

where \( \Psi(\cdot) \) is a continuous, positive, increasing and strictly convex function. The assumption of a strictly positive nominal interest rate in the present model is made to avoid discontinuity in money demand when \( R(t) = 0 \). Denoting by \( \pi^* > 0 \) the target level of steady state inflation, I assume \( \Psi'(\pi^*) > 1 \). That is, monetary policy is ‘active’ by satisfying the Taylor principle (see Taylor, 1999, 2012, 2021, Woodford, 2003, Galí, 2015, and Walsh, 2017). This constraint is meant to guarantee that whenever monetary policy makers detect symptoms of inflationary (disinflationary) pressure, they will tighten (ease) policy sufficiently to ensure an increase (decrease) in the real interest rate.

Public transfer payments and interest payments on government bonds are financed by lump-sum taxation, seignorage revenues and issuance of new bonds. Without loss of generality for the present analysis, I set government purchases equal to zero. Hence, the flow budget constraint of the public sector in per capita terms is given by

\[ \dot{b}(t) + \dot{m}(t) = (R(t) - \pi(t) - n) b(t) - \tau(t) - (\pi(t) - n) m(t). \]  

(19)

Following Benhabib, Schmitt-Grohé and Uribe (2001, 2002) and Canzoneri, Cumby and Diba (2010), equation (19) can be written as

\[ \dot{a}(t) = (R(t) - \pi(t) - n) a(t) - \bar{\pi}(t) - \bar{\pi}(t) \]  

(20)

where \( \bar{\pi}(t) = b(t) + m(t) \) are total government liabilities and \( \bar{\pi}(t) = \bar{\pi}(t) + R(t)\bar{\pi}(t) \) is
the primary surplus inclusive of interest savings from the issuance of money.

For my purposes, throughout the paper fiscal policies are assumed to be Ricardian in the sense of Benhabib, Schmitt-Grohé and Uribe (2001, 2002). That is, the government must respect the terminal boundary condition precluding Ponzi’s games and requiring that the present discounted value of total government liabilities in per capita terms converges to zero,

$$\lim_{t \to \infty} \pi(t)e^{-\int_0^t (R(j) - \pi(j) - n) dj} = 0,$$

(21)

for all possible, equilibrium and off-equilibrium, time paths of the remaining endogenous variables. Integrating equation (20) forward, given condition (21) that ensures public solvency, yields the intertemporal budget constraint of the public sector:

$$\pi(0) = \int_0^\infty \pi(t) e^{-\int_0^t (R(j) - \pi(j) - n) dj} dt.$$

(22)

3.4 Equilibrium Inflation Dynamics

Equilibrium in the goods’ market requires that $\bar{y}(t) = \bar{c}(t)$. Equilibrium in the money market implies $\bar{m}(t) = \bar{c}(t)/\Omega(R(t))$. Total output $\bar{Y}(t)$ is assumed to grow at the rate of population growth $n$, without loss of generality. Per capita output is thus constant, $\bar{y}(t) = \bar{y}$.

For a generic variable at the population level $\bar{Z}(t)$, let now

$$z(t) = \frac{\bar{Z}(t)}{\bar{Y}(t)} = \frac{\bar{Z}(t)}{\bar{y}}$$

(23)

indicate the corresponding variable relative to the size of the economy $\bar{Y}(t)$. It then
follows
\[ m(t) = \frac{1}{\Omega(R(t))}. \] (24)

Furthermore, from the law of motion of per capita consumption (17), the real interest rate that guarantees equilibrium in the goods’ market is increasing in the real value of government liabilities relative to output:
\[ R(t) - \pi(t) = \rho + \frac{\Lambda'(R(t))}{\Lambda(R(t))} \dot{R}(t) + \frac{\beta(\rho + \mu)}{\Lambda(R(t))} \Lambda(R(t)) a(t). \] (25)

Using the monetary policy rule (18) into equation (25), one obtains that equilibrium dynamics of inflation must obey
\[ \dot{\pi}(t) = \frac{\Lambda(\Psi(\pi(t)))}{\Lambda'(\Psi(\pi(t)))\Psi'(\pi(t))} (\Psi(\pi(t)) - \pi(t) - \rho) - \frac{\beta(\rho + \mu)}{\Lambda'(\Psi(\pi(t)))\Psi'(\pi(t))} \Lambda'(R(t)) \Lambda(R(t)) a(t). \] (26)

From (26), the time path of inflation is influenced by the real financial wealth-to-output ratio, except in the limiting case in which the birth rate \( \beta \) is equal to zero. Therefore, in order to close the model and investigate the implied macroeconomic dynamics, one needs to specify the policy rule describing the behavior of the fiscal authority.

4 Strict Fiscal Discipline and Liquidity Traps

Let me first pay attention to the dynamic consequences of a budgetary policy regime in which the fiscal authority gradually adjusts the stock of real government liabilities relative to the size of the economy in order to converge towards a given target level \( a^* > 0 \) in the long run. Thus, consistently with Minea and Villieu (2013), Maebayashi, Hori and Futagami (2017) and Cheron et al. (2019), the fiscal adjustment rule takes
the form
\[ \dot{a}(t) = -\phi (a(t) - a^*), \] (27)
where \(a^*\) is to be interpreted as a government policy parameter and \(\phi > 0\) captures the pace of the consolidation in the case in which \(a(t)\) is larger than \(a^*\).

Given the supply of money that in equilibrium endogenously adjusts to the demand of money according to condition (24)—since in my model the monetary authority controls the nominal interest rate \(R(t)\) on the basis of rule (18)—equation (27) consequently sets down the equilibrium issuance of government bonds, given by
\[ b(t) = a(t) - \frac{1}{\Omega(\Psi(\pi(t)))}. \] (28)

Combining (20) expressed in per unit of output and (27), it also follows that to implement the fiscal policy targeting rule the government must adjust the primary surplus according to
\[ s(t) = (\Psi(\pi(t)) + \phi - \pi(t) - n) a(t) - \phi a^*. \] (29)

Setting \(\pi'(t) = 0\) and \(\dot{a}(t) = 0\) in equations (26) and (27) yields the following ‘modified Fisher equation’:
\[ \Psi(\pi) = \rho + \frac{\beta(\rho + \mu)}{\Lambda(\Psi(\pi))} a^* + \pi. \] (30)

Because the monetary policy reaction function \(\Psi(\cdot)\) is positive—respecting the zero lower bound on nominal interest rates—and satisfies \(\Psi'(+), \Psi''(\cdot) > 0\), the steady-state relation (30) has two solutions, \(\pi^*\) and \(\pi^L\). In addition, since I have assumed that \(\pi^* > 0\) is the target inflation rate at which \(\Psi'(\pi^*) > 1\), the alternative steady-state
value $\pi^L$ must obey $\pi^L < \pi^*$, is possibly negative, and necessarily does not verify the Taylor principle, that is, $\Psi'(\pi^L) < 1$, so that monetary policy is ‘passive’. Thus, the Taylor principle cannot prevail globally.

