Essays on Monetary/Fiscal Policy Mix

by

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Dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Department of Economics
in the Graduate School of Duke University
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Abstract

This dissertation consists of two essays on monetary/fiscal policy mix. In the first essay, I study an impact of transfer payments on macroeconomic activity of the US economy during the Great Inflation and Great Moderation periods. In a standard structural VAR, there is a positive statistically significant response of output and inflation to a transfer payments shock in the pre-Volcker sample. However, the impact becomes insignificant in the post-Volcker sample. In a quantitative model, a switch from a non-Ricardian regime, where inflation moves to stabilize government debt, to a Ricardian where the Central Bank controls inflation, explains this difference in multipliers. This indicates that the US economy did experience a change in the monetary/fiscal policy mix in the early 80s. In the second essay, I analyze output and welfare multipliers of government spending under different monetary and fiscal policy interaction regimes between the Central Bank and Treasury. In a quantitative macroeconomic model government spending has larger output multiplier in a passive monetary/active fiscal policy regime. However, welfare multiplier of government spending is bigger in the active monetary/passive fiscal policy regime. Therefore, policymakers should distinguish between output and welfare effects of the fiscal program when choosing a policy regime to finance it.

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1

Transfer Payments Multiplier and Policy Regimes

1.1 Introduction

One of the most interesting research questions in macroeconomics concerns the effects of government spending on macroeconomic activity. In general, government spending include government purchases and transfer payments. Majority of both theoretical and empirical research has been devoted to understanding the impact of government purhases (government consumption and investment).[1] However, recent studies document that the share of transfers in the composition of government spending has been steadily increasing during the post-war period.[2] Given this pattern in the composition of government spending it becomes interesting to identify what factors are important for the transmission of transfer programs into the aggregate macroeconomic variables and whether studying the impact of transfer payments can help understand the properties of the US macroeconomy.

[1] Ramey(2016) provides a detailed discussion of the literature on fiscal multiplier.

[2] Oh and Reis (2012) discuss the historical dynamics of government spending in the US and propose targeting as a mechanism through which transfers can have a positive aggregate effect. Romer and Romer (2016) estimate the impact of Social Security Benefits on consumption in the US economy.

In this chapter I show that estimating the impact of transfer payments on output and inflation of the US economy can identify the prevailing monetary/fiscal policy mix chosen by the Central Bank and Treasury in order to stabilize government debt. First, I document that the impact of transfers on the US macroeconomy has changed over time. In particular, I estimate a structural VAR on two subsamples in the US time series: the first one from 1962Q3 to 1979Q3 known as the Great Inflation and the second one from 1982Q2 to 2007Q3 known as the Great Moderation.[3] A shock to transfers during the first subsample induces a postive statistically significant response of output and inflation, and no response in the nominal interest rate. However, in the second subsample, neither inflation nor output moved in response to a transfer shock and the nominal interest rate remained the same.

Following Leeper (1991), there exists two policy regimes that policymakers can choose in order to keep debt on a stable path. In the first, known as Ricardian, fiscal authority moves taxes to stabilize debt and monetary authority keeps inflation on target.[4] In the second, called non-Ricardian, fiscal authority doesn't commit to moving taxes in response to debt and Central Bank allows inflation to keep debt on a stable path. Given that in the non-Ricardian regime even in the absense of distortionary taxation, fiscal disturbances can have an impact on the macroeconomy and nominal interest rate remains passive, a change in the policy regime would explain observed dynamics of output and inflation during the pre and post Volcker periods.

This change of power between the Central Bank and the Treasury has been studied by Bianchi and Ilut (2015) who show using an estimated DSGE model that the US economy experienced a switch from non-Ricardian regime to Ricardian with a

[3] It is also common in the literature to refer to the former sample as a pre-Volcker period and the latter as a post-Volcker due to an appointment of Paul Volcker as Chairman of the Fed in August of 1979. I will interchangeably use both terminologies further in the text.

[4] See Seater (1993) for a detailed review of the literature on Ricardian equivalence.

break point occuring around the appointment of Paul Volcker as a Fed Chairman in the August of 1979. The facts documented in this paper and proposed explanation line up with Bianchi and Ilut (2015).

The next section relates paper to the literature. Section 1.2 provides an empirical analysis of the impact of transfer payments on the US macroeconomy during the Great Inflation and Great Moderation periods. Section 1.3 describes a model used to analyze the impact of transfer payments. Section 1.4 presents quantitative implications of the model. Section 1.5 concludes.

1.1.1 Related Literature

This chapter builds on the literature on monetary and fiscal policy interactions that goes back to Sargent and Wallace (1981). Further, Leeper (1991), Sims (1994), Woodford (1994, 2001) discuss price level determination. Cochrane (2001) studies the impact of debt maturity structure on the price level. Leeper and Zhou (2013) analyze optimal monetary/fiscal policy mix and maturity structure of the nominal government debt. Leeper and Leith (2016) discuss fiscal theory of the price level in the context of policy rules and optimal monetary and fiscal policies.

Several papers study empirical aspects of monetary and fiscal policy interactions. Davig and Leeper (2006) estimate regime switching monetary and fiscal policy rules over the post-war period in the United States and then use a calibrated DSGE model to discuss tax non-neutralities due to the fiscal theory of the price level mechanism. Bianchi and Ilut (2015) estimate a model for the US economy that allows for monetary/fiscal policy mix to change and find that a regime swtich occured in the early 80s. They further explore the role of agent's beliefs about policy regimes for the dynamics of inflation during the pre-Volcker period. Bhattarai et al (2016), Traum and Yang (2011) and Tan (2015) also study monetary and fiscal policy interactions in the context of an estimated macroeconomic model.

This chapter is also related to the literature on the empirical estimation of the fiscal multiplier. Blanchard and Perotti (2002) and estimate the impact of government spending and tax shocks on output. Perotti (2004) documents that the government spending multiplier in OECD countries has declined in the post-1980 period. Romer and Romer (2016) study an impact of Social Security benefit increases on consumption in the US and find an immediate large positive response. Ramey (2016) provides a detailed analysis of the literature on fiscal shock.

1.2 Empirical Evidence

In this section I document empirical evidence on the impact of transfer payments on the GDP of the US economy using structural VAR. I consider the time period from 1962Q3 to 2007Q3. Following the literature on monetary policy, I consider two subsamples: the first corresponds to the dates from 1962Q3 to 1979Q3, a period of high inflation and high volatility of the macroeconomic variables known as the Great Inflation. The second, known as the Great Moderation, started with the appointment of Paul Volcker as a Chairman of the Federal Reserve in August of 1979 and ended in the Fall of 2007. It features low inflation and low volatility of the macroeconomic aggregates. I consider the period range from 1982Q2 to 2007Q3 for the post-Volcker subsample. In the following sections I estimate the impact of transfer payments during the pre-Volcker and post-Volcker periods.

1.2.1 Data

I use quarterly data. Real GDP, GDP deflator and fiscal variables are from the NIPA tables released by the BEA (NIPA tables 1.1.4, 1.1.5 and 3.2). Tax revenue defined as Federal current tax receipts (Table 3.2, line 2) plus contributions for government social insurance (Table 3.2, line 11) plus Federal income receipts on assets (Table 3.2, line 12). Transfers are defined as Federal current transfer payments (NIPA table

3.2, line 22) + Federal capital transfer payments (NIPA table 3.2, line 43) + Federal subsidies (NIPA table 3.2, line 32).[5] The series for the Fed Funds rate is obtained by averaging monthly series downloaded from FRED.

1.2.2 Econometric Specification

In order to identify the transfer payment shock and estimate its impact on macroeconomic activity, I will be using a 6-variable structural VAR that includes the following varibles: the log of real government consumption expenditures, g_t; the log of real transfer payments, tr_t; the log of real tax revenues, t_t; the log of the price level deflator, p_t; the log of the real GDP, y_t and the Federal Funds rate, i_t. The structural VAR has the following form:

$$A_0 Y_t = \sum_{j=1}^{p} A_j Y_{t-j} + \epsilon_t,$$

where $Y_t = \begin{bmatrix} g_t & tr_t & t_t & p_t & y_t & i_t \end{bmatrix}$, ϵ_t is a vector of structural shocks and $p = 4$ is the number of lags used in the estimation. Further, restrictions must be imposed on the matrix A_0 to fully recover structural form. Following Blanchard and Perotti (2002), I order government consumption first given the implementation lags due to the political process that determines a given fiscal program. I order transfer payments second followed by tax revenues.[6] The rest of the variables are similar to Perotti (2004). Confidence bands are computed using bootstrap after bootstrap procedure from Kilian (1998).

1.2.3 Response of Output, Prices and the Nominal Interest Rate

I now turn to the analysis of the responses of output, the price level and the nominal interest rate to the transfer payments shock in both pre-Volcker and post-Volcker subsamples.

[5] Important policy question is to analyze the impact of different categories of transfer payments on the macroeconomic aggregates.

[6] I also experimented with ordering transfers last and the results were qualitatively similar.

Figure 1.1 shows an impulse response of output to a one standard deviation shock to transfers during the Great Inflation and the Great Moderation periods. There is a positive statistically significant response of output to the transfer payments shock during the Great Inflation period while the response during the Great Moderation is statistically insignificant.

Figure 1.2 plots a dynamic response of the price level to the same transfer payments shock in both subsamples. Similar to the results in Figure 1.2, there is a positive response of prices to a transfer payment shock during the Great Moderation sample, while the impact becomes statistically insignificant during the Great Inflation period.

Figure 1.3 shows the response of the nominal interest rate to a one standard deviation transfer payments shock. Both in the Great Inflation and Great Moderation subsamples nominal interest rate did not respond to a transfer payments shock.

1.2.4 Response of Fiscal Policy Variables

Can the difference in the responses of output and price level during the Great Inflation and Great Moderation be driven primarily by direct effect of transfer payments or was there a change in some other fiscal policy variables, i.e. government consumption expenditures, which can also affect the output and the price level? To answer this question, I will now focus on the dynamic response of government consumption expenditures and tax revenues to a transfer payment shock.

Figure 1.4 plots the dynamic response of government consumption expenditures to an exogenous movement in transfer payments. In both Great Inflation and Great Moderation subsamples, this category of government spending did not move after a transfer payments shock.[7]

[7] Within an economic model this allows to specify government consumption expenditures as an exogenous process independent of the transfer payments shock. However, government consumption expenditures could be specified to follow a certain policy rule that allows for the response to any

Figure 1.5 plots an impulse response of tax revenue to a transfer payments shock. During the Great Inflation, tax revenue initially drops after an increase in transfers, while during the Great Moderation it remains statistically insignificant from zero.

1.2.5 Discussion

The facts shown above imply that there was a change in the transmission mechanism of transfer payments into the macroeconomy. In particular, output and inflation did increase in response to transfer payments and nominal interest rate didn't move during the Great Inflation period. However, during the Great Moderation output and inflation didn't respond to transfer shocks and nominal interest rate also reimained the same.

It's important to note that since government consumption expenditures didn't respond to transfers during the Great Inflation, the mechanism underlying the propagation of the transfer payments shocks shouldn't work through the changes in other components of government spending and their effect on output. In addition, theory that explains the above mentioned impact of transfer payments on output and inflation should be consisistent with a decrease in tax revenue in response to a transfer payment shock during the Great Inflation and no change in tax revenue during the Great Moderation period.

