Monetary & fiscal policy implications for rising government debt under labor endogeneity

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Abstract

Several advanced economies are heading towards a period of fiscal stress; aging population raises government transfers which in turn increases nominal government debt. Existing literature studies how alternative combinations of monetary and fiscal policies can stabilize real debt in the face of exponentially rising transfers. This paper develops an overlapping generations (OG) model with endogenous labor to study the implications of labor supply decisions on the path of real government debt under alternative monetary and fiscal policy combinations and finds that adopting a policy regime where the monetary authority passively targets inflation in the face of rising transfers, even before the economy is at the fiscal limit, might stabilize inflation better than an active monetary regime. The model in the paper has been calibrated to the US economy to demonstrate dynamic effects.

Keywords: government debt, Debt-to-GDP ratio, monetary policy, fiscal policy, monetary-fiscal interactions, alternative regimes, inflation, labor endogeneity

JEL Classification: E5, E52, E62

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First received, April 15, 2017; Revision received, August 8, 2017; Accepted, August 16, 2017.

1 Introduction

The concern about fiscal sustainability is growing in a large number of countries, both developed and developing. Every economy faces a fiscal limit which, as defined by Leeper (2009), is a point beyond which tax collections can no longer rise and government expenditures can no longer be reduced; or in other words it is one "that delivers the maximum government debt-GDP ratio that can be sustained without appreciable risk of default."The ability of a government to raise revenues through taxes is limited by political factors and economic reasons. On one hand, taxes act like a wedge and create distortion in economic activities. On the other hand, political constraints arising from the electorate's intolerance may restrict tax rates from reaching the peak of a Laffer curve. Indeed, Trabandt and Uhlig (2009) claim that many European countries are at the peak of their Laffer curves for labor taxes. Owing to the recent recession and financial crises, coupled with an aging population, several ad¬vanced nations are approaching a period of fiscal stress. In the absence of credible plans for financing, individuals are faced with uncertainty about the taxes they may have to pay or the transfers they may receive in the future. This paper introduces labor endogeneity in an Overlapping Generations (OG) model to study the impact of labor supply decisions on the path of government debt, under alternative monetary-fiscal policy combinations.

Conventionally, controlling inflation and maintaining the value of government debt are the major tasks of monetary and fiscal policies, respectively. This paper looks at the possibility of an alternative assignment. Fiscal policy could be assigned to control inflation, leaving monetary policy to maintain the value of debt, which is the core of the fiscal theory of price level associated with Leeper (1991), Sims (1994) and Woodford (1995).

One of the major concerns among economists is that when the economy hits the fiscal limit, it will no longer be possible to set interest rates independently of inflation and primary surpluses independently of outstanding debt, which indicates a situation in which the monetary policy-maker will no longer be able to control the inflation rate. This has led to a number of studies regarding alternative policy regimes. Richter (2015) uses a Perpetual Youth Model to assess the implication on fiscal stress of intergenerational redistributions of wealth and the maturity of government debt. In particular, he concludes that intergenerational transfers of wealth strengthen the expectational effects of the fiscal limit. Delaying reform increases the severity and duration of the stagflationary period. Davig et al. (2010) show that temporarily unstable government debt may cause monetary policy to lose control over inflation in the short run. However, an aspect that has not received sufficient attention is that the fiscal limit depends not only on the economic and political environment including exogenous disturbances, but also on the behavior of private agents. Private individuals are aware of the forthcoming fiscal limit and the change in monetary and fiscal policy regimes may alter their behavior and in turn, have previously unexplored implications for the path of debt-to-GDP ratio and inflation. In this paper, using an OG model with endogenous labor, I find that, even before the tax rate is at its maximum, monetary policy may fail to anchor inflation at the steady state level, and switching to an alternative regime might enable monetary and fiscal authorities to control inflation.

The rest of the paper is summarized as follows: descriptions of households, market for capital, firms and monetary and fiscal authorities are set up in Sections 2, 3, 4 and 5. Section 6 demonstrates the equilibrium including the steady state. In section 7, the implication of an increase in population growth on the government debt and the economy is analyzed under alternative policy regimes.