Examine next local equilibrium dynamics. Linearizing the dynamic equation around a steady-state point $(a^*, \pi)$ and using (27), one obtains the system

$$
\begin{pmatrix}
\dot{a}(t) \\
\dot{\pi}(t)
\end{pmatrix} = J^{(a^*, \pi)} \begin{pmatrix}
a(t) - a^* \\
\pi(t) - \pi
\end{pmatrix},
$$

(31)

where

$$
J^{(a^*, \pi)} = \begin{pmatrix}
-\phi & 0 \\
-\frac{\beta(\rho + \mu)}{\Lambda'(\Psi(\pi))\Psi'(\pi)} & J^{(a^*, \pi)}_{22}
\end{pmatrix},
$$

(32)

with

$$
J^{(a^*, \pi)}_{22} = \frac{(\Psi'(\pi) - 1) \Lambda'(\Psi(\pi))}{\Lambda'(\Psi(\pi))\Psi'(\pi)} + \frac{\beta(\rho + \mu)}{\Lambda'(\Psi(\pi))} a^*.
$$

The two eigenvalues of the Jacobian matrix $J^{(a^*, \pi)}$ are $-\phi < 0$ and $J^{(a^*, \pi)}_{22}$. Observe that $J^{(a^*, \pi)}_{22} > 0$ since $\Psi'(\pi^*) > 1$, so that one eigenvalue is positive and one eigenvalue is negative when evaluated at the target-inflation steady state $(a^*, \pi^*)$. Because $\pi(t)$ is a jump variable with a free initial condition and $a(t)$ is a state variable, local determinacy of equilibrium prevails in the neighborhood of the intended steady state. That is, around $(a^*, \pi^*)$ there exists a unique equilibrium converging asymptotically to that steady state. Specifically, the only trajectory of $(a(t), \pi(t))$ converging asymptotically

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4The stock of real government liabilities relative to output should be counted as a state variable of the system because its value cannot jump independently of the inflation rate. To see this, denote by $A(0)$ and $M(0)$ the initial stocks of nominal government liabilities and nominal money, respectively, whose values are predetermined. Hence, the ratio $A(0)/M(0) = a(0)/m(0) = a(0)\Omega(\Psi(\pi(0)))$ cannot jump, because $A(0)/M(0)$ is predetermined. It follows that only $\pi(0)$ can jump freely in system (31), and the Blanchard-Kahn conditions guarantee that a steady state is locally determined if one root of the Jacobian matrix is positive and one root is negative.
to \((a^*, \pi^*)\) is given by the following saddle-path solution:

\[
\pi(t) = \pi^* + \frac{\beta(\rho + \mu)}{\Lambda'(\Psi(\pi^*)) \Psi'(\pi^*) \left( \phi + J_{a^*, \pi^*}^{(\pi^*, a^*)} \right)} (a(t) - a^*),
\]

(33)

\[
a(t) = a^* + (a(0) - a^*) e^{-\phi t}.
\]

(34)

where equation (33) describes the stable arm of the saddle path, which is positively sloped—reflecting the fact that real government liabilities positively affect the inflation rate via the wealth effect on consumption. Observe, on the other hand, that \(J_{a^*, \pi^*}^{(a^*, \pi^*)} \geq 0\) if and only if \([\beta(\rho + \mu)/\Lambda(\Psi(\pi))] a^* \geq (1 - \Psi'(\pi^* \Lambda(\Psi(\pi^*))) / [\Lambda'(\Psi(\pi^*))) \Psi'(\pi^*)],\)

since \(\Psi'(\pi^*) < 1\). Appendix C shows, in particular, that the case \(J_{a^*, \pi^*}^{(a^*, \pi^*)} < 0\) proves to largely apply for any empirically plausible model’s parameterization. So both eigenvalues are robustly negative when evaluated at the low-inflation steady state \((a^*, \pi_L^*)\).

This implies that local indeterminacy of equilibrium prevails in the neighborhood of the unintended steady state. That is, around \((a^*, \pi_L^*)\) there exists a continuum of equilibrium paths of \((a(t), \pi(t))\) converging asymptotically to that steady state.

Now, one might arguably appeal to the equilibrium determinacy result around the intended steady state to persuade readers about the stabilizing effects of strict fiscal constraints of the type given by the adjustment rule (27), in particular by advocating three properties of the local solution. First, under the debt targeting fiscal regime equations (33) and (34) imply that, for \(a(0) \neq a^*\), inflation uniquely converges towards the central bank’s target rate. Second, the higher the speed of adjustment of government liabilities towards the long-run objective \(a^*\), measured by the parameter \(\phi\), the faster inflation approaches to the target. Third, equations (30) and (33)-(34) yield the following long-run and impact effects of a government policy change in the
target level $a^*$ on the inflation rate:

$$\frac{d\pi^*}{da^*} = \frac{\beta(\rho + \mu)}{\Lambda(\Psi(\pi^*)) (\Psi'(\pi^*) - 1) + \beta(\rho + \mu) \Lambda'(\Psi(\pi^*)) \Psi'(\pi^*)/\Lambda(\Psi(\pi^*))} > 0, \quad (35)$$

so that, using the fact that $A(0)/M(0) = a(0)/m(0) = a(0) \Omega(\Psi(\pi(0)))$, where $A(0)$ and $M(0)$ denote the initial predetermined stocks of nominal government liabilities and nominal money, respectively, which implies $da(0)^+/d\pi(0)^+ = -\Omega'(\Psi(\pi(0))) \Psi'(\pi(0))/[(A(0)/M(0)) \Omega(\Psi(\pi(0)))^2]$, 

$$\frac{d\pi(0)^+}{da^*} = \frac{d\pi^*}{da^*} + \frac{\beta(\rho + \mu)}{\Lambda'(\Psi(\pi^*)) \Psi'(\pi^*) (\phi + J_{22})} \left( \frac{da(0)^+}{d\pi(0)^+} \frac{d\pi(0)^+}{da^*} - 1 \right), \quad (36)$$

Thus, a reduction in the target level of real government liabilities relative to the size of the economy enables the monetary authority to set a lower inflation target, for it induces a fall in the steady-state real interest rate via the modified Fisher equation. This reflects the fact that the fiscal consolidation brings about a redistribution of resources from current to future generations, since it lowers the future tax burden required to finance the reduced interest payments on government bonds. On impact inflation jumps downwards from $\pi(0)$ to $\pi(0)^+$ onto the new stable arm described by equation $[33]$, undershooting the new long-run equilibrium, since $d\pi(0)^+/da^* < d\pi^*/da^*$. Notice that only in the special case of a zero birth rate, $\beta = 0$, inflation would be independent of fiscal variables, since the model would collapse into the infinitely-
lived single representative agent paradigm, exhibiting the Ricardian debt equivalence and no longer describing an economy with intergenerational heterogeneity.