Empirical evidence in Mishkin (1990) points to an increase in asset market participation of the US households during the post-Volcker period. This was further confirmed in Bilbiie et al (2008) who show that in an estimated DSGE model fraction of non-savers is around 50 percent and is statistically significant during the pre-Volcker period. However, the share drops to around 25 percent and becomes insignificant during the post-Volcker sample.[8] Can this drop in the share of rule-of-thumb house-

standard business cycle shock.

[8] This point estimate is consistent with micro level evidence in Kaplan et al (2014) who use data from the 1989 - 2010 waves of the United State SCF.

holds account, at least qualitatively, for differences in the impact of transfers during the Great Inflation and Great Moderation? Given that output, inflation and nominal interest rate didn't move in response to transfer payments during the post-Volcker period, this drop could account for the dynamics of these variables during the Great Moderation. However, note that during the Great Inflation nominal rate didn't move either. Given this, the theory that relies on a change in the fraction of rule-of-thumb consumers should simultaneously be able to account for a passive response of the nominal interest, i.e. standard Taylor principle reasoning shouldn't apply. Thus, the above mentioned break in the fraction of rule-of-thumb households can't separately account for a change in the dynamic response of the macroeconomy to a transfer payments shock in the Great Inflation and Great Moderation subsamples.

Perotti (2004) and Bilbiie et al (2008) show that the impact of government consumption expenditure shocks on macroeconomic activity in the post-war US economic history has declined over time. Similar statement can be made regarding the impact of transfer payments which had an impact on macroeconomic activity during the pre-Volcker period and did not have any effect in the post-Volcker period.

Another important point is that during the pre-Volcker period tax revenues declined in response to an increase in the transfer payments. In the post-Volcker sample tax revenues did not respond to the transfer payments shock. Depending on the response of government debt to a transfer payments shock, monetary/fiscal policy mix switch explanantion of the observed differences in the impact of transfer payments on inflation and output discussed in the next section can be consistent with a response of tax reveues in both pre-Volcker and post-Volcker periods.[9]

[9] I leave empirical investigation of this relationship for future research.

1.3 The Model

In this section I present a calibrated model used to analyze the impact of transfer payments on the macroeconomy across monetary/fiscal policy interaction regimes between the Central Bank and Treasury. The main ingredients of the model are based on Woodford (2003) and Gali (2008), and include monopolistic competition and sticky prices. It also follows Leeper (1991) and Bianchi and Ilut (2015) to incorporate monetary and fiscal policy interactions between the Central Bank and the Treasury. The economy consists of a representative household, final good producer, monopolistically competitive intermediate good producers, monetary authority and fiscal authority.

1.3.1 Household

There is a representative household that maximizes the following lifetime utitliy function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big\{ \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \Big\}$$

subject to the budget constraint:

$$P_t C_t + B_t + P_t T_t = P_t W_t N_t + (1 + i_{t-1}) B_{t-1} + P_t \Pi_t + P_t Z_t$$

where C_t stands for consumption, W_t is a real wage received by the household, P_t is a general price level in the economy, Π_t are profits paid by the firm to the household, B_t are one-period governnment bonds which are purchased at price $(1 + i_t)^{-1}$ in period t and mature in period $t + 1$.[10] Government transfer payment to the household are

[10] Woodford (2001), Leeper and Zhou (2013), and Bianchi and Ilut (2015) discuss implications of different degrees of debt maturity structure for monetary/fiscal policy interactions which might also have interesting implications for the impact of transfer payments. However, for the purpose of monetary/fiscal policy mix identification studied in this chapter, it is sufficient to conduct all of the analysis in the environment with one-period government debt.

denoted Z_t and T_t is a lump-sum tax paid by the household to the fiscal authority.

1.3.2 Firms

The economy consists of two types of firms: firms that produce final good and firms that produce intermediate goods. Final good Y_t is produced by a competitive firm that combines intermediate inputs Y_{it} using the technology defined by

$$Y_t = \Big[\int_0^1 Y_{i,t}^{\frac{\epsilon-1}{\epsilon}} di \Big]^{\frac{\epsilon}{\epsilon-1}}$$

where $\epsilon > 1$ denotes degree of substitution between inputs. Demand for intermediate good i is further determined as

$$Y_{i,t} = \Big[\frac{P_{i,t}}{P_t} \Big]^{-\epsilon} Y_t$$

with $P_{i,t}$ being the price of the good i and P_t is the aggregate price index given by

$$P_t = \Big[\int_0^1 P_{i,t}^{\frac{\epsilon-1}{\epsilon}} di \Big]^{\frac{\epsilon}{\epsilon-1}}$$

Intermediate good i is produced by a monopilist using a linear production technology

$$Y_{i,t} = N_{i,t}$$

where $Y_{i,t}$ is the amount of goods produced by firm i, , $N_{i,t}$ denotes amount of labor hired by firm i and denominated in hours.[11]

Intermediate goods firm i takes wage W_t and aggregate price level P_t as given and chooses prices $P_{i,t}$ and labor $N_{i,t}$ to maximize expected present discounted value of profits to the household specified as

[11] The environment can be extended to include physical capital in the production function of intermediate goods and the impact of transfer payment shocks on output and inflation in a given monetary/fiscal policy regime, discussed later in the text, will remain qualitatively the same. I keep the environment simple by using a model without physical capital.

$$\mathbb{E}_0 \sum_{t=0}^{\infty} Q_t \{ P_{i,t} Y_{i,t} - P_t W_t N_{i,t} - P_t AC_{i,t}^{\pi} \}$$

where Q_t is a stochastic discount factor used by a household to discount future profits, $AC_{i,t}^{\pi}$ represent adjustment costs to change a price. I will follow Rotemberg (1982) and specify price adjustment costs as

$$AC_{i,t}^{\pi} = \frac{\phi_{\pi}}{2} \big(\frac{P_{i,t}}{P_{i,t-1}} - \Pi^{\star} \big)^2 Y_t$$

where $\phi_{\pi} > 0$ and $\pi^{\star}$ is an inflation target of the monetary authority.

1.3.3 Government

The government consists of a monetary authority and fiscal authority. Each period t the government issues one-period nomial bonds B_t and collects lump-sum taxes T_t to finance interest rate payments on debt $(1 + i_{t-1})B_{t-1}$ and transfer payments to the household Z_t.[12] The flow government budget constraint is given as

$$B_t = (1 + i_{t-1})B_{t-1} + P_t Z_t - P_t T_t.$$

I follow Woodford (2003) and Bhattarai et al (2014) to rewrite the flow government budget constraint as

$$(1 + i_t)^{-1} b_t = \frac{b_t}{\Pi_t} + Z_t - T_t$$

where $b_t \equiv \frac{(1+i_t)B_t}{P_t}$ is a real maturity value of government debt.

Transfer payments follow exogenous process given by

[12] The environment can be extended to include government consumption and investment as an exogenous programs financed using nominal debt. The impact of transfer payment shocks on inflation and output under different monetary and fiscal policy interaction regimes will remain qualitatively the same.

$$\left(\frac{Z_t}{\bar{Z}}\right) = \left(\frac{Z_{t-1}}{\bar{Z}}\right)^{\rho} e^{\sigma\epsilon_t}, \epsilon_t \sim N(0,1)$$

where $\bar{Z}$ is a steady state level of transfer payments and σ_Z is a standard deviation of the shock to transfer payments calibrated during quantitaive analysis.

1.3.4 Monetary and Fiscal Policy Rules

The Central Bank sets nominal interest rate according to the following rule:[13]

$$1 + i_t = \frac{1}{\beta}\left(\frac{\Pi_t}{\Pi^{\star}}\right)^{\psi}.$$

Treasury uses the following tax rule:

$$\frac{T_t}{\bar{T}} = \left(\frac{b_{t-1}}{\bar{b}}\right)^{\delta}$$

where $\bar{T}$ and $\bar{b}$ represent steady state levels of tax revenues and real maturity value of government debt correspondingly.

1.3.5 Monetary and Fiscal Policy Interactions

Leeper (1991) distinguishes four policy regions in the model with fixed parameter values according to the existence and uniqueness of the solution. There are two determinacy regions. The first one that is known as Active Monetary/Passive Fiscal regime (AM/PF) is a usual textbook case: Taylor principle is satisfied ($\phi_\pi > 1$) and fiscal authority moves taxes to stabilize government debt ($\delta > \beta^{-1} - 1$).[14] In this regime, monetary authority targets inflation and Treasury provides fiscal backing for the Central Bank by passively adjusing taxes. Following the terminology in Woodford (1995) one can refer to this regime as Ricardian. In this monetary/fiscal policy mix

[13] The nominal interest rate rule can also be modified to include persistence component and/or response to output gap. This will not be relevant for monetary/fiscal policy regime identification.

[14] See Gali (2008).

any movements in the real value of government debt have no effect on macroeconomic aggregates since lump-sum taxes will be adjusting to keep government debt on a stable path.

The other determinacy region is Passive Monetary/Active Fiscal regime (PM/AF): monetary authority disregards the Taylor principle ($\phi_\pi < 1$) and fiscal authority is not committed to stabilizing government debt ($\delta < \beta^{-1} - 1$). In this regime Central Bank allows inflation to adjust in order to stablize the process for government debt and fiscal disturbances can have an effect on the macroeconomy since households internalize that there will be no offseting movements in lump-sum taxes by the Treasury. Woodford (1995) refers to this policy regime configuration as non-Ricardian.[15]

When both monetary and fiscal authorities are active (AM/AF) there is no equilibrium and when both are passive (PM/PF) there exist multiple equilibria.

1.4 Quantitative Analysis

In this section I calibrate the model and discuss how impulse responses of output and inflation to a transfer payments shock within the model and in the data can be used to identify the prevailing monetary/fiscal policy mix during the pre-Volcker and post-Volcker samples.

1.4.1 Model parameterization

The model is calibrated at the quarterly frequency. I set $\beta = 0.99$ which implies a steady state annual interest rate of 4 percent. Elasticity of substitution ϵ is set to 11. The price adjustment cost parameter $\phi_\pi = 116$. Steady state inflation Π^* is set to 1. I set $\psi^M = 1.5$ and $\delta^M = 0.3$ during AM/PF regime, so that Taylor principle applies and lump-sum tax responds to government debt. I use the following range of

[15] Bianchi and Melosi (2014) discuss how in the context of a model with parameter instability this distinction between Ricardian and non-Ricardian policy regimes breaks down and depends on agents' beliefs about the future.

parameter values for interest rate rule and tax rule coefficients in the PM/AF regime: $\psi^F = \{0, 0.5, 0.8\}$ and $\delta^F = 0$. Standard deivation of the shock to transfer payments σ is set to increase transfer payments by one percent above steady state level on impact. The range of values for the persistence of transfer payments $\rho_Z = \{0, 0.3, 0.6, 0.9\}$, i.e. no persistence, low persistence, medium persistence and high persistence. Table 1.1 summarizes the range of parameter values used in the quantitative model.