2 Households

There are two overlapping generations and each generation lives for two periods. Each generation works in the period in which they are born (when they also pay taxes) and in the next period they retire (when they receive transfers). The size of a generation born at time t is given by:

$$\Psi_t = (1 + n_t)\Psi_{t-1} \tag{1}$$

where n_t is the growth rate of population which follows an AR(1) process:

$$n_t = (1-\rho)n^{ss} + \rho n_{t-1} + \varepsilon_t \qquad 0 < \rho < 1$$

Hence, size of total population in each time period is: $\Psi_t + \Psi_{t-1} = \Psi_t + \frac{\Psi_t}{1+n_t}$

Each individual supplies l_t units of labor in the first period of their lives but retires in the second period. There is a physical constraint on labor supply:

$$0 \leq l_t \leq l^{\max} \tag{2}$$

Individuals are born without assets. In the first period, they divide their wage income between consumption and saving in the form of nominal government bonds, B_t, for which they receive nominal interest, R_t, at time, $t+1$, and saving for capital, s_t, for which they earn a real interest, r_{t+1}, at time $t+1$. Their savings become the stock of assets they bring forward to the second period. They consume all of their assets in the second period plus the interest on the assets held from the first to the second period.

The notation for consumption is as follows: c_{1t} is consumption at time t for individuals born at time t (workers), c_{2t} is consumption at time t for individuals born at time $t-1$ (retired). Individuals born at time t choose consumption and labor supply to maximize their lifetime utility as follows:

$$Max\ [\log c_{1t} + \chi \log(1-l_t)] + \beta E(\log c_{2t+1}) \qquad \chi > 0; 0 < \beta < 1$$

subject to the following constraints:

$$c_{1t} + b_t + s_t = (1-\tau_t)w_t l_t \tag{3}$$

$$c_{2t+1} = z_{t+1} + \frac{1+R_t}{1+\pi_{t+1}} b_t + (1+r_{t+1})s_t \tag{4}$$

where $s_t > 0$ (to prevent individuals from borrowing without repaying), χ is the leisure parameter, β is the discount factor, π_t is the inflation rate; τ_t is the tax rate; z_{t+1} is the transfer that the individual receives from the government in the second period of his life, w_t is the real wage rate per hour for labor. Household optimization requires satisfaction of the following Euler equation which governs the optimal path of consumption across time:

$$c_{1t}^{-1} = \beta E(\frac{1+R_t}{1+\pi_{t+1}})c_{2t+1}^{-1} \tag{5}$$

$$c_{1t}^{-1} = \beta E(1+r_{t+1})c_{2t+1}^{-1} \tag{6}$$

The utility loss from giving up one unit of consumption at time t to buy a bond or to save in the from of capital must be equal to the utility gain from a unit of consumption at $t+1$.

$$\frac{1}{1-l_t} = \frac{(1-\tau_t)w_t}{c_{1t}} \tag{7}$$

The utility loss from increasing labor supply at t must be compensated by utility gained from increased consumption at t. Since the return on holding bonds, $E\frac{1+R_t}{1+\pi_{t+1}}$ and buying capital, $E(1+r_{t+1})$, is greater than the return on holding output for consumption in the next period, individuals will always hold the unconsumed parts of their income in the form of bonds and savings for capital.

3 Market for capital

In each period t, there is a market for borrowing and lending of capital which is in equilibrium when savings for capital equals investment in each period. If $\Psi_t s_t$ is aggregate savings (of the working individuals) and $\Psi_{t-1}s_{t-1}$ is the dis-saving of the retired, then net aggregate saving at time t is:

$$\Psi_t s_t - \Psi_{t-1} s_{t-1} = K_{t+1} - K_t$$

$$i.e., K_{t+1} = \Psi_t s_t \tag{8}$$

that is, savings at t is available for new capital at $t+1$. The demand for capital comes from firms that use capital in production at $t+1$. In per capita form:

$$(1 + n_{t+1})k_{t+1} = s_t \tag{9}$$

4 Firms

Firms have a constant returns to scale Cobb Douglas production function as folows:

$$Y_t = F(K_t, l_t\Psi_t) = K_t^{\mu}(l_t \times \Psi_t)^{(1-\mu)} \qquad 0 < \mu < 1 \tag{10}$$

where $K_t = \Psi_{t-1}s_{t-1}$. The production function can be expressed in per capita terms as follows: $y_t = f(k_t) = k_t^{\mu} l_t^{1-\mu}$, where $y_t = Y_t/\Psi_t$ and $k_t = K_t/\Psi_t$. Investment is given by: $K_{t+1} - (1-\delta)K_t$ where $0 < \delta < 1$ is the rate of depreciation of capital. Agents who are old and retired at t=1 collectively endowed with an initial amount of capital $K(0) > 0$.