Summing up, should the economy be expected to permanently remain in the neighborhood of the inflation target, the above three implications obtained in the general case $\beta > 0$ do support the consensus view that an appropriate fiscal commitment and a correct pace at which a fiscal consolidation plan is implemented sustain the central bank’s objective of maintaining price stability. The point, however, is that the overall story is radically different if one does not limit to local analysis and look instead at the global behavior of the system.

To this purpose, first observe that from equation (27), the $\dot{a}(t) = 0$–locus is given by $a(t) = a^*$, which in the phase plane $(a(t), \pi(t))$ is vertical. On the other hand, from equation (26), the $\dot{\pi}(t) = 0$–locus is implicitly given by

$$
(\Psi(\pi(t)) - \pi(t) - \rho) \Lambda(\Psi(\pi(t))) = \beta(\rho + \mu) a(t).
$$

(38)

Because

$$
\frac{d\pi(t)}{da(t)} \bigg|_{\dot{\pi}(t) = 0} = \frac{\beta(\rho + \mu)}{(\Psi'(\pi(t)) - 1) \Lambda(\Psi(\pi(t))) + (\Psi(\pi(t)) - \pi(t) - \rho) \Lambda'(\Psi(\pi(t))) \Psi'(\pi(t))},
$$

(39)

which is positive at $(a^*, \pi^*)$, negative at $(a^*, \pi^L)$ (see Appendix C), and infinity when $(1 - \Psi'(\pi(t))) \Lambda(\Psi(\pi(t))) = (\Psi(\pi(t)) - \pi(t) - \rho) \Lambda'(\Psi(\pi(t))) \Psi'(\pi(t))$, in the phase plane $(a(t), \pi(t))$ the $\dot{\pi}(t) = 0$–locus is horizontally U-shaped. The two loci intersect at the steady states $(a^*, \pi^*)$ and $(a^*, \pi^L)$. Then, from (27) and (26), I have $\dot{a}(t) > (<) 0$ if $a < (>) a^*$ and $\dot{\pi}(t) > (<) 0$ if $(\Psi(\pi(t)) - \pi(t) - \rho) \Lambda(\Psi(\pi(t))) > (<) \beta(\rho + \mu) a(t)$.

The resulting global dynamics are characterized in Figure 1. The stable arm of
Figure 1: Dynamic behavior of \((a(t), \pi(t))\) under strict fiscal discipline

The saddle point passing through the steady state \((a^*, \pi^*)\), has a slope given by \(\beta(\rho + \mu)/\left[\Lambda' (\Psi(\pi^*)) \Psi'(\pi^*) \left(\phi + J^{(\pi^*, a^*)}_{22}\right)\right] > 0\) that is lower than the slope of the \(\dot{\pi}(t) = 0\)-locus evaluated at \((a^*, \pi^*)\), given by \(\beta(\rho + \mu)/\left[\Lambda' (\Psi(\pi^*)) \Psi'(\pi^*) J^{(\pi^*, a^*)}_{22}\right] > 0\). It clearly emerges that, in the neighborhood of the intended steady state \((a^*, \pi^*)\), there exists an infinite number of initial values for the inflation rate featured by \(\pi(0) < \pi^* + \left\{\beta(\rho + \mu)/\left[\Lambda' (\Psi(\pi^*)) \Psi'(\pi^*) \left(\phi + J^{(\pi^*, a^*)}_{11}\right)\right]\right\} (a(0) - a^*)\) such that \((a(t), \pi(t))\) will spiral into deflationary trajectories converging to the trapping steady state \((a^*, \pi^L)\).

The saddle manifold associated with \((a^*, \pi^*)\) is precisely the boundary of the basin of attraction of \((a^*, \pi^L)\).

In other words, once a global perspective is accounted for, inflation no longer needs to jump on the saddle path leading to the target rate to guarantee dynamic stability.

\(^5\)Notice that global inflation dynamics originating around \((a^*, \pi^*)\) follow a (non-)monotonic behavior if they start to the right (left) of the \(\dot{\pi}(t) = 0\)-locus.
All initial values of inflation bounded above by the saddle path are equilibrium values for they make \((a(t), \pi(t))\) approach to the alternative steady state \((a^*, \pi^*)\). This implies that the economic system is affected by global indeterminacy.

In the present framework with dyachronous heterogeneity, deflationary paths generate, *per se*, a redistribution of real financial wealth from future to current generations, since the associated rise in the stock of government liabilities in real terms causes the fiscal burden borne by future cohorts’ to increase in order to avoid public insolvency. This intergenerational reallocation of resources beneficial to current generations would exert, *ceteris paribus*, a stimulus to aggregate consumption and as a consequence to prices, thereby potentially offsetting the initial deflationary perturbations, along lines analogous to the traditional wealth-effect channel emphasized in the static models of Pigou (1943, 1947) and Patinkin (1965). Nevertheless, if the fiscal policy regime forces the government to adjust gradually the real amount of government liabilities relative to the size of the economy at a certain level—similarly, say, to the permanent commitment rules in the Maastricht Treaty and the Fiscal Compact reforming the Stability and the Growth Pact in the European Union—following out-of-fundamentals deflationary slumps primary surpluses are expected to expand in order to choke off a potential escalation of real debt. The resulting fiscal austerity actions bring about a negative wealth effect on current cohorts’ consumption and consequently strengthen the deflationary pressures over time, hence validating the initial arbitrary revision in agents’ expectations and making the economy descend in a self-fulfilling manner into a steady state that displays the characteristics of a liquidity trap: monetary policy turns

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6The Fiscal Compact—formally ‘Treaty on Stability, Coordination and Governance in the Economic and Monetary Union’—is in force since 2013, although temporarily suspended from 2020 to 2023 because of the pandemic crisis, and features a well-defined debt reduction benchmark rule. Specifically, the rule establishes that Member States whose debt-to-GDP ratio exceeds the 60% threshold are required to reduce their ratios to the reference value at an average rate of one-twentieth per year.
to be powerless in positively affecting aggregate demand and thus prices, losing control over inflation and incurring sunspot fluctuations to the extent that the interest-rate policy stance is passive in the vicinity of the effective lower bound—so that the Taylor principle is no longer satisfied.