1.4.2 Impulse Responses

Figure 1.6 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a positive one standard deviation shock to transfer payments. There are no movements in ouput and inflation when the macroeconomy is in regime M. This dynamics is in line with an impulse response observed in the post-Volcker period. When households receive transfer payments financed by government debt, they internalize that taxes will move in the future since the prevailing regime is Ricardian. Tax policy is lump-sum, thus an increase in transfers has no effect on output and inflation.[16]

Figure 1.7 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a one standard deviation transfer payments shock with no persistence. Dynamic response of output and inflation under regime F is consistent with an impulse response observed in the data during the pre-Volcker period where both inflation and output going up. During this monetary/fiscal policy mix between the Central Bank and Treasury, an increase in transfer payments financed by government debt creates a non-Ricardian wealth effect on households since they internalize that future taxes are not going to move to stabilize debt. It is the Central Bank that is now responsible for keeping debt on a stable path using passive monetary policy rule. With sticky prices, this decreases the real interest rate and generates a positive

[16] Leeper (1991) and Woodford (1995) discuss this in more detail.

response of output to a transfer payments shock. Also, even though the transfer payment program has no persistence, the impact still lasts after initial shock due to non-Ricardian wealth effect from government debt used to finance the transfer payments program. Under calibration of the model presented above this generates positive impact of transfer payments on output and inflation at all horizons.

Figure 1.8 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a one standard deviation transfer payments shock when the program has low persistence $\rho = 0.3$ in regime F. The mechanism underlying the propagation of the transfer payment shock is the same as discussed in the paragraph above. However, the impact is quantitatively different: output and inflation increase more than in the case of no persistence, and the drop in the real value of debt and the real interest rate is now larger.

Figure 1.9 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a one standard deviation transfer payments shock when the program has medium persistence $\rho = 0.6$ in regime F. The mechanism underlying the propagation of the transfer payment shock is the same as discussed above but has interesting quantitative and qualitative differences relative to the previous cases. Both inflation and output increase more than in the case of no persistence or low persistence, and the drop in the real interest rate is larger. However, due to a larger increase in inflation, real maturity value of debt now drops rather than going up as in the no persistence or low persistence cases.

Figure 1.10 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a one standard deviation transfer payments shock when the program has high persistence $\rho = 0.9$ in regime F. Both inflation and output increase more than in any other cases discussed above, and the drop in the real interest rate is also larger. As in the medium persistence case, due to an increase in inflation, real maturity value of debt now drops rather than going up as in the no

persistence or low persistence cases. Quantitatively, this drop is larger than in the case of medium persistence.

Figure 1.11 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a one standard deviation transfer payments shock when the program has medium persistence and monetary policy rule coefficient $\psi = 0.5$ in Regime F. Relative to the interest rate peg ($\psi = 0$) inflation increase more and output increases less, and the drop in the real interest rate is larger.[17] Differently from the interest rate peg, due to monetary policy responding to inflation, the real value of debt changes sign and increases in response to the transfer payment shock.

Figure 1.12 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a one standard deviation transfer payments shock when the program has medium persistence and monetary policy rule coefficient $\psi = 0.8$ in Regime F. Since monetary policy now responds to inflation, real value of government debt and inflation go up more than in the previous case ($\psi = 0.5$).

1.4.3 Discussion

As was shown above, it's a necessary within the model to have a regime switch from Ricardian to non-Ricardian. This is in line with Bianchi and Ilut (2015) who find that the prevailing regime during the pre-Volcker period was a regime of fiscal dominace and post-Volcker period is characterized by a switch to the monetary dominance. The evidence presented in this paper and essentiality of a regime switch to explain the change in the propagation of transfer payment shocks during the Great Inflationa and Great Moderation provide additional support towards the change of the monetary/fiscal policy mix in the history of the United States during the post-war period.

[17] This is consistent with the result in Bhattarai et al (2014) who find that in regime F inflation responds more to demand shocks when monetary authority is more active.

Another interesting result from quantitative exercises in the model is that there are difference is the responses of the real maturity value of debt to the transfer payments program across monetary/fiscal policy regimes. In the regime M real maturity value of debt goes up, while under certain persistence levels of the program it goes down in the regime F. Thus, financing transfer payments using regime F can increase output of the economy and not have a negative effect on the fiscal position.

1.5 Conclusion

In this paper I investigate how dynamic response of the macroeconomy to a transfer payments shock can identify the prevailing monetary/fiscal policy mix. Using standard structural VAR I document that output and inflation did positively respond to transfer payments during the pre-Volcker period. However, during the post-Volcker period the impact was statistically insignificant from zero. Building on Leeper (1991) and Woodford (1995), and using quantitative model I show that this identifies prevailing monetary/fiscal policy mix as a Ricardian during the post-Volcker period and as a non-Ricardian in the pre-Volcker sample.

Table 1.1: Parameter values used in the quantitative model with transfer payments.

Parameter	Description	Value
β	Discount factor	0.99
ϵ	Elasticity of substution	11
ϕ_π	Price adjustment cost	116
Π^*	Steady state inflation	1
ψ^M	Monetary policy rule response to inflation in regime M	1.5
ψ^F	Monetary policy rule response to inflation in regime F	$\{0, 0.5, 0.8\}$
δ^M	Fiscal policy rule response to debt in regime M	0.3
δ^F	Fiscal policy rule response to debt in regime F	0
ρ	Persistence of the transfer payments shock	$\{0, 0.3, 0.6, 0.9\}$
100σ	Standard deviation of the shock to transfer payments	1

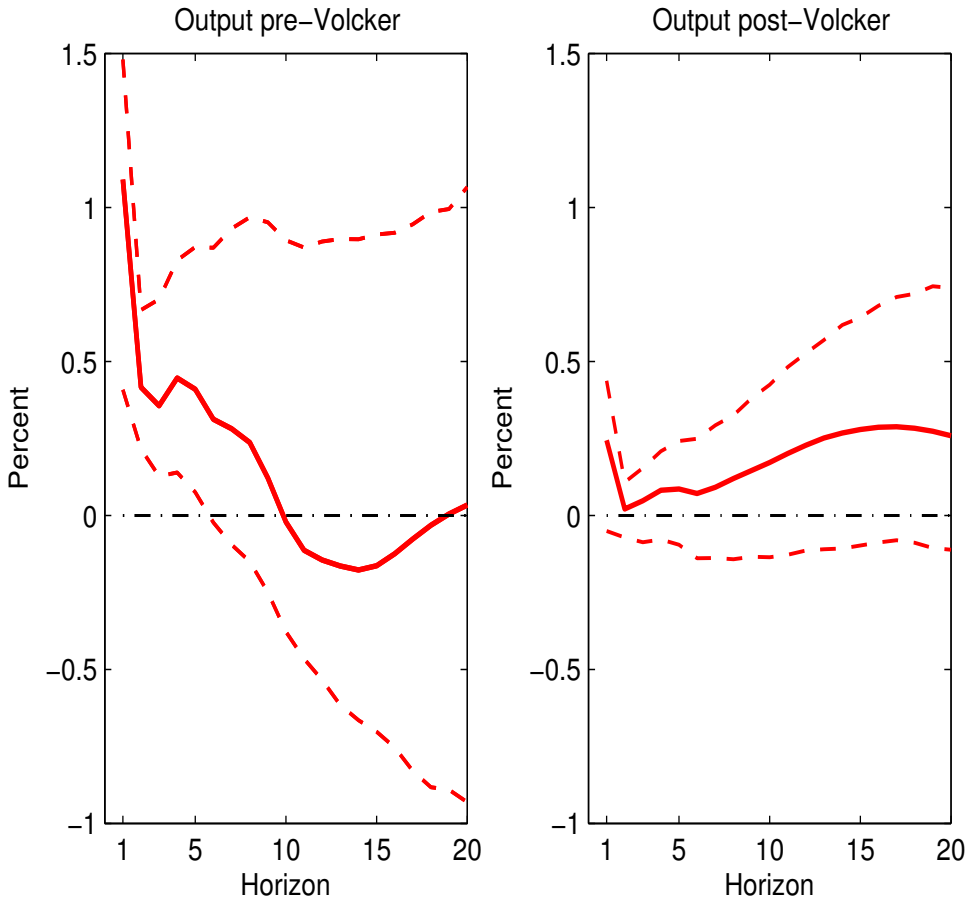

FIGURE 1.1: Response of output to a transfer payments shock in the pre-Volcker and post-Volcker periods.

The fugure shows the response to a one standard deviation shock to transfer payments. Solid lines are point estimates; dashed lines are 80 percent confidence bands.

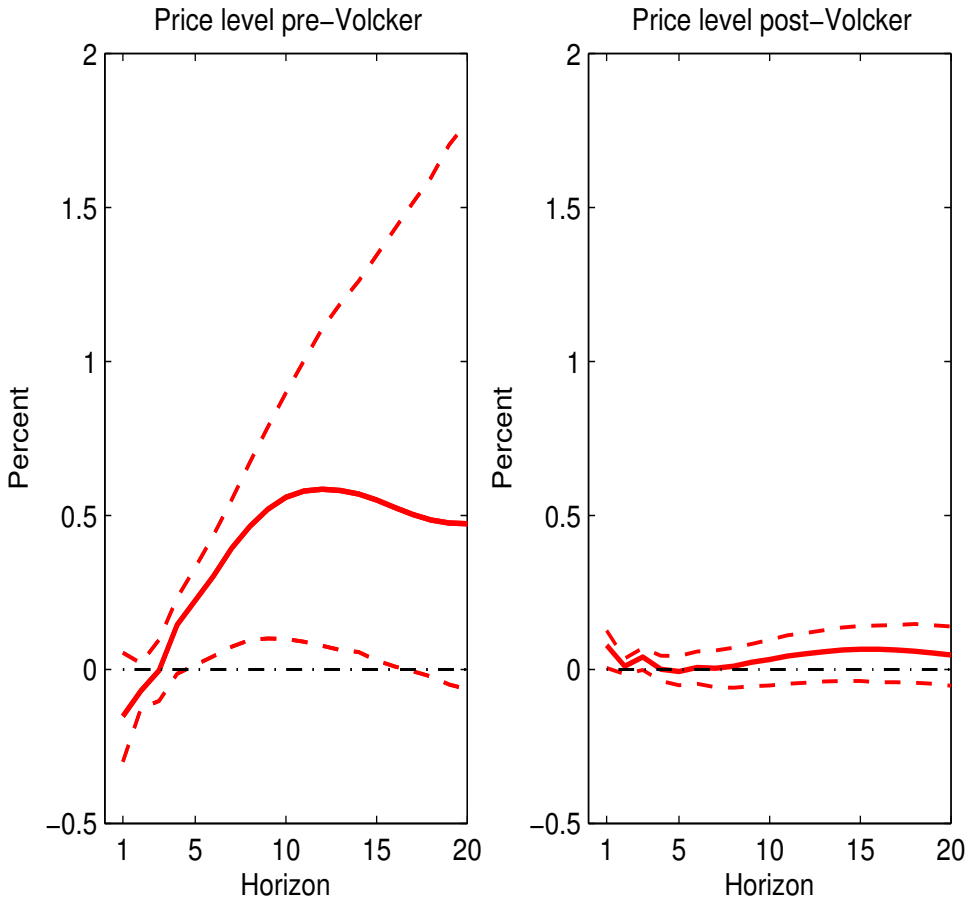

FIGURE 1.2: Response of the pricel level to a transfer payments shock in the pre-Volcker and post-Volcker periods.