Denoting r_t is the real rental price of capital and w_t is the real wage rate for workers, standard profit maximization yields:

$$r_t = f'(k_t) - \delta - n_t = \mu\frac{y_t}{k_t} - (\delta + n_t) \tag{11}$$

$$w_t = f'(l_t) = (1-\mu)\frac{y_t}{l_t} \tag{12}$$

5 Monetary and fiscal policies

5.1 The budget constraint of the government

The government is faced with the following flow budget constraint:

$$\Psi_{t-1}z_t + \Psi_{t-1}\frac{(1+R_{t-1})}{(1+\pi_t)}\frac{B_{t-1}}{P_{t-1}} = \tau_t w_t l_t \Psi_t + \frac{B_t}{P_t}\Psi_t \tag{13}$$

where $z_t = (1-\rho_z)z^{ss} + \rho_z z_{t-1} + \varepsilon_t$ is the promised real transfers per person to the generation that is at the second period of their lives, τ_t is the tax rate, and $0 < \rho_z < 1$, $\varepsilon_t \sim N(0, \sigma_z^2)$.

5.2 Fiscal policy

Fiscal policy finances real transfers z_t with income tax revenues, $\tau_t w_t l_t$, and the sale of nominal bonds, B_t. At some point, however, the tax policy reaches its maximum, $\tau^{\max}$ (the fiscal limit). Tax policy evolves according to the following equation:

$$\tau_t = \tau^{ss} + \gamma(\frac{b_t}{y_t} - \frac{b^{ss}}{y^{ss}}) \tag{14}$$

where $\gamma > 0$ is the fiscal policy parameter, τ^{ss} is the steady state tax rate, b^{ss}, y^{ss} is the debt issued per person at the steady state, i.e. $b^{ss} = \frac{(1+n^{ss})\tau^{ss}w^{ss}l^{ss} - z^{ss}}{r^{ss} - n^{ss}}$.

5.3 Monetary policy

Monetary policy follows a conventional Taylor Rule. Here, it is written as the inverse of the nominal interest rates and inflation rates Leeper (2009). The monetary authority sets short term nominal interest rates as follows:

$$\frac{1}{1+R_t} = \frac{1}{1+R^{ss}} + \alpha[\frac{1}{1+\pi_t} - \frac{1}{1+\pi^{ss}}] \tag{15}$$

where α is the monetary policy parameter, R^{ss} is the steady state nominal interest rate, π^{ss} is the steady state inflation rate.

5.4 Policy regimes

Table 1. Alternative policy regimes

	Monetary policy	**Fiscal policy**
Regime M	Active (Example: $\alpha > 1 + r$)	Passive (Example: $\gamma > r$)
Regime F	Passive (Example: $0 \leq \alpha \leq 1 + r$)	Active (Example: $0 \leq \gamma \leq r$)

The regimes are defined following Leeper (1991) terminology. A policy authority that is free to pursue its objectives without paying attention to the state of government debt is called "active", while an authority whose behavior is constrained and responds to government debt shocks is termed "passive". Conventionally, monetary policy is "active" and controls inflation, while fiscal policy is "passive" and stabilizes debt. Table (1) demonstrates the alternative regimes.

Regime M - Active Monetary Policy, Passive Fiscal Policy: This regime is a combination of an interest rate rule in which the central bank hawkishly adjusts the nominal interest rate in response to current infl ation and a tax rule in which the tax authority responds to government debt sufficiently to stabilize it by adjusting tax rates. The equation for inflation can be obtained by using equation (15) and the household's first order condition (5):

$$\frac{\beta}{\alpha}[E(\frac{1}{1+\pi_{t+1}})\frac{c_{1t}^{-1}}{Ec_{2t+1}^{-1}} - \frac{1}{1+\pi^{ss}}] = \frac{1}{1+\pi_t} - \frac{1}{1+\pi^{ss}} \tag{16}$$

If current inflation is pinned at the steady state level, expected equilibrium inflation is:

$$E(\frac{1}{1+\pi_{t+1}}) = \frac{1}{1+\pi^{ss}}\frac{c_{1t}^{-1}}{Ec_{2t+1}^{-1}} \tag{17}$$

Compared to Davig and Leeper (2011) even when current inflation is pegged at the steady state level, expected inflation may not be anchored by policy alone. Expected inflation depends on the inter-temporal marginal rate of substitution of consumption of private agents.