In synthesis, the stabilizing effects of fiscal consolidation strategies that result from a local-dynamics perspective break down, and are even reversed, from a global-dynamics perspective. Unlike conventional wisdom, strict fiscal discipline does not support price stability for, on the contrary, is likely to give rise to a self-fulfilling austerity-decelerating inflation nexus that amplifies the possibility of expectations-driven liquidity traps.

5 Escaping Liquidity Traps through Activist Fiscal Policy Regimes

Consider now the dynamic implications of a policy regime in which the fiscal authorities are assumed to react actively—in a complementary way with respect to monetary policy—in the event that off-target decelerating inflation paths leading to a liquidity trap materialize, provided that intertemporal budget constraint of the government is always satisfied.

Applying (23) to (20) yields the flow budget constraint of the public sector in terms of ratios to output:

\[ \dot{a}(t) = (R(t) - \pi(t) - n) a(t) - s(t). \quad (40) \]

The solvency condition thus requires that

\[ \lim_{t \to \infty} a(t)e^{- \int_0^t (R(j) - \pi(j) - n) dj} = 0, \quad (41) \]
or, equivalently,
\[ a(0) = \int_{0}^{\infty} s(t) e^{-\int_{0}^{t}(R(j)-\pi(j)-n) dj} dt. \] (42)

Suppose, in particular, that the feedback budgetary policy rule takes the form
\[ s(t) = \Theta (\Psi(\pi(t)) - \pi(t)) a(t) + \Gamma (\Psi(\pi(t)) - \pi(t)), \] (43)

where \( \Theta(\cdot) \) and \( \Gamma(\cdot) \) are continuous and increasing functions. The idea behind rule (43) is that, whenever fiscal policy makers observe symptoms of decelerating inflation—with the central bank that decreases the real interest rate according to the Taylor principle in the attempt to reverse dynamics, they will ease budgetary policy by ensuring a decline in primary surpluses or a rise in primary deficits through tax cuts and/or transfer increases. The fiscal expansion complementary to the Taylor-type feedback rule is assumed to occur both directly via \( \Gamma(\cdot) \) and indirectly via the reduction of the sensitivity of the primary surplus with respect to total government liabilities, measured by \( \Theta(\cdot) \). Functions \( \Theta(\cdot) \) and \( \Gamma(\cdot) \) are such that the solvency condition (41) is globally satisfied. Specifically, using the resulting law of motion of \( a(t) \),
\[ \dot{a}(t) = (\Psi(\pi(t)) - \pi(t) - n - \Theta (\Psi(\pi(t)) - \pi(t))) a(t) - \Gamma (\Psi(\pi(t)) - \pi(t)), \] (44)

this occurs when, should government liabilities embark on potentially explosive paths, beyond a certain arbitrarily chosen threshold level for \( a(t) \) function \( \Theta(\cdot) \) becomes permanently positive (see, e.g., Bohn, 1991, 1998), so that
\[ \lim_{t \to \infty} \int_{0}^{t} \Theta (\Psi(\pi(v)) - \pi(v)) dv = +\infty, \] (45)
and, in addition,

$$\lim_{t \to \infty} -e^{-\int_0^t \Theta(\Psi(v) - \pi(v))dv} \int_0^t \Gamma(\pi(v)) \pi(v) - e^{-\int_0^t (R(j) - \pi(j) - n - \Theta(\Psi(j) - \pi(j))) dj} dv = 0.$$  (46)

Under (45), condition (46) is surely verified when the present discounted value of future primary deficits associated to function $\Gamma(\cdot)$ in (43) is lower than $+\infty$—an arguably realistic assumption.

Setting $\dot{a}(t) = 0$ and $\dot{\pi}(t) = 0$ in the dynamic equations (44) and (26) yields

$$a = \frac{\Gamma(\Psi(\pi) - \pi)}{(\Psi(\pi) - \pi - n - \Theta(\Psi(\pi) - \pi))},$$  (47)

$$\Psi(\pi) = \rho + \beta(\rho + \mu) \frac{\Lambda(\Psi(\pi))}{a + \pi}.$$  (48)

Close inspection of (47) and (48) reveals that there exist at least two steady states, $(a^*, \pi^*)$ and $(a^L, \pi^L)$, obeying $\pi^* > \pi^L$, $\Psi'(\pi^*) > 1$, $\Psi'(\pi^L) < 1$, and $a^* \geq a^L$. This reflects the fact that, for a given $a$, the modified Fisher equation (48) continues to have two solutions for $\pi$, one in which monetary policy is active and one in which monetary policy is passive, analogously to the previous section.

Linearizing equations (44) and (26) in the neighborhood of any steady-state point $(a, \pi)$, one obtains the system

$$\left(\begin{array}{c}
\dot{a}(t) \\
\dot{\pi}(t)
\end{array}\right) = K^{(a, \pi)} \left(\begin{array}{c}
a(t) - a \\
\pi(t) - \pi
\end{array}\right),$$  (49)
\[
K_{22}^{(a, \pi)} = \left( \psi' (\pi) - 1 \right) \Lambda \left( \psi (\pi) \right) \psi' (\pi) + \frac{\beta (\rho + \mu)}{\Lambda' (\psi (\pi))} a.
\]

The determinant and the trace of the Jacobian matrix \(K^{(a, \pi)}\) are

\[
\det K^{(a, \pi)} = \left( \psi (\pi) - \pi - n - \Theta (\psi (\pi) - \pi) \right) K_{22}^{(a, \pi)} + \frac{\beta (\rho + \mu)}{\Lambda' (\psi (\pi))} a.
\]

\[
\text{tr} K^{(a, \pi)} = \psi (\pi) - \pi - n - \Theta (\psi (\pi) - \pi) + K_{22}^{(a, \pi)}.
\]

Observe that \(\det K^{(a^*, \pi^*)} < 0\) if

\[
\Gamma' (\psi^* (\pi) - \pi^*) + \Theta' (\psi^* (\pi) - \pi^*) a^* > a^* + \frac{\left( \psi^* (\pi) - \pi^* - n - \Theta (\psi^* (\pi) - \pi^*) \right) \Lambda' (\psi^* (\pi)) \psi' (\pi^*) K_{22}^{(a^*, \pi^*)}}{\beta (\rho + \mu) (\psi' (\pi^*) - 1)}.
\]