The fugure shows the response to a one standard deviation shock to transfer payments. Solid lines are point estimates; dashed lines are 80 percent confidence bands.

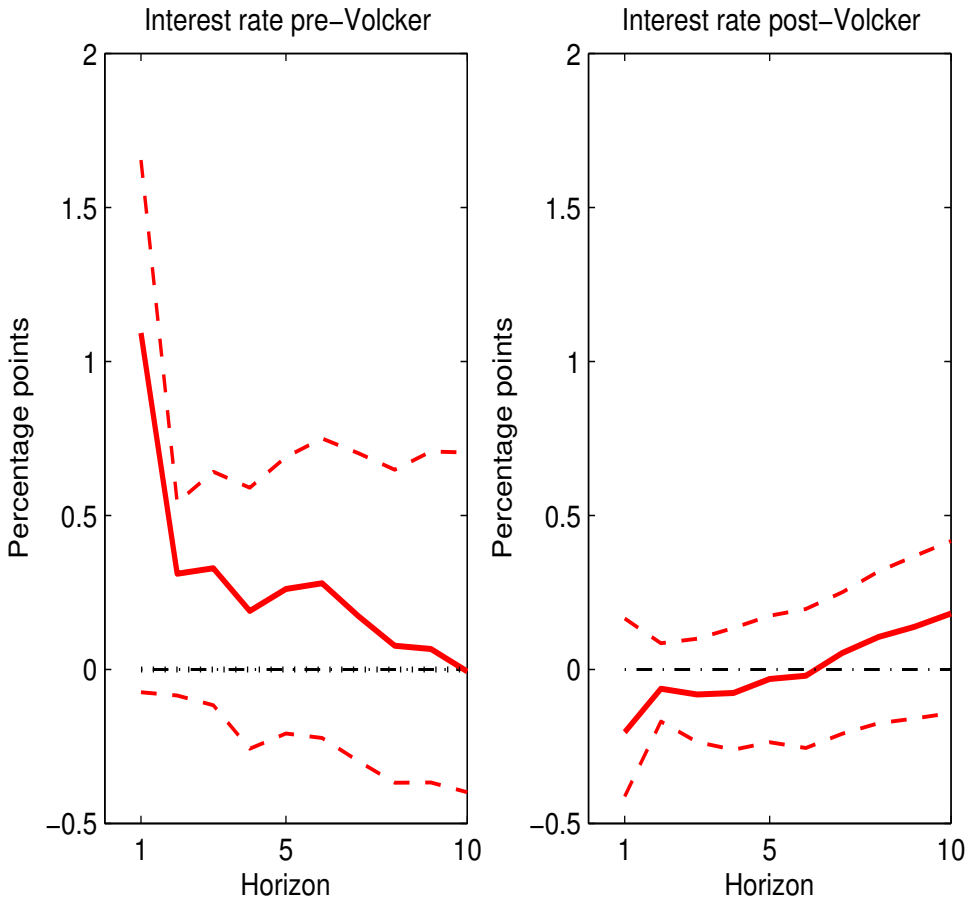

FIGURE 1.3: Response of the nominal interest rate to a transfer payments shock in the pre-Volcker and post-Volcker periods.

The fugure shows the response to a one standard deviation shock to transfer payments. Solid lines are point estimates; dashed lines are 80 percent confidence bands.

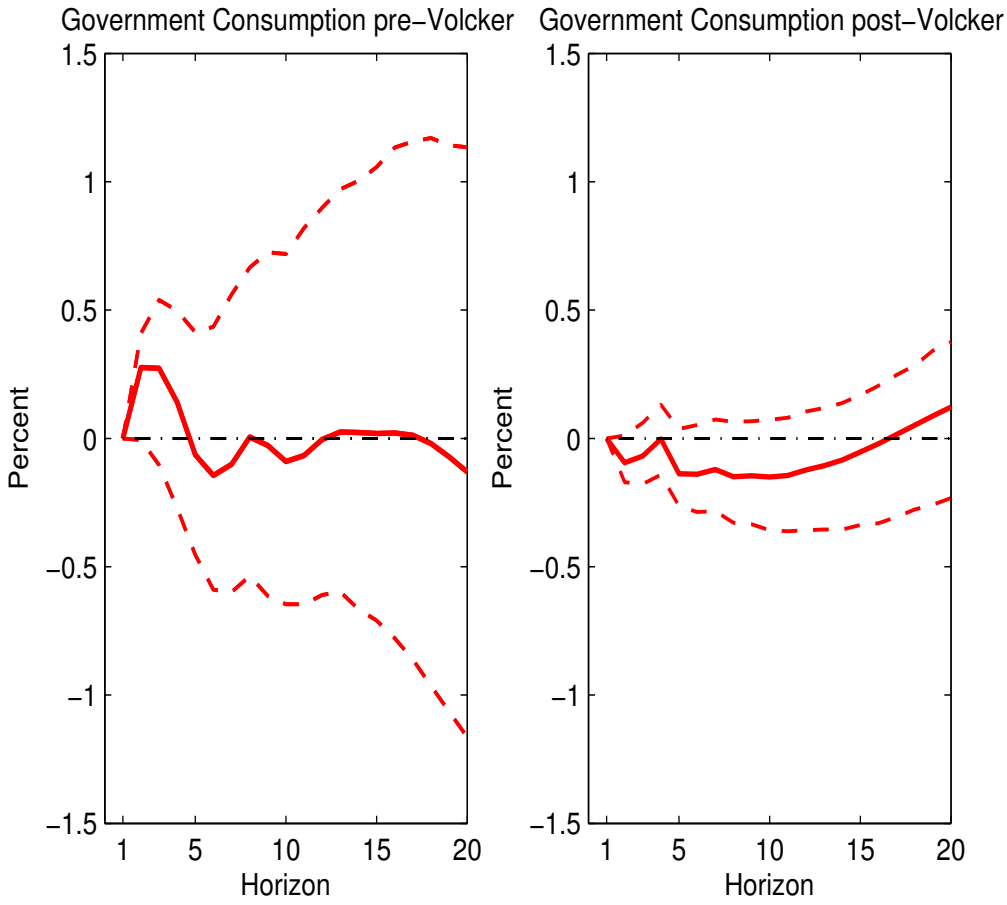

FIGURE 1.4: Response of government consumption to a transfer payments shock in the pre-Volcker and post-Volcker periods.

The fugure shows the response to a one standard deviation shock to transfer payments. Solid lines are point estimates; dashed lines are 80 percent confidence bands.

FIGURE 1.5: Response of tax revenue to a transfer payments shock in the pre-Volcker and post-Volcker periods.

The fugure shows the response to a one standard deviation shock to transfer payments. Solid lines are point estimates; dashed lines are 80 percent confidence bands.

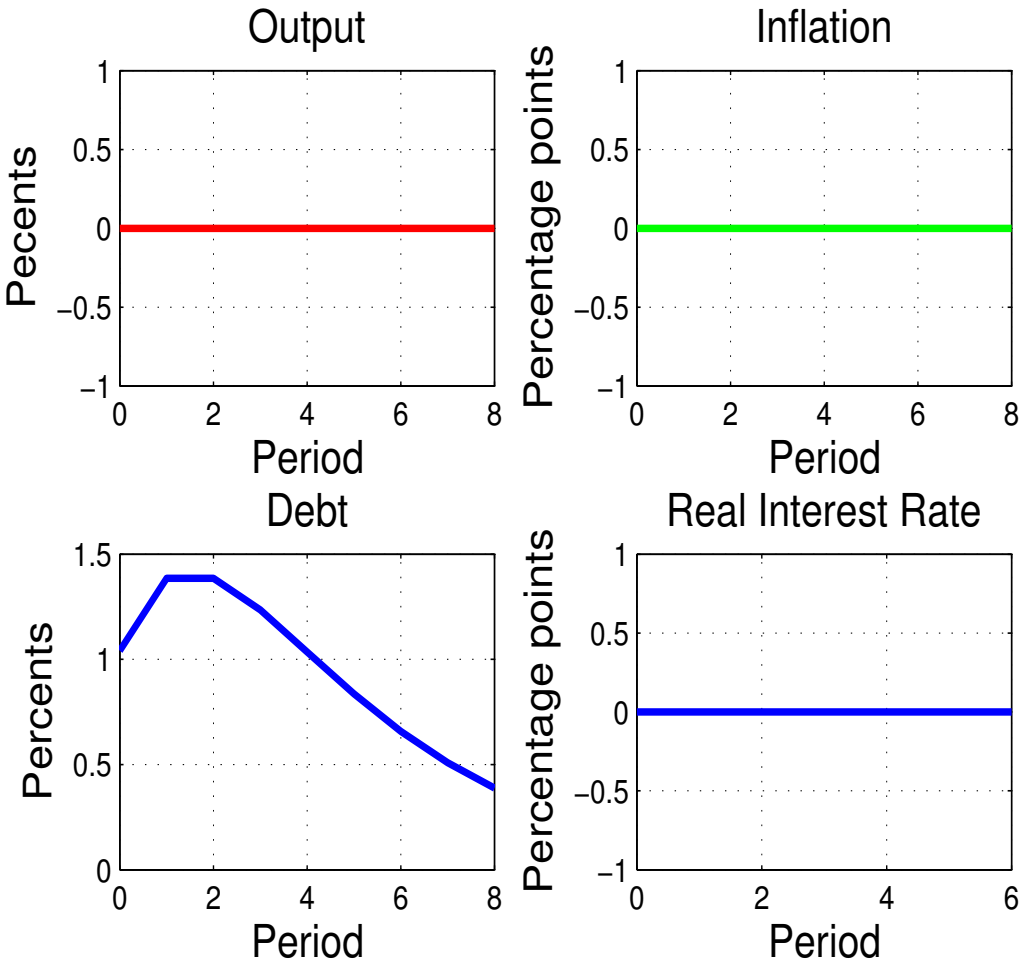

FIGURE 1.6: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime M.