Regime F-Passive monetary policy, Active fiscal policy: Here, I consider policy: Here, I consider (following Leeper (1991)) the extreme case where $\tau_t = \tau^{\max}$. The monetary authority sets the nominal interest rate to R^{ss}.

6 Equilibrium

From equations (5) and (6):

$$E(1+r_{t+1}) = E(\frac{1+R_t}{1+\pi_{t+1}}) \tag{18}$$

Definition 1 *A competitive equilibrium consists of the sequences* $\{c_{1t}, c_{2t}, l_t, k_t, b_t, s_t, y_t, R_t, \tau_t, r_t, w_t, z_t\}$ *such that:*

1. $\{c_{1t}, c_{2t}, l_t, k_t, b_t, s_t, y_t, r_t, w_t\}$ *solves the household's problem given* $\{R_t, \tau_t, z_t\}$,
2. *The aggregate resource constraint is satisfied:* $Y = \Psi_t c_{1t} + \Psi_{t-1} c_{2t} + (K_{t+1} - (1-\delta)K_t)$
3. *The market for capital clears:* $(1+n_{t+1})k_{t+1} = s_t$

The present value budget constraint for individuals (obtained from equation (3) and (4)) is:

$$c_{1t} + \frac{c_{2t+1}}{(1+R_t)/(1+\pi_{t+1})} = (1-\tau_t)w_t l_t + \frac{z_{t+1}}{(1+R_t)/(1+\pi_{t+1})} \tag{19}$$

The savings function: Combining equations (3), (4), (5) and (6) gives the savings function as follows:

$$s_t = \frac{\beta(1-\tau_t)w_t l_t}{1+\beta} - \frac{z_{t+1}}{(1+\beta)(1+r_{t+1})} - b_t \tag{20}$$

Savings proportionally increases with the real wage rate and real interest rate, but decreases with expected transfers or government debt. In equation (20): $\partial s_t/\partial w_t > 0$, $\partial s_t/\partial(1+r_{t+1}) > 0$, $\partial s_t/\partial z_{t+1} < 0$ and $\partial s_t/\partial b_t < 0$. Plugging the value of savings from equation (20) in equation (9) gives the amount of capital formed at time *t*.

$$k_{t+1} = \frac{\beta}{(1+\beta)(1+n_{t+1})}(1-\tau_t)w_t l_t - \frac{z_{t+1}}{(1+\beta)(1+r_{t+1})(1+n_{t+1})} - \frac{b_t}{(1+n_{t+1})} \tag{21}$$

The labor supply equation can be derived from equation (6), (7) and (19):

$$l_t = (\frac{1}{1+\beta}+1)^{-1}[1 - \frac{z_{t+1}}{(1+\beta)(1-\tau_t)(1+r_{t+1})w_t}] \tag{22}$$

An increase in the real wage rate raises the opportunity cost of leisure, leading individuals to substitute leisure with labor. An increase in the tax rate, or real interest rate, or transfers has the exact opposite effect.

6.1 The steady state

In steady state equilibrium, where all variables are constant for all t, the nominal interest rate is set by the monetary authority at R^{ss}, and consequently, the inflation rate is $(1+\pi^{ss}) = \frac{1+R^{ss}}{\beta}$. The fiscal authority sets the tax rate at τ^{ss}. The steady state real wage rate and real return on capital per capita are:

$$w^{ss} = (1-\mu)\frac{y^{ss}}{l^{ss}} \tag{23}$$

$$r^{ss} = \mu \frac{y^{ss}}{k^{ss}} - (\delta + n^{ss}) \tag{24}$$

Substituting the value of l and k from equations (23) and (24) respectively, in the production function, the steady state solution for wage rate is obtained:

$$w^{ss} = (1 - \alpha)[\frac{\alpha}{\delta + n^{ss} + r^{ss}}]^{\frac{\alpha}{(1-\alpha)}} \tag{25}$$