That is, local determinacy of equilibrium applies in the neighborhood of the intended steady state \((a^*, \pi^*)\), where \(\psi' (\pi^*) > 1\), provided that fiscal policy is sufficiently reactive to potential disinflationary pressures. In particular, the locally unique trajectory of \((a (t), \pi (t))\) converging asymptotically to \((a^*, \pi^*)\) is given by the saddle-path solution
expressed by

\[ \pi(t) = \pi^* - \frac{\beta(\rho + \mu)}{\Lambda'(\Psi(\pi^*)) \Psi'(\pi^*)} \left( \varepsilon_1 - K_{22}^{(\pi^*, \pi^*)} \right)(a(t) - a^*), \]  

(54)

\[ a(t) = a^* + (a(0) - a^*) e^{\varepsilon_1 t}. \]  

(55)

where \( \varepsilon_1 \) is the negative eigenvalue associated to \( K^{(\pi^*, \pi^*)} \) and equation (54) is the stable arm of the saddle path, which is positively sloped since \( K_{22}^{(\pi^*, \pi^*)} > 0 \)—reflecting again the positive comovement between agents’ wealth and inflation. On the other hand, the unintended steady state \( (a_L, \pi_L) \) with \( \Psi'(\pi_L) < 1 \), exhibiting deflation or disinflation, may no longer be a sink—differently from the case of a strict fiscal discipline examined in Section 4. Indeed, observe that \( \det K^{(a^*, \pi^*)} > 0 \) if

\[ \Gamma'(\Psi(\pi_L) - \pi_L) + \Theta'(\Psi(\pi_L) - \pi_L) a_L > a_L + \frac{\left( \Psi(\pi_L) - \pi_L - n - \Theta(\Psi(\pi_L) - \pi_L) \right) \Lambda'(\Psi(\pi_L)) \Psi'(\pi_L) \left( -K_{22}^{(a^*, \pi_L)} \right)}{\beta(\rho + \mu) (1 - \Psi'(\pi_L))}. \]  

(56)

where \( K_{22}^{(a^*, \pi^*)} < 0 \) on the basis of any empirically plausible model’s calibration (see Appendix C), and \( \text{tr} \ K^{(a^*, \pi^*)} > 0 \) if

\[ \Theta(\Psi(\pi_L) - \pi_L) < \rho - n + \frac{\beta(\rho + \mu)}{\Lambda(\Psi(\pi_L))} a + K_{22}^{(a^*, \pi^*)}. \]  

(57)

That is, the steady state \( (a_L, \pi_L) \) becomes unstable if fiscal policy is sufficiently activist and the sensitivity of the primary surpluses with respect to government liabilities is relatively low. For what will follow, in particular, it is worth pointing out that
\[
\left( \text{tr } K^{(a^L, \pi^L)} \right)^2 - 4 \text{det } K^{(a^L, \pi^L)} > (\leq) 0 \text{ if }
\]

\[
\Gamma' \left( \Psi(\pi^L) - \pi^L \right) + \Theta' \left( \Psi(\pi^L) - \pi^L \right) a^L
\]

\[
< (>) a^L + \frac{\left( \Psi(\pi^L) - \pi^L - n - \Theta \left( \Psi(\pi^L) - \pi^L \right) \right) \Lambda' \left( \Psi(\pi^L) \right) \Psi'(\pi^L) \left( -K_{22}^{(a^L, \pi^L)} \right)}{\beta (\rho + \mu) (1 - \Psi'(\pi^L))}
\]

\[
+ \frac{\Lambda' \left( \Psi(\pi^L) \right) \Psi'(\pi^L) \left( \Psi(\pi^L) - \pi^L - n - \Theta \left( \Psi(\pi^L) - \pi^L \right) + K_{22}^{(a^L, \pi^L)} \right)^2}{4 \beta (\rho + \mu) (1 - \Psi'(\pi^L))}. \tag{58}
\]

As a result, provided that fiscal policy is not overly aggressive, the roots associated to the Jacobian matrix \( K^{(a^L, \pi^L)} \) are real, implying that \((a^L, \pi^L)\) is an unstable node. In this case, there exists a continuum of curved paths that are tangent to the negatively-slopped unstable branch given by

\[
\pi(t) = \pi^L - \frac{\beta (\rho + \mu)}{\Lambda' \left( \Psi(\pi^L) \right) \Psi'(\pi^L) \left( \eta_1 - K_{22}^{(a^L, \pi^L)} \right)} \left( a(t) - a^L \right), \tag{59}
\]

where \( \eta_1 > 0 \) is the non-dominant eigenvalue of \( K^{(a^L, \pi^L)} \). By contrast, should fiscal policy be excessively aggressive, roots are complex, implying that \((a^L, \pi^L)\) is an unstable spiral point.

I am now ready to elucidate the consequences for global dynamics under activist fiscal policy regimes satisfying conditions (53), (56) and (57). From equation (44), the \( \dot{a}(t) = 0 \)-locus is given by

\[
\frac{\Gamma \left( \Psi(\pi(t)) - \pi(t) \right)}{\Psi'(\pi(t)) - \pi(t) - n - \Theta \left( \Psi(\pi(t)) - \pi(t) \right)} = a(t), \tag{60}
\]
from which

\[
\frac{d\pi(t)}{da(t)}\bigg|_{\dot{a}(t)=0} = \frac{\Gamma(\Psi(\pi(t)) - \pi(t))}{(\Psi'(\pi(t)) - 1) (\Gamma'(\Psi(\pi(t)) - \pi(t))) + \Theta'(\Psi(\pi(t)) - \pi(t)) a(t) - a(t) a(t)}. \tag{61}
\]

In what follows, I shall assume the restrictions \(\Gamma(\Psi(\pi(t)) - \pi(t))|_{a(t)=0} > 0\) and 
\(\Gamma'(\Psi(\pi(t)) - \pi(t)) + \Theta'(\Psi(\pi(t)) - \pi(t)) a(t) - a(t)|_{a(t)=0} > 0\), according to which fiscal policy avoids the existence of more than two steady states. Hence, the slope of the \(\dot{a}(t) = 0\)–locus is positive at \((\pi^*, a^*)\), negative at \((a^L, \pi^L)\), and infinity when \(\Psi'(\pi(t)) = 1\). Therefore, in the phase plane \((a(t), \pi(t))\) the \(\dot{a}(t) = 0\)–locus is horizontally U-shaped. As in the previous section, the \(\dot{\pi}(t) = 0\)–locus implicitly given by \(38\) is also horizontally U-shaped. The two loci intersect at the steady states \((a^*, \pi^*)\) and \((a^L, \pi^L)\).