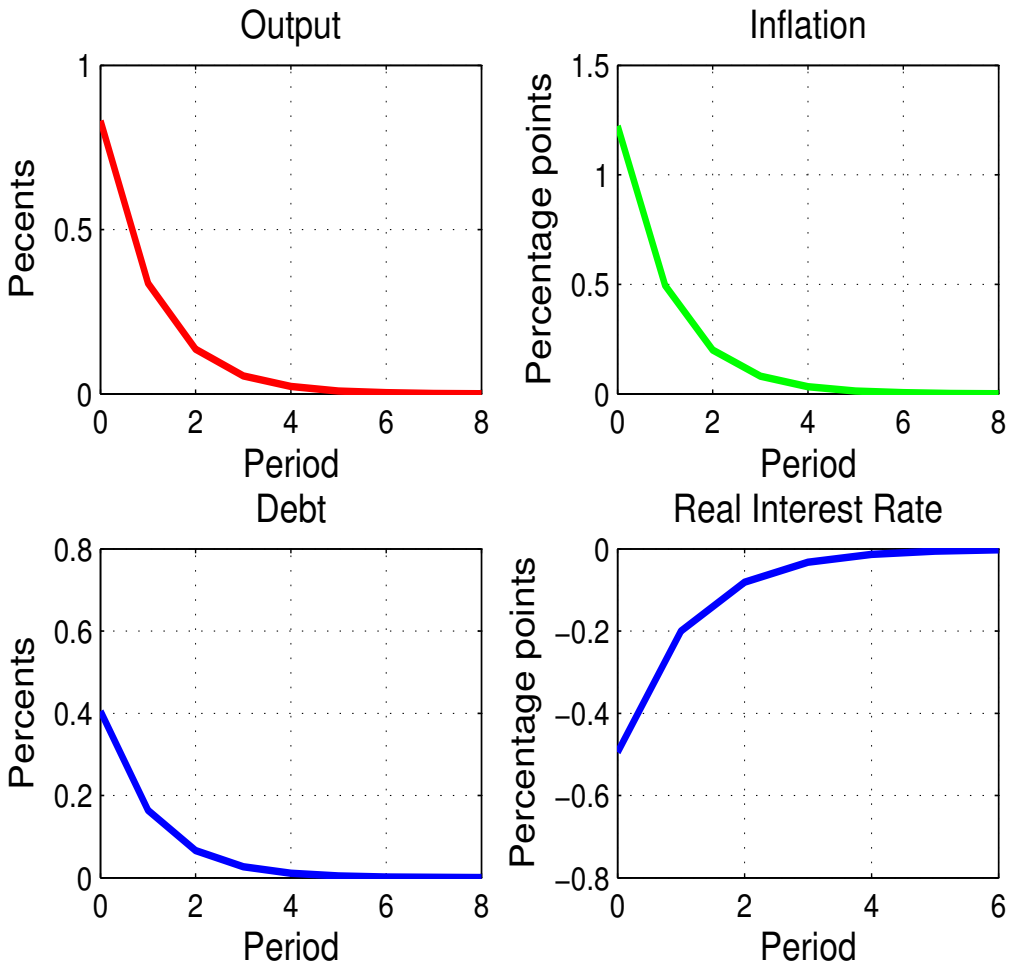

FIGURE 1.7: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime F; No persistence: $\rho = 0$.

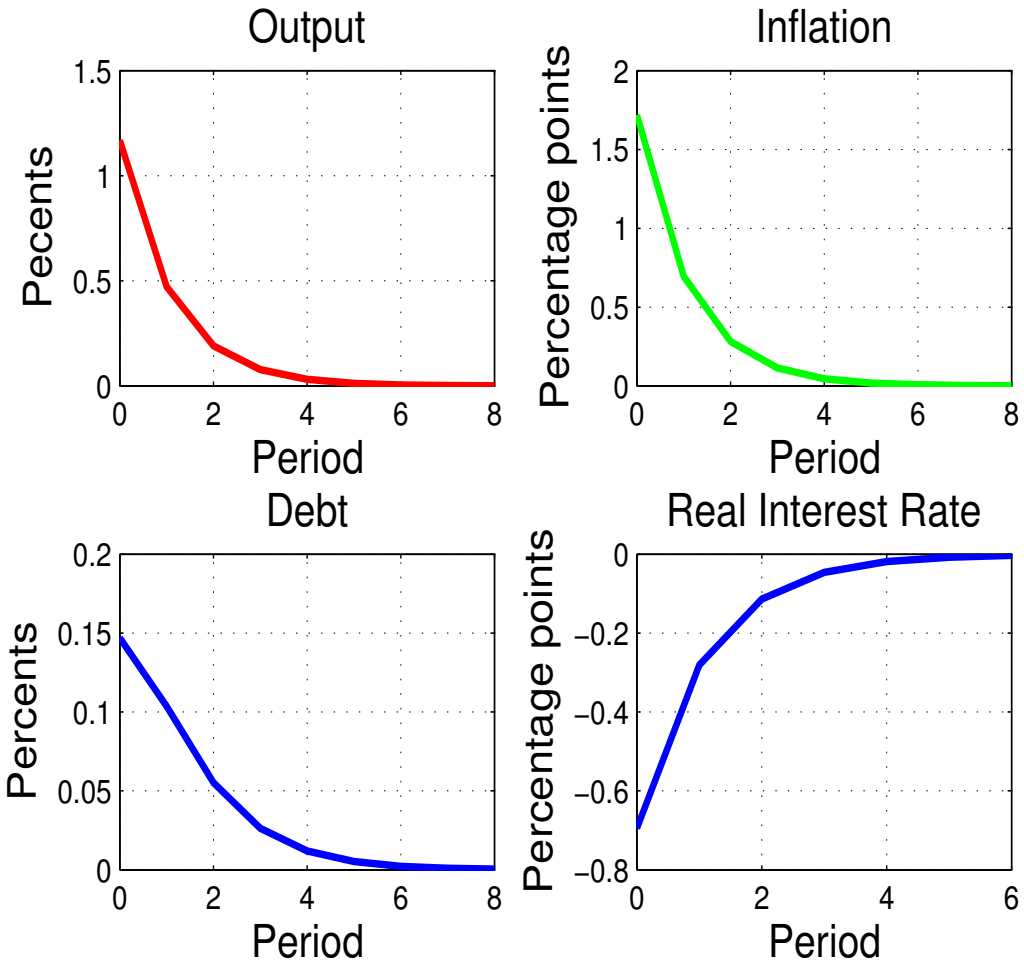

FIGURE 1.8: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime F; Low persistence: $\rho = 0.3$.

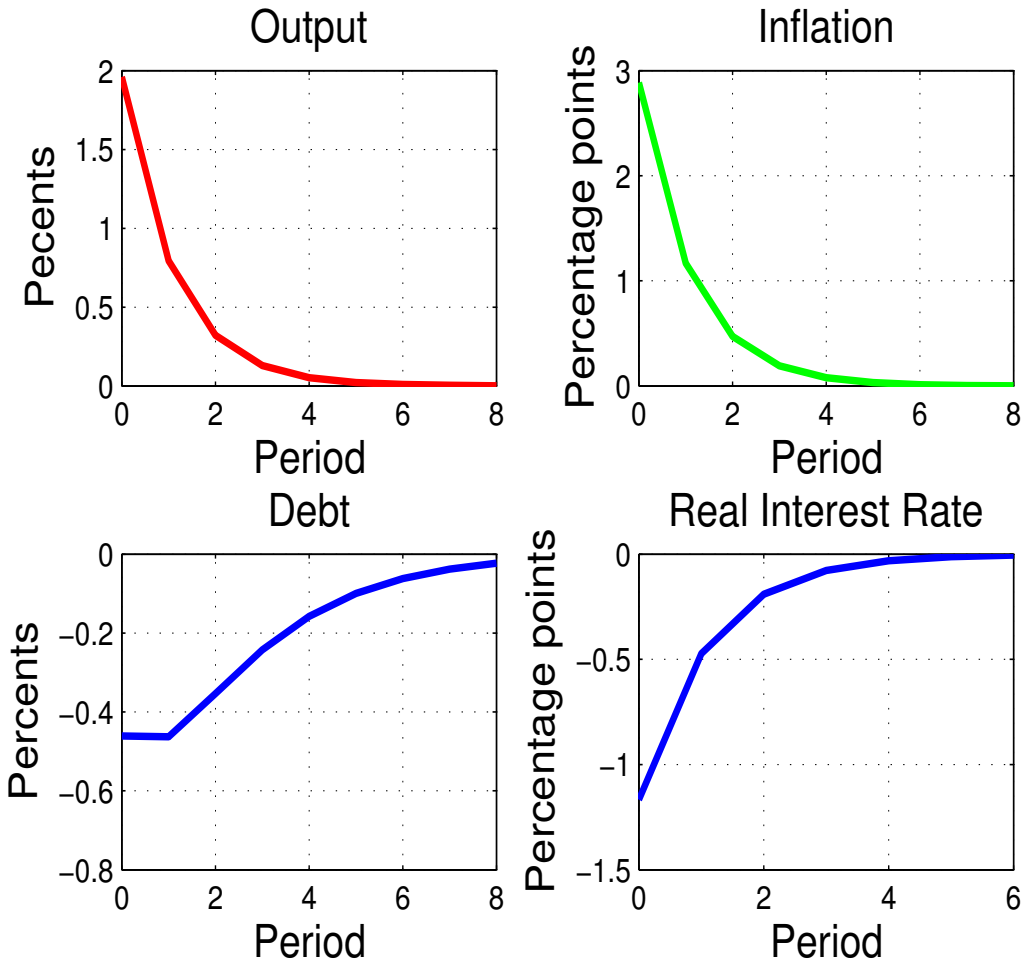

FIGURE 1.9: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime F; Medium persistence: $\rho = 0.6$.

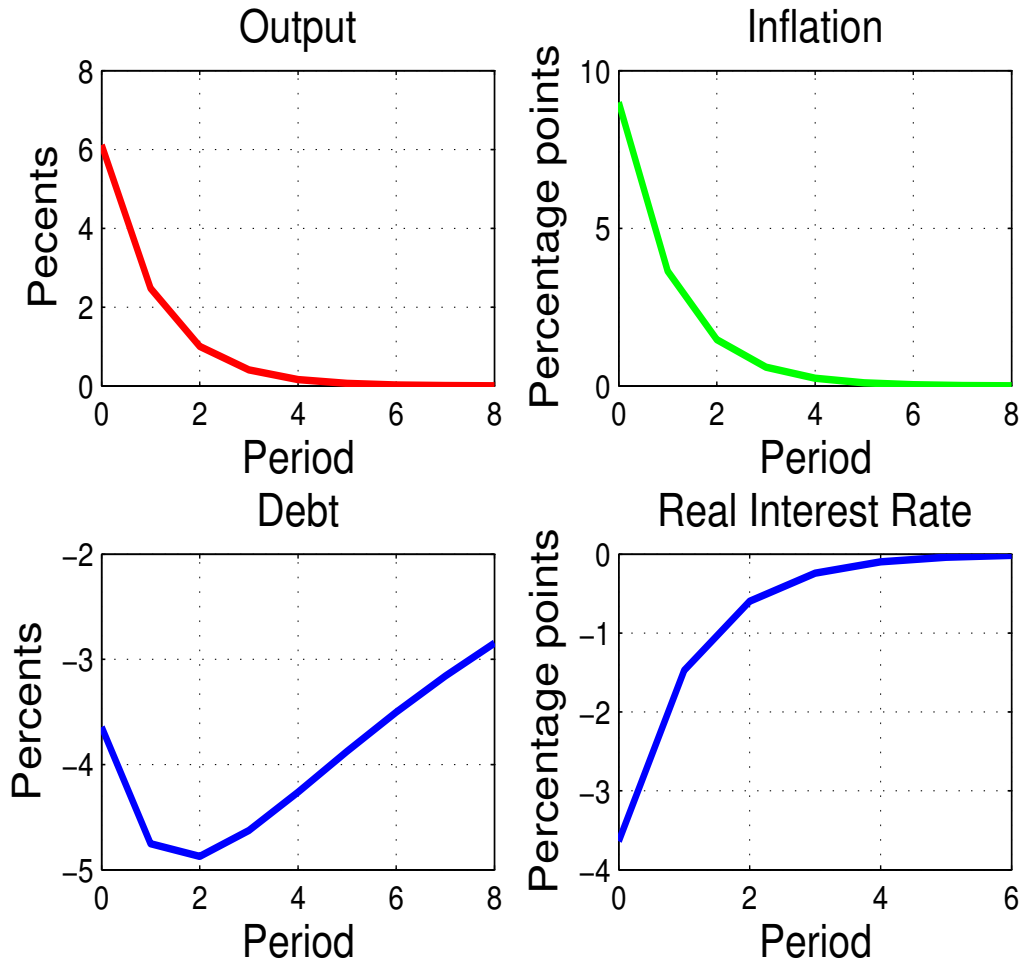

FIGURE 1.10: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime F; High persistence: $\rho = 0.9$.