Plugging $1 + r^{ss} = \frac{1}{\beta}$ in equation (22) in its steady state yields the following solution for l^{ss}:

$$l^{ss} = 1 - \frac{z^{ss}}{(1 - \tau^{ss})w^{ss}} \tag{26}$$

The solution for the steady state level of savings is given by:

$$s^{ss} = \frac{\beta}{(1+\beta)}[(1 - \tau^{ss})w^{ss}l^{ss} - z^{ss}] - b^{ss} \tag{27}$$

An increase in nominal debt issued by the government reduces the savings for capital. An increase in wage income or a decrease in the transfers per person increases the savings for capital. Plugging the value of savings in equation (9) gives the solution to steady state capital:

$$k^{ss} = \frac{\beta}{(1+\beta)(1+n^{ss})}[(1 - \tau^{ss})w^{ss}l^{ss} - z^{ss}] - \frac{b^{ss}}{(1+n^{ss})} \tag{28}$$

An increase in government debt crowds out private investment. (From equation (28), $\partial k^{ss}/\partial b^{ss} < 0$.) Given l^{ss} and k^{ss}, output is determined by:

$$y^{ss} = (l^{ss})^{(1-\mu)} (k^{ss})^{\mu} \tag{29}$$

From the individual agents' optimality conditions and feasibility:

$$c_1^{ss^{-1}} = \beta(1 + r^{ss})c_2^{ss^{-1}} \tag{30}$$

Since $1 + r^{ss} = \beta$, $c_2^{ss} = c_1^{ss}$, i.e. in the steady state, consumption of the working population ss ssssn is equal to that of the retired population. Plugging $c_2^{ss} = c_1^{ss}$, y^{ss} and k^{ss} in the aggregate ss ss resource constraint the solution for c_1^{ss} and c_2^{ss} can be obtained:

$$c_1^{ss} = \frac{(1 + n^{ss})y^{ss} - (\delta + n^{ss})k^{ss}}{2} = c_2^{ss} \tag{31}$$

7 Dynamics around the steady state

The purpose of this section is to explore the dynamics around the steady state. Our purpose is to analyze the effects of rising government debt under alternative policy regimes. In this model, government debt increases when there is an increase in population growth. Hence, while our main interest lies in analyzing the role of monetary and fiscal policy in the face of rising government debt, we can do so in this model by exploring the effects of an increase in population growth rate, which in turn leads to an increase in government debt when the current population retires. In order to explore the dynamic implications around the steady state, values are assigned to parameters in the equations. The steady state growth rate of population was chosen to match the current population growth rate of US. The values of the baseline parameters have been chosen following Richter. Table (2) summarizes the baseline parameters and Table (3) summarizes the policy parameters.