From the properties of the Jacobian matrix, it emerges that the slope of the \(\dot{a}(t) = 0\)–locus is lower than the slope of the \(\dot{\pi}(t) = 0\)–locus if evaluated at \((a^*, \pi^*)\) and the opposite occurs if the slopes are evaluated at \((a^L, \pi^L)\). From \(14\) and \(26\), I have that 
\(\dot{a}(t) > ( < ) 0\) if \((\Psi(\pi(t)) - \pi(t) - n - \Theta(\Psi(\pi(t)) - \pi(t))) a(t) > ( < ) \Gamma(\Psi(\pi(t)) - \pi(t))\) 
and \(\dot{\pi}(t) > ( < ) 0\) if \((\Psi(\pi(t)) - \pi(t) - \rho) \Lambda(\Psi(\pi(t))) > ( < ) \beta(\rho + \mu)a(t)\).

In the case of real roots associated to \(K^{(a^*, \pi^*)}\), which require that fiscal policy is not overly aggressive at the liquidity-trap steady state, the resulting global dynamics are characterized in Figure 2. The stable arm of the saddle point passing through \((a^*, \pi^*)\) has a positive slope given by 
\(-\beta(\rho + \mu) / \left[\Lambda'(\Psi(\pi^*)) \Psi'(\pi^*) \left(\varepsilon_1 - K^{(\pi^*, a^*)}_{22}\right)\right] > 0\), which is higher than the slope of the \(\dot{a}(t) = 0\)–locus evaluated at \((a^*, \pi^*)\), given by \(61\) at \((a^*, \pi^*)\), and lower than the slope of the \(\dot{\pi}(t) = 0\)–locus evaluated at \((a^*, \pi^*)\), given by 
\(\beta(\rho + \mu) / \left[\Lambda'(\Psi(\pi^*)) \Psi'(\pi^*) K^{(\pi^*, a^*)}_{22}\right] > 0\). Since the steady state \((a^L, \pi^L)\) is an unstable node, there exists one trajectory—the heteroclinic orbit \(H\)—originating in the neighborhood of the steady state \((a^L, \pi^L)\), negatively slopped around \((a^L, \pi^L)\) because
Figure 2: Dynamic behavior of \((a(t), \pi(t))\) under moderately activist fiscal policies tangent to the negatively sloped eigenspace related to the nondominant eigenvalue \(\eta_1\) expressed by equation (59), and converging asymptotically to the steady state \((a^*, \pi^*)\) locally along the associated saddle path whose stable arm is given by equation (54).

The existence of such a saddle connection guarantees global determinacy of equilibrium, according to which even if the economy lies in the neighborhood of the liquidity-trap steady state at which monetary policy is passive, now inflation and real government liabilities will uniquely escape from \((a_L, \pi_L)\) and converge towards the target steady state at which monetary policy is active. The reason why liquidity traps are eradicated

\[\text{As the heteroclinic orbit } H \text{ is tangent to the eigenspace associated to } \eta_1 \text{ in the neighborhood } (a^L, \pi^L), \text{ it lies between the } \dot{a}(t) = 0 \text{–locus and that eigenspace and never crosses this line. As a result, the } H \text{–trajectory is enclosed by a ‘trapping region’ whose sides are given by the } \pi(t) = 0 \text{–locus between the two steady-state equilibria, a line passing through the steady state } (a^L, \pi^L) \text{ whose slope is given by the eigenvector associated to the non-dominant eigenvalue } \eta_1, \text{ and a line passing through the steady state } (a^*, \pi^*) \text{ whose slope is given by the slope of the associated saddle path, between } (a^*, \pi^*) \text{ and the previous line. All the trajectories starting inside the trapping area escape from it, with the exception of those starting at any point along the heteroclinic orbit. In other words, only the orbit does not hit the boundaries of the trapping area and follows a non-monotonous path—in terms of dynamic behavior of } a(t) \text{—that changes direction when } \dot{\pi}(t) = 0.\]
with no commitment to trigger unsustainable budget deficits is that a sequence of tax cuts and transfer increases financed by bond issues and future primary surpluses expands both human and financial wealth for currently alive households, thus spuring aggregate consumption, since government debt is net wealth for living generations. This course of sustainable fiscal policy measures, which partly shift the sequence of future net taxes to future generations thereby leading current generations to dissave, is capable of reflating the economy due to the induced excess demand in the goods’ market and restoring in general equilibrium dynamic convergence of inflation towards the intended steady state.

On the other hand, in the case of complex roots associated to $K^{(a^L, \pi^L)}$, which occur when fiscal policy is overly aggressive at the unintended steady state, the implied global dynamics become those displayed in Figure 3. Even though fiscal expansions are able to escape liquidity traps along a heteroclinic orbit leading to $(a^*, \pi^*)$ as in the

Figure 3: Dynamic behavior of $(a(t), \pi(t))$ under overly activist fiscal policies
previous case, now global indeterminacy prevails because the steady state \((a^L, \pi^L)\) is an unstable spiral point. Hence, if the economy lies in the vicinity of the liquidity-trap steady state, there exists a large class of initial values for the inflation rate compatible with a globally stable perfect foresight equilibrium. Furthermore, the inflation rate may fluctuate for relatively long periods of time in a region whereby monetary policy is necessarily passive because of the effective lower bound on the nominal interest rate, away from the intended steady state. Taken together, these results give analytical support to the view that excessively lax fiscal stimuli, although expected to be repaid by large future net taxes needed to redeem the government debt eventually, are likely to be a quite severe source of macroeconomic instability.

In synthesis, should the latter case of macroeconomic instability induced by too aggressive fiscal boosts be ruled out by fiscal policy makers, the theoretical findings demonstrated in my analysis clearly lead to the conclusion that moderately activist demand side oriented budgetary interventions, responding to deflationary pressures under the respect of the government’s intertemporal budget constraint, do constitute an essential tool of ‘last resort’ in order to avert liquidity traps and, at the same time, preserve the stabilizing properties of the rules-based approach to monetary policy.