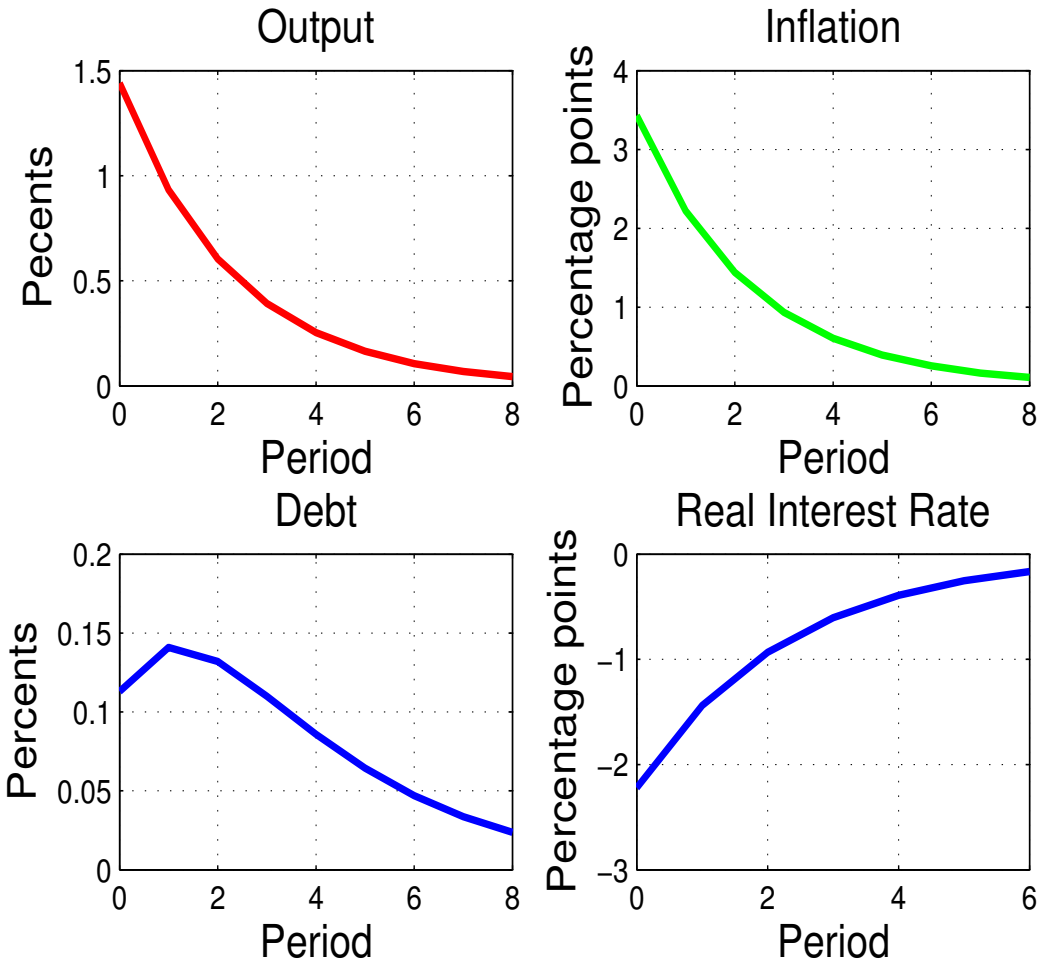

FIGURE 1.11: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime F; Medium persistence: $\rho = 0.6$; Monetary policy response $\psi = 0.5$.

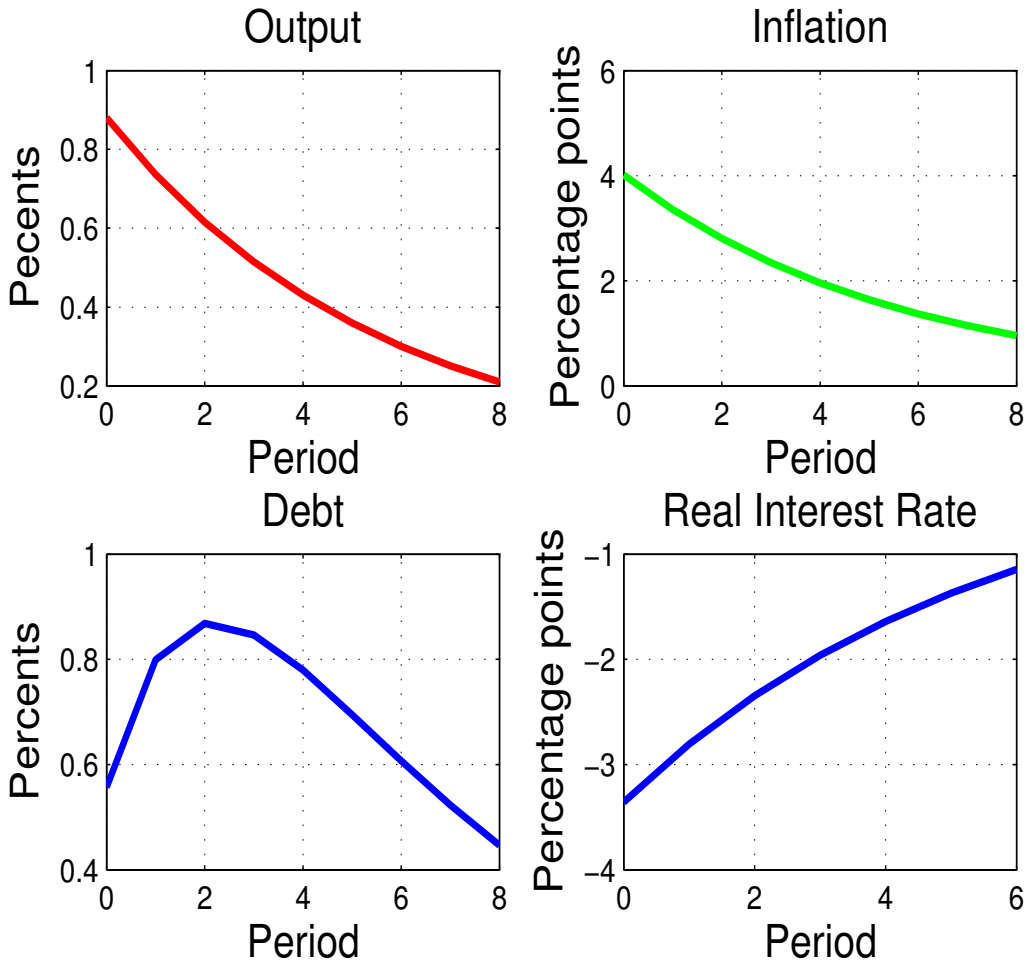

FIGURE 1.12: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to transfer payments in the regime F; Medium persistence: $\rho = 0.6$; Monetary policy response $\psi = 0.8$.

2

Government Spending and Monetary/Fiscal Policy Mix: Implications for Output and Welfare

2.1 Introduction

Following the Great Recession a lot of attention in the literature has shifted towards analyzing macroeconomic effects of fiscal policy. In particular, the literature has been mainly studying output effects of fiscal programs and the analysis was mainly conducted under the assumption that the government adjusts lump-sum tax to finance the stimulus.[1] But fiscal policy should also be concerned with welfare effects of stimus programs, and the Central Bank and Treasury can interact to stabilize government debt.

In this chapter I compare output and welfare multipliers of government spending across two monetary and fiscal policy interaction regimes: active monetary/passive fiscal (regime M) and passive monetary/active fiscal (regime F).[2] In a quantitative

[1] See Eggertson (2010), Christiano et al (2011), Woodford (2012), Mertens and Ravn (2014), Ramey and Zubairy (2017), Bilbiie et al (2017) among others.

[2] Following Leeper (1991), Sims (1994) and Woodford (1995) active authority is free to follow it's own goal and passive authority is constrained by the actions of the active authority and is responsible for keeping government debt on a stable path.

New Keynesian model calibrated to standard parameter values, output multplier of government spending is larger in regime F, however welfare effects of government spending are significantly larger in regime M.[3] Thus, policymakers should take into account that larger output multiplier of government spending should not necessarily translate into larger level of welfare multiplier.

As Beck-Friis and Willems (2017) discuss, in a standard New Keynesian model, government spending in the regime F operate through the direct effect via resource constraint of the economy, intertemporal effect through lower real interest rate and non-Ricardian wealth effect from household's holdings of government debt since lump-sum tax does not respond to movements in debt. Similar mechasnism underlies the impact of government spending on inflation. Under standard calibrations of the model it turns out that output and inflation multipliers of government spending are larger in regime F. However, larger increase in output in regime F generates larger deviations from the natural level of output. Together with additional welfare losses from higher inflation this leads to lower welfare effects of government spending in regime F. I then vary persistence of government spending program and quantify welfare losses from government spending in regime F relative to regime M.

The next section relates paper to the literature. Section 2.2 describes the model used to analyze the output and welfare multipliers of government spending. Section 2.3 presents quantitative implications of the model. Section 2.4 concludes.

2.1.1 Related Literature

This paper is related to the literature on government spending multiplier in the context of quantitative macroeconomic models. Baxter and King (1993) study government spending multiplier in the neoclassical framework. Gali et al (2007) analyze

[3] Kim (2003), Leeper et al (2015) show in the context of the New Keynesian sticky price model that output multiplier of government spending is larger in regime F than in regime M.

the impact of government spending on output in the New Keynesian environment that features rule-of-thumb consumers. Eggertson (2010), Christiano et al (2011), Woodford (2012) and Rendahl (2016) study the government spending multiplier at the zero lower bound environment. Zubairy (2014), Leeper et al (2017) estimate the impact of government spending on the macroeconomy in the DSGE model.

Another branch of the literature examines the welfare effects of government spending. Sims and Wolf (2017) use an estimated DSGE model to quantify the output and welfare effects of governemnt consumption and government investment. Using New Keynesian model Bilbiie et al (2017) show that at the zero lower bound environment output multiplier of government spending can be large but welfare detrimental. In this chapter I emphasize a similar distinction between output and welfare effects of government spending but in the context of monetary/fiscal policy interactions between the Central Bank and Treasury.

There is a growing number of papers that study output multiplier of different categories of government spending in quantitative macroeconomic models. Boehm (2016) analyzes the impact of government purchases of durable goods on output. Leeper et al (2010) uses neoclassical growth model to study the effects of government investment. Bouakez et al (2014) study the output multiplier of public investment at the zero lower bound and it's dependence on time-to-build constraint.

This chapter builds on the literature on monetary and fiscal policy interactions that goes back to Sargent and Wallace (1981). Further, Leeper (1991), Sims (1994), Woodford (1994) develop fiscal theory of the price level. Cochrane (2001) studies the impact of debt maturity structure on the price level. Davig and Leeper (2011) estimate regime switching monetary and fiscal policy rules for the US economy and analyze government spending multiplier under different monetary/fiscal policy interaction regimes. Bianchi and Ilut (2015) identify the change in the monetary/fiscal policy mix in the US after the appointment of Paul Volcker as the Fed Chairman.