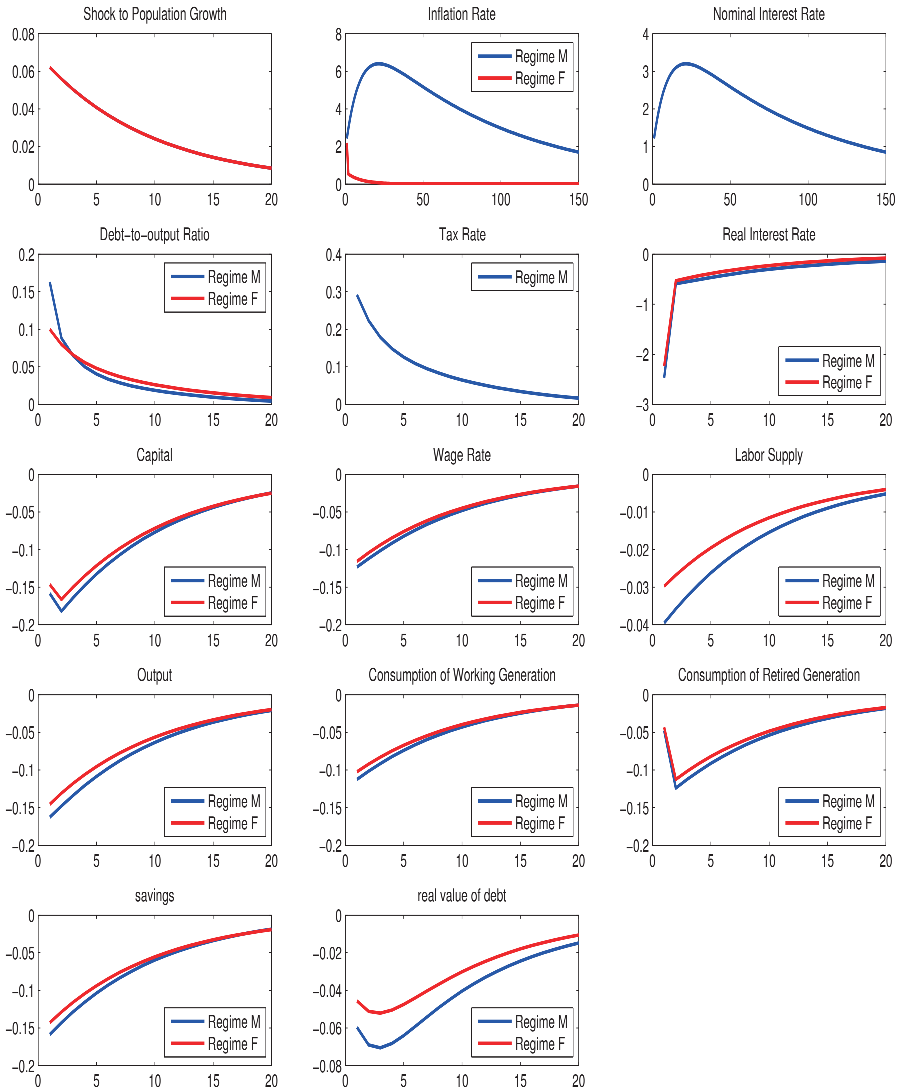
Table 2. Baseline parameters

μ	β	δ	τ^{ss}	τ^{max}	n^{ss}	R^{ss}	π^{ss}	ρ_n	$\frac{z^{ss}}{y^{ss}}$	$\frac{b^{ss}}{y^{ss}}$
0.33	0.989	0.10	0.019	0.024	0.72	0.04	0.02	0.9	0.09	0.385

Table 3. Policy parameters

	Monetary	**Fiscal**
Regime M	α = 1.5	γ = 0.15
Regime F	α = 0	γ = 0

The value of auto-regressive coefficient, ρ_n, is set to 0.9 (I use the value Richter (2015) uses for the autoregressive co-efficient for a stationary transfer shock) to match the growth in transfers. Figure (1) displays responses to a one standard deviation shock to population growth which results in increased transfer payments for the govern-



ment. The figure depicts the response of output, consumption, capital, labor, wages, interest rate, inflation, savings, and debt to the shock under Regime M and F. Under Regime M, the fiscal authority raises tax rates in response to the increased government debt resulting from the population growth, following the tax rule (in order to keep the level of debt unchanged).

Higher taxes induce workers to supply less hours of labor. Consequently output decreases during the period of the shock. Since the inflation rate increases by more than the nominal interest rate, it leads to a decline in the expected real interest rate, which discourages savings of the current working generation, resulting in lower capital formed for the next period. Although the government raises taxes to stabilize debt after the increase in transfers, the decrease in tax revenues leads to an increase in the current level of nominal government debt. However, the higher inflation rate lowers the real value of government debt. As output decreases by more than the value of real debt, real debt-to-output ratio increases. Consumption of the current generation decreases by more than that of the retired generation.

Alternatively, under Regime F, an increase in government debt owing to the population growth shock, is not followed by higher tax rates. Hence, the decrease in labor supply is less than in the case of Regime M. As seen in figure (1), inflation rate increases in the period of the shock, however, it is less than that under an active monetary regime. Further, inflation rate goes back to the steady state sooner than under the alternative regime, which leads to the conclusion that inflation rate is controlled better under an active fiscal regime in the face of rising government debt.

8 Conclusion

The inclusion of labor endogeneity in an overlapping generations model provides useful insights to the evolution of government debt and the role of monetary and fiscal policy. The main finding in this paper is that a passive monetary and active fiscal policy regime is better able to stabilize inflation and the government debt as well as the real-debt-to-output ratio in the economy in the face of rising government transfers. Under both regimes, the private agents suffer from lower levels of output and consumption in the face of rising government debt and inflation, however, the effects are more intense under an active monetary regime.

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