6 Conclusions

As the nominal interest rates set by central banks in most major economies have turned close to zero and even negative as a consequence of the secular stagnation and in order to counter the ongoing pandemic crisis—within a prolonged period of below-target inflation—the issue of how to escape undesirable deflationary paths associated to a situation of liquidity trap without creating space for other forms of macroeconomic in-
stability, such as fiscal unsustainability or a burst of inflation, is a pressing concern for policy makers. The present paper explores the scope for aggregate stability in a monetary model with overlapping generations of finitely-lived agents that displays multiple steady-state equilibria due to the existence of a binding lower bound on nominal interest rates. First, I depart from the standard literature on confidence-driven liquidity traps based upon the infinitely-lived single representative agent theoretical paradigm, because in the present framework wealth effects on aggregate demand dynamics emerging from intergenerational heterogeneity critically affect both the monetary and fiscal policy transmission mechanism. Hence, the model I present is a natural extension of the seminal work by Benhabib, Schmitt-Grohé and Uribe (2002). Second, I depart from the standard literature on fiscal policy multipliers based upon local approximations of dynamic stochastic general equilibrium models, because I take into account nonlinearities and potential connections between multiple steady-state equilibria resulting from a global-dynamics perspective. Hence, my framework relaxing the Ricardian equivalence due to disconnectedness across generations is a natural alternative to the prominent work by Mertens and Ravn (2014), grounded on a nonlinear New Keynesian model with distortionary taxation. Third, I concentrate on the stabilizing role of intertemporal reallocations of taxes and transfers in an otherwise standard monetary model with flexible prices. Hence, the model I employ is a useful complement the theoretical analysis developed by Schmidt (2016), based on the implications of Ricardian government spending rules in the context a typical New Keynesian model.

My analysis leads to three conclusions. First, a rigid degree of fiscal discipline of the type prescribed by the Maastricht-Treaty and the Fiscal-Compact frameworks in the European Union, in which the government is required to gradually adjust the stock of
real government liabilities relative to the size of the economy in order to guarantee convergence towards a target level in the long run, is not a precondition to price stability, as commonly believed. On the contrary, it is a potentially severe source of macroeconomic imbalances, because it typically makes the economy exposed to the emergence of unintended liquidity traps, which preclude the central bank from uniquely pinning down inflation at the target rate. The central reason is that, under this fiscal policy regime, following deflationary dynamics driven by arbitrary revisions in private agents’ expectations the government is expected to rise primary surpluses in order to rule out escalation of debt in real terms. Thus austerity actions produce a negative wealth effect on current cohorts’ consumption, amplifying the initial deflationary perturbations over time. Global indeterminacy emerges, since any inflation trajectory bounded above by the saddle path passing through the target steady state can be validated as an equilibrium outcome.

Second, implementing an intertemporally balanced fiscal stimulus in response to out-of-equilibrium deflationary paths—with no need to make the liquidity-trap steady state fiscally unsustainable as argued within the classical Ramsey-type single representative agent paradigm—exerts an decisive role, complementary to inflation-targeting-oriented interest rate feedback rules of the Taylor-type, in ensuring macroeconomic stability. Sustainable bond-financed fiscal boosts, decreasing taxes and/or increasing public transfers in reaction to deflationary pressures under the respect of the public solvency condition, are capable of eradicating liquidity traps and, at the same time, drive inflation into a globally stable trajectory converging to the target rate. The reason is twofold. On the one hand, under a fiscal policy regime preventing the applications of fiscal austerity measures following deflationary slumps, a redistribution of real financial
wealth from future to current generations occurs, since deflation increases the real value of government liabilities, thereby enhancing the burden of future fiscal retrenchment. On the other hand, fiscal expansions financed by bond issues and future taxes net of transfers enlarge both human and non-human wealth for living generations. The two effects induce currently alive individuals to dissave, spurring aggregate consumption despite the increases in real interest rates in the vicinity of the trapping equilibrium. Following the resulting excess demand in the goods’ market, price increases are necessary to absorb the disequilibrium.

Third, global determinacy is not guaranteed by all types of expansionary budgetary policies that seek to fight liquidity traps. Overly aggressive fiscal stimulus, in particular, induces spiral dynamics around the liquidity-trap steady state. In this event, although liquidity traps are escaped along a saddle connection from the steady state at which monetary policy is passive to the steady state at which monetary policy is active and convergence of inflation to the target rate is ensured, global indeterminacy applies, thus warning against the enforcement of excessively pronounced fiscal boosts expected to be paid back by large future primary surpluses.

Should the latter case be avoided, however, the foregoing results provide sound analytical microfoundations to the view that demand side oriented fiscal intervention respecting the government’s intertemporal budget constraint, because of the existence of a binding lower bound on nominal interest rates that severely limit the power of the central bank, constitutes a tool of ‘last resort’ for liquidity traps to be aptly averted and, at the same time, for aggregate stability to be preserved.
Appendix A

Using the definition of total consumption (5) and the optimal intratemporal condition (7), the instantaneous utility function takes the form

$$\log \Upsilon(s, t) = \log q(t) + \log \bar{\pi}(s, t), \quad (62)$$

where $q(t) \equiv \Upsilon \left( \frac{\Omega(R(t))}{\Omega(R(t)) + R(t)} \right)$ is identical across all generations and can be interpreted as the utility-based cost of living index of the basket of physical goods and real balances. Thus, the intertemporal optimization problem can be expressed as follows:

$$\max_{\{\bar{\pi}(s,t)\}} \int_0^\infty \log q(t) + \log \bar{\pi}(s, t)e^{-(\mu + \rho)t} dt, \quad (63)$$

subject to

$$\dot{a}(s, t) = (R(t) - \pi(t) + \mu) a(s, t) + y(s, t) - \tau(s, t) - x(s, t), \quad (64)$$

the no-Ponzi game condition (4), and given $a(s, 0)$. Hence, optimality implies the Euler equation in terms of total consumption (8) and the transversality condition (9). Integrating forward (64) and employing both the transversality condition (9) and the law of motion of total consumption (8) yield the level total consumption expressed as a linear function of total wealth, that is, equation (10). From (7), I have

$$\bar{\pi}(s, t) = \Lambda(R(t))\bar{c}(s, t), \quad (65)$$
where \( \Lambda(R(t)) \equiv 1 + R(t)/\Omega(R(t)) \). Time-differentiating (65) gives

\[
\dot{x}(s, t) = \Lambda'(R(t))\bar{c}(s, t) \dot{R}(t) + \Lambda(R(t))\dot{c}(s, t).
\] (66)

Substituting (65) and (66) into (8) results in the law of motion for individual consumption (13).