2.2 The Model

In this section I present a calibrated model used to analyze the impact of government spending on the macroeconomy across monetary/fiscal policy interaction regimes between the Central Bank and Treasury. The main ingredients of the the model are based on Woodford (2003) and Gali (2008), and include monopolistic competition and sticky prices. It also follows Leeper (1991) and Bianchi and Ilut (2015) to incorporate monetary and fiscal policy interactions between the Central Bank and the Treasury. The economy consists of a representative household, final good producer, monopolistically competitive intermediate good producers, monetary authority and fiscal authority.

2.2.1 Household

There is a representative household that maximizes the following lifetime utitliy function:[4]

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big\{ \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \Big\}$$

subject to the budget constraint:

$$P_t C_t + B_t = P_t W_t N_t + (1 + i_{t-1}) B_{t-1} + P_t \Pi_t - P_t T_t$$

where C_t stands for consumption, W_t is a real wage received by the household, P_t is a general price level in the economy, Π_t are profits paid by the firm to the household, B_t are one-period governnment bonds which are purchased at price $(1 + i_t)^{-1}$ in period t and mature in period $t+1$.[5] Household pays a lump-sum tax T_t to the fiscal authority.

[4] The environment can be modified to include government spending in the utility function. As long as G enters the utility function in the additively separable way, this will not affect welfare comparisons across monetary/fiscal policy regimes.

[5] Woodford (2001), Leeper and Zhou (2013), and Bianchi and Ilut (2015) discuss the implications of

2.2.2 Firms

The economy consists of two types of firms: firms that produce final good and firms that produce intermediate goods. Final good Y_t is produced by a competitive firm that combines intermediate inputs Y_{it} using the technology defined by

$$Y_t = \Big[\int_0^1 Y_{i,t}^{\frac{\epsilon-1}{\epsilon}} di \Big]^{\frac{\epsilon}{\epsilon-1}}$$

where $\epsilon > 1$ denotes degree of substitution between inputs. Demand for intermediate good i is further determined as

$$Y_{i,t} = \Big[\frac{P_{i,t}}{P_t} \Big]^{-\epsilon} Y_t$$

with $P_{i,t}$ being the price of the good i and P_t is the aggregate price index given by

$$P_t = \Big[\int_0^1 P_{i,t}^{\frac{\epsilon-1}{\epsilon}} di \Big]^{\frac{\epsilon}{\epsilon-1}}$$

Intermediate good i is produced by a monopilist using a linear production technology

$$Y_{i,t} = N_{i,t}$$

where $Y_{i,t}$ is the amount of goods produced by firm i, , $N_{i,t}$ denotes amount of labor hired by firm i and denominated in hours.[6]

Intermediate goods firm i takes wage W_t and aggregate price level P_t as given and chooses prices $P_{i,t}$ and labor $N_{i,t}$ to maximize expected present discounted value of profits to the household specified as

different degrees of debt maturity structure for monetary/fiscal policy interactions. For the purpose of this chapter I conduct all of the analysis in the environment with one-period government debt.

[6] I work with a model that does not include physical capital. An interesting extension will be to compare output/welfare effects of government investment across different monetary/fiscal policy interaction regimes. I leave this for future research.

$$\mathbb{E}_0 \sum_{t=0}^{\infty} Q_t \{ P_{i,t} Y_{i,t} - P_t W_t N_{i,t} - P_t AC_{i,t}^{\pi} \}$$

where Q_t is a stochastic discount factor used by a household to discount future profits, $AC_{i,t}^{\pi}$ represent adjustment costs to change a price. I will follow Rotemberg (1982) and specify price adjustment costs as

$$AC_{i,t}^{\pi} = \frac{\phi_\pi}{2} \big(\frac{P_{i,t}}{P_{i,t-1}} - \Pi^\star \big)^2 Y_t$$

where $\phi_\pi > 0$ and $\pi^\star$ is an inflation target of the monetary authority.

2.2.3 Government

The government consists of a monetary authority and fiscal authority. Each period t the government issues one-period nomial bonds B_t and collects lump-sum taxes T_t to finance interest rate payments on debt $(1 + i_{t-1})B_{t-1}$ and government consumption G_t. The flow government budget constraint is given as

$$B_t = (1 + i_{t-1})B_{t-1} + P_t G_t - P_t T_t.$$

I follow Woodford (2003) and Bhattarai et al (2014) to rewrite the flow government budget constraint as

$$(1 + i_t)^{-1} b_t = \frac{b_t}{\Pi_t} + G_t - T_t$$

where $b_t \equiv \frac{(1+i_t)B_t}{P_t}$ is a real maturity value of government debt.

Government purchases follow exogenous process given by

$$\Big(\frac{G_t}{\bar{G}} \Big) = \Big(\frac{G_{t-1}}{\bar{G}} \Big)^{\rho} e^{\sigma \epsilon_t}, \epsilon_t \sim N(0,1)$$

where $\bar{G}$ is a steady state level of government purchases and σ is a size of the shock to government purchases calibrated during quantitaive analysis.

2.2.4 Monetary and Fiscal Policy Rules

The Central Bank sets nominal interest rate according to the following rule:[7]

$$1 + i_t = \frac{1}{\beta}\Big(\frac{\Pi_t}{\Pi^\star}\Big)^{\psi}.$$

Treasury uses the following tax rule:

$$\frac{T_t}{\bar{T}} = \Big(\frac{b_{t-1}}{\bar{b}}\Big)^{\delta}$$

where $\bar{T}$ and $\bar{b}$ represent steady state levels of tax revenues and real maturity value of government debt correspondingly.

2.2.5 Monetary and Fiscal Policy Interactions

Leeper (1991) distinguishes four policy regions in the model with fixed parameter values according to the existence and uniqueness of of the solution. There are two determinacy regions. The first one that is known as Active Monetary/Passive Fiscal regime (AM/PF) is a usual textbook case: Taylor principle is satisfied ($\phi_\pi > 1$) and fiscal authority moves taxes to stabilize government debt ($\delta > \beta^{-1} - 1$).[8] In this regime, monetary authority targets inflation and Treasury provides fiscal backing for the Central Bank by passively adjusing taxes. Following the terminology in Woodford (1995) one can refer to this regime as Ricardian. In this monetary/fiscal policy mix any movements in the real value of government debt have no effect on macroeconomic

[7] The nominal interest rate rule can also be modified to include persistence component and/or response to output gap and government debt. This might have interesting implications for quantifying the effects of government spending on output and welfare. I leave this extensions for future research.

[8] See Gali (2008).

aggregates since lump-sum taxes will be adjusting to keep government debt on a stable path.

The other determinacy region is Passive Monetary/Active Fiscal regime (PM/AF): monetary authority disregards the Taylor principle ($\phi_\pi < 1$) and fiscal authority is not committed to stabilizing government debt ($\delta < \beta^{-1} - 1$). In this regime Central Bank allows inflation to adjust in order to stablize the process for government debt and fiscal disturbances can have an effect on the macroeconomy since households internalize that there will be no offseting movements in lump-sum taxes by the Treasury. Woodford (1995) refers to this policy regime configuration as non-Ricardian.

When both monetary and fiscal authorities are active (AM/AF) there is no equilibrium and when both are passive (PM/PF) there exist multiple equilibria.

2.3 Quantitative Analysis

In this section I calibrate the model and discuss how impulse responses of output and inflation to a government spending shock depend on monetary/fiscal policy interactions between the Central Bank and Treasury. I then compare the differences in the welfare effects of government spending across two policy regimes.

2.3.1 Model parameterization

The model is calibrated at the quarterly frequency. I set $\beta = 0.99$ which implies a steady state annual interest rate of 4 percent. Elasticity of substitution ϵ is set to 11. The price adjustment cost parameter $\phi_\pi = 116$. Steady state inflation Π^* is set to 1. I set $\psi^M = 1.5$ and $\delta^M = 0.3$ during AM/PF regime, so that Taylor pinciple applies and taxes respond to stabilize government debt. The following parameters are used for interest rate rule and tax rule coefficients in PM/AF regime: $\psi^F = 0$ and $\delta^F = 0$. Standard deivation of the shock to government spending σ is set to increase government spending by one percent of steady state output on impact. The

range of values for the persistence of government spending $\rho_G = \{0, 0.3, 0.6, 0.9\}$, i.e. no persistence, low persistence, medium persistence and high persistence. Table 2.2 summarizes parameter values used in the quantitative model.

2.3.2 Impulse Responses

In this subsection I will describe quantitative impulse response of endogenous variables of the model to government spending shock in both policy regimes depending on the persistence of the program. I will then discuss welfare implications of government spending.

Figure 2.1 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a positive one standard deviation shock to government spending across two policy regimes discussed above. Increase in both inflation and output is larger in regime F. Since government spending program has no persistence, it has no direct impact on output and inflation after initial period and the differences in the impact of government spending shock at all horizons are driven by general equilibrium effects through the real interest rate and movements in the real value in government debt. In regime M active monetary policy responds to increase in increase in inflation from government spending by raising the real interest which reduces partial equilibrium impact of the shock. In regime F passive monetary policy rule allows real interest rate to fall which amplifies the direct effect of government spending on output. In addition, since government debt is not backed by future taxes there is an additional positive effect on output and inflation coming from an increase in debt holdings by the household which propagate initial shock over time even with zero persistence in the government spending process. Larger increase in output and inflation from government spending in regime F also lead to a lower increase in the real value of debt relative to the increase in regime M.[9]

[9] See Beck-Friis and Willems (2017) for a detailed discussion of the role of government debt in

Figure 2.2 plots impulse responses of output, inflation, real maturity value of debt and real interest rate to a positive one standard deviation shock to government spending across policy regimes when the program has low persistence $\rho = 0.3$. Non-Ricardian wealth effect from government bonds and a decrease in the real interest rate due to passive monetary policy in regime F generate larger output multiplier of government spending relative to regime M. In both regimes government spending lead to an increase in the real value of government debt. However, similar to the case with no persistence, larger increase in output and inflation in regime F leads to a lower rise in the real value of government debt.

Figures 2.3 and 2.4 plot impulse responses of output, inflation, real maturity value of debt and real interest rate to a positive one standard deviation shock to government spending across policy regimes when the program has medium ($\rho = 0.6$) and high ($\rho = 0.9$) persistence. Similar to the previous cases, non-Ricardian wealth effect from government bonds and passive monetary policy in regime F generate larger output multiplier of government spending relative to regime M. However, differently from no persistence and low persistence cases, increase in output and inflation is large enough to actually reduce the real value of debt.[10]

Figure 2.5 shows welfare gains of financing one standard deviation increase in government spending using regime M relative to regime F. For any level of persistence of the fiscal program, welfare multiplier is larger during regime M. Government spending are more welfare detrimental in regime F since they generate larger welfare costs of inflation and larger output gap. These welfare losses are larger the more persistent is the fiscal program. Quantitatively, moving to regime M from regime

propagating government spending shock.

[10] Due to non-Ricardian wealth effect from holding government bonds, decrease in the real value of debt leads to a reduction in inflation and output. However, direct effect of government spending, amplified by the decrease in the interest rate, is strong enough and generates a large increase in output and inflation. This allows to sustain in equilibrium negative comovement between output/inflation and real value of debt.