**Appendix B**

Aggregate wealth in per capita terms is, by definition, given by

\[
\bar{a}(t) = \beta \int_{-\infty}^{t} \bar{a}(s, t) e^{\beta(s-t)} ds.
\] (67)

Differentiating with respect to time gives

\[
\dot{\bar{a}}(t) = \beta \bar{\pi}(t, t) - \beta \bar{\pi}(t) + \beta \int_{-\infty}^{t} \bar{\pi}(s, t) e^{\beta(s-t)} ds,
\] (68)

Since \( \bar{a}(t, t) \) is equal to zero, by assumption, using (3) into (68) yields

\[
\dot{\bar{a}}(t) = \mu \bar{\pi}(t) + \rho \bar{\pi}(t) + (R(t) - \pi(t)) \bar{c}(t) + \bar{\gamma}(t) - \bar{\pi}(t) - \bar{\pi}(t) - R(t)\bar{m}(t)
\] = \( R(t) - \pi(t) - n \bar{a}(t) + \bar{\gamma}(t) - \bar{\pi}(t) - \bar{c}(t) - R(t)\bar{m}(t) \). (69)

From (12), the per capita aggregate consumption is given by

\[
\bar{c}(t) = \left( \frac{\mu + \rho}{\Lambda(R(t))} \right) (\bar{a}(t) + \bar{h}(t)),
\] (70)
Differentiating with respect to time the definition of per capita aggregate consumption gives

\[
\dot{c}(t) = \beta \bar{c}(t, t) - \beta \bar{c}(t) + \beta \int_{-\infty}^{t} \dot{c}(s, t) e^{\beta (s-t)} ds, \tag{71}
\]

where \( \bar{c}(t, t) \) represents consumption of the newborn generation. Because \( \bar{c}(t, t) = 0 \) and \( \bar{h}(t, t) = \bar{h}(t), \tag{12} \) implies

\[
\bar{c}(t, t) = \frac{(\mu + \rho)}{\Lambda(R(t))} \bar{h}(t). \tag{72}
\]

Substituting \( \bar{h}(s, t) \), \( 70 \) and \( 72 \) into \( 71 \) yields the time path of per capita aggregate consumption, given by \( 17 \).

**Appendix C**

Suppose that the subutility function \( \Upsilon(\bar{c}(s, t), \bar{m}(s, t)) \) is of the CES-type, in line with Galí (2015) and Walsh (2017):

\[
\Upsilon(\bar{c}(s, t), \bar{m}(s, t)) = \left[ \delta \bar{c}(s, t) \frac{\varepsilon + 1}{\varepsilon} + (1 - \delta) \bar{m}(s, t) \frac{\varepsilon + 1}{\varepsilon} \right]^{\frac{\varepsilon}{\varepsilon + 1}}, \tag{73}
\]

with \( 0 < \delta, \varepsilon < 1 \), where \( \varepsilon \) represents the elasticity of substitution between consumption and real money holdings. It then follows

\[
\frac{\bar{m}(s, t)}{\bar{c}(s, t)} = \frac{1}{\Omega(R(t))} = \left( \frac{\delta}{1 - \delta} \right)^{-\varepsilon} R(t)^{-\varepsilon}, \tag{74}
\]

\[
\Lambda(R(t)) = 1 + \left( \frac{\delta}{1 - \delta} \right)^{-\varepsilon} R(t)^{1-\varepsilon}, \tag{75}
\]

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\[ \Lambda'(R(t)) = (1 - \varepsilon) \left( \frac{\delta}{1 - \delta} \right)^{-\varepsilon} R(t)^{-\varepsilon} \]

For advanced economies’ annual data, in the monetary policy literature it is common to set \( \rho = 0.04 \) and \( \Psi(\pi^*) = 0.06 \), (see, e.g., Woodford, 2003, and Benhabib, Schmitt-Grohé and Uribe, 2001). I initially set \( \varepsilon = 0.5 \), implying a log-log interest elasticity of money demand of \(-0.5\), consistently with the seminal paper by Lucas (2000). Using (74), the parameter \( \delta \) is initially chosen so that the implied annual consumption velocity of money is equal to unity, which is plausible value when a broad monetary aggregate such as \( M3 \) is employed. So I obtain \( \delta = 0.9434 \). In the baseline calibration, I set \( \Psi(\pi^L) = 0.001 \) and \( \Psi'(\pi^L) = 0.1 \) and \( a^* = 0.6 \). In line with United Nations World Population Prospects 2019 for 2015-2020 with reference to high-income countries, I set \( n = 0.0047 \) and \( \mu = 0.012366 \), implying a life expectancy at birth of 80.87 years and a birth rate of 0.017066. Therefore, I have

\[
J_{22}^{(a^*, \pi^L)} = \frac{(\Psi'(\pi^L) - 1) \left[ 1 + (\frac{\delta}{1 - \delta})^{-\varepsilon} \Psi(\pi^L)^{1 - \varepsilon} \right]}{\Psi'(\pi^L) \left[ (1 - \varepsilon) \left( \frac{\delta}{1 - \delta} \right)^{-\varepsilon} \Psi(\pi^L)^{-\varepsilon} \right]} + \frac{\beta(\rho + \mu)}{1 + (\frac{\delta}{1 - \delta})^{-\varepsilon} \Psi(\pi^L)^{1 - \varepsilon}} a^* \quad (77)
\]

\[
= -1.951
\]

The result \( J_{22}^{(a^*, \pi^L)} < 0 \) is robust to large variations in parameter values. In particular, \( J_{22}^{(a^*, \pi^L)} \) continues to be negative if: (a) \( \varepsilon \), the elasticity of substitution between consumption and real money holdings, is lowered from the baseline value of 0.5 to a value in the range \((0.05, 0.5)\), implying a diminished log-log interest elasticity of money demand consistently with the empirical results obtained by Ireland (2009); (b) the an-

8https://population.un.org/wpp/.
annual consumption velocity of money is increased from 1 to a value in the range (1, 20), should \( M0, M1, \) or \( M2 \) be used as monetary aggregates; (c) \( \Psi(\pi^L) \), the nominal interest rate at the liquidity trap steady-state, is increased from 0.001 to a value in the range (0.001, 0.1); (d) \( \Psi'(\pi^L) \), the monetary policy feedback reaction to inflation at the liquidity-trap steady-state, is decreased from 0.1 to a value in the range (0.1, 0.01); (e) \( a^* \), the target level for the government liabilities to output ratio, is increased from 0.6 to a value in the range (0.6, 2).

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