F leads to almost double increase in welfare multiplier from government spending program.

2.4 Conclusion

In this essay, I used a quantitative model to analyze output and welfare multipliers of government spending under different monetary and fiscal policy interaction regimes between the Central Bank and Treasury. Government spending has larger output multiplier in a passive monetary/active fiscal policy regime where Treasury promises not to move taxes to stabilize government debt and Central Bank allows inflation to move to keep debt on a stable path. However, welfare multiplier of government spending is bigger in the active monetary/fiscal policy regime where Central Bank controls inflation and Treasury moves taxes to keep debt on a stable path. Therefore, policymakers should be aware that larger output multiplier does not necessarily translate into larger welfare multiplier.

Table 2.1: Parameter values used in the model with government spending.

Parameter	Description	Value
β	Discount factor	0.99
ϵ	Elasticity of substution	11
ϕ_π	Price adjustment cost	116
Π^*	Steady state inflation	1
ψ^M	Monetary policy rule response to inflation in regime M	1.5
ψ^F	Monetary policy rule response to inflation in regime F	0
δ^M	Fiscal policy rule response to debt in regime M	0.3
δ^F	Fiscal policy rule response to debt in regime F	0
ρ	Persistence of the government purchases shock	$\{0, 0.3, 0.6, 0.9\}$
100σ	Standard deviation of the shock to government purchases	1

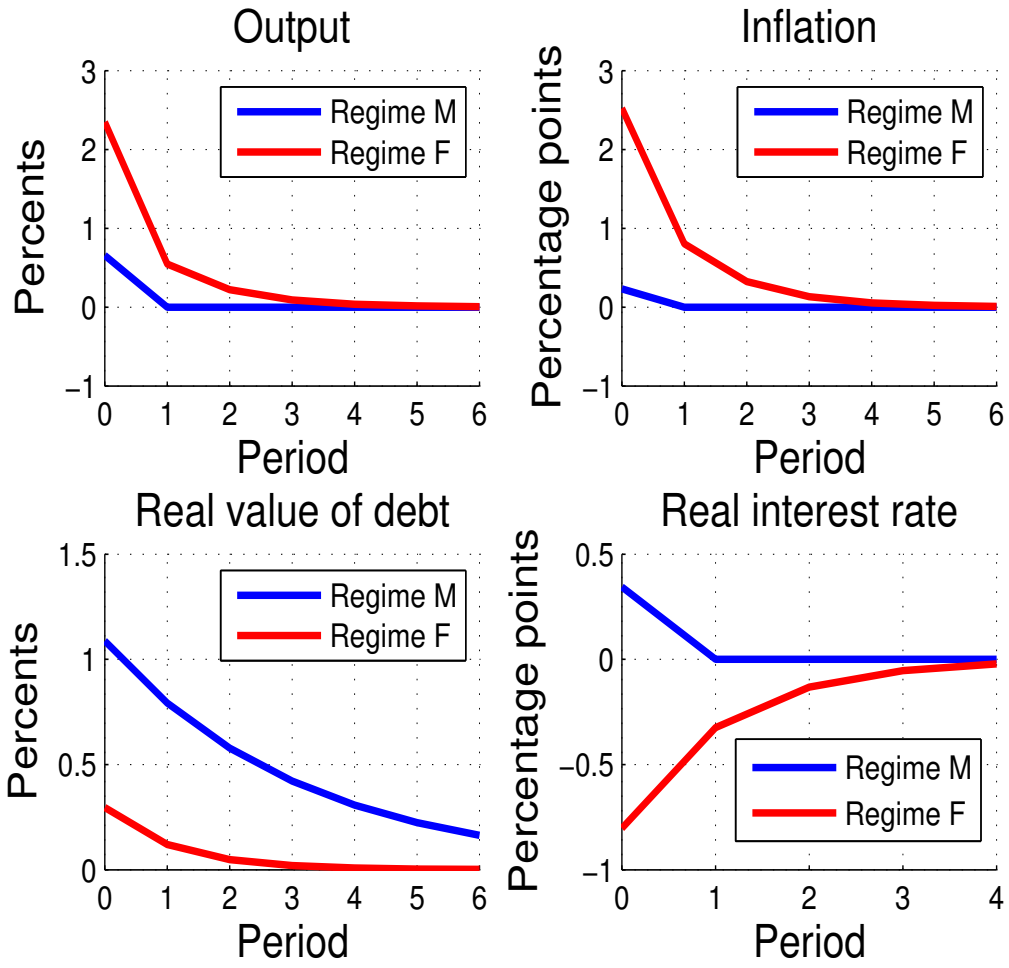

FIGURE 2.1: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to government purchases in regime M and regime F; no persistence; $\rho = 0$.

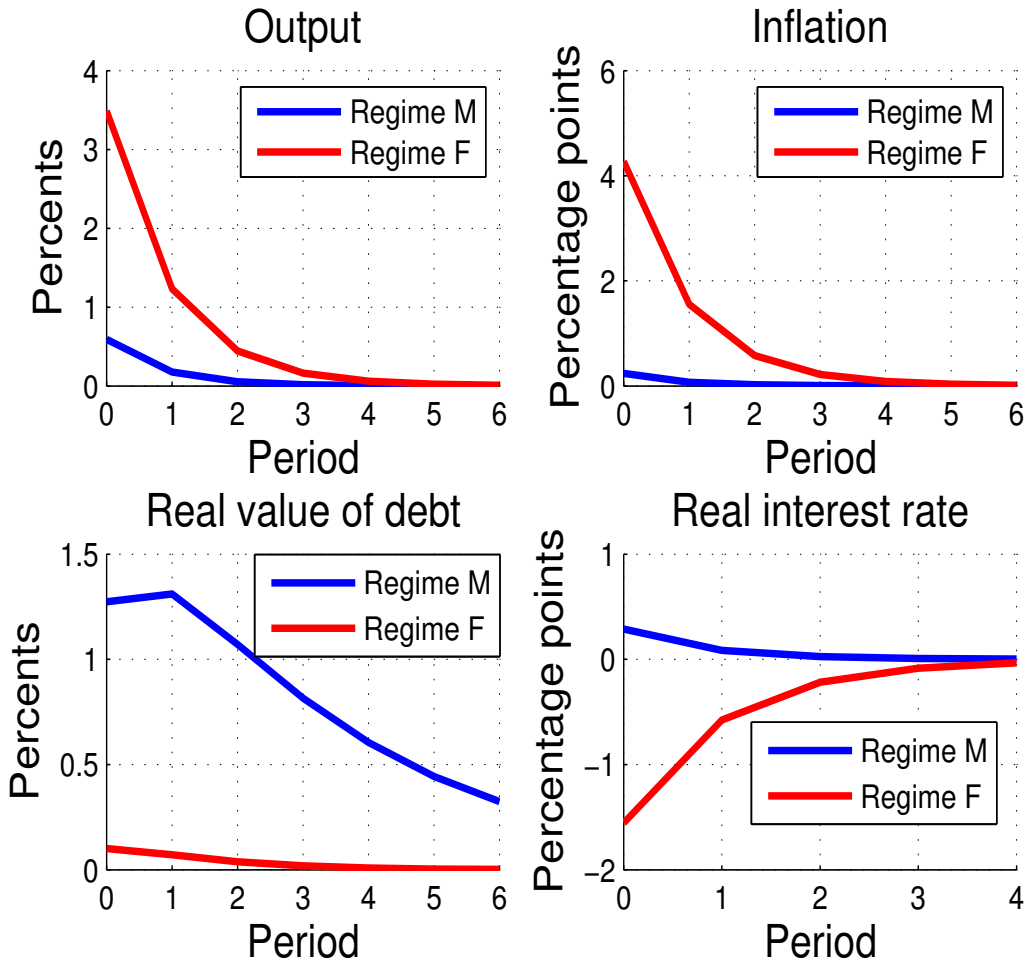

FIGURE 2.2: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to government purchases in regime M and regime F; low persistence; $\rho = 0.3$.

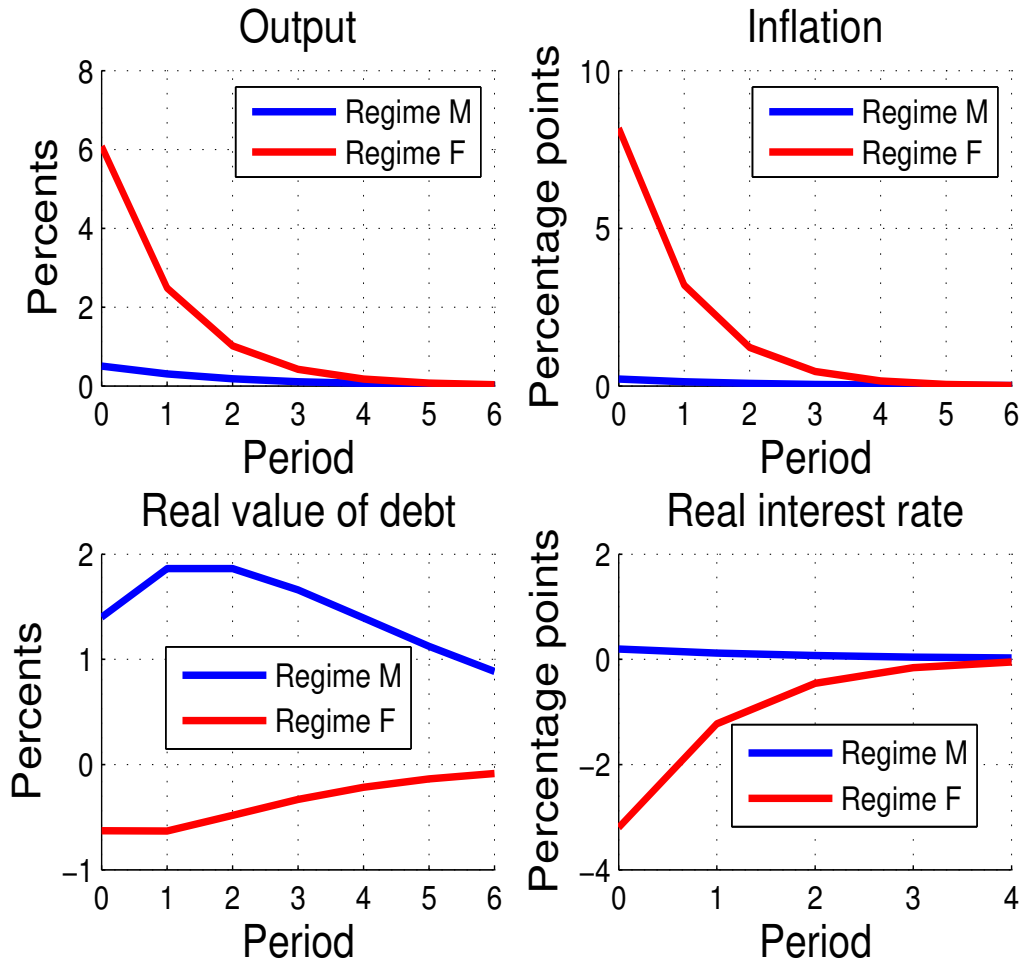

FIGURE 2.3: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to government purchases in regime M and regime F; no persistence; $\rho = 0.6$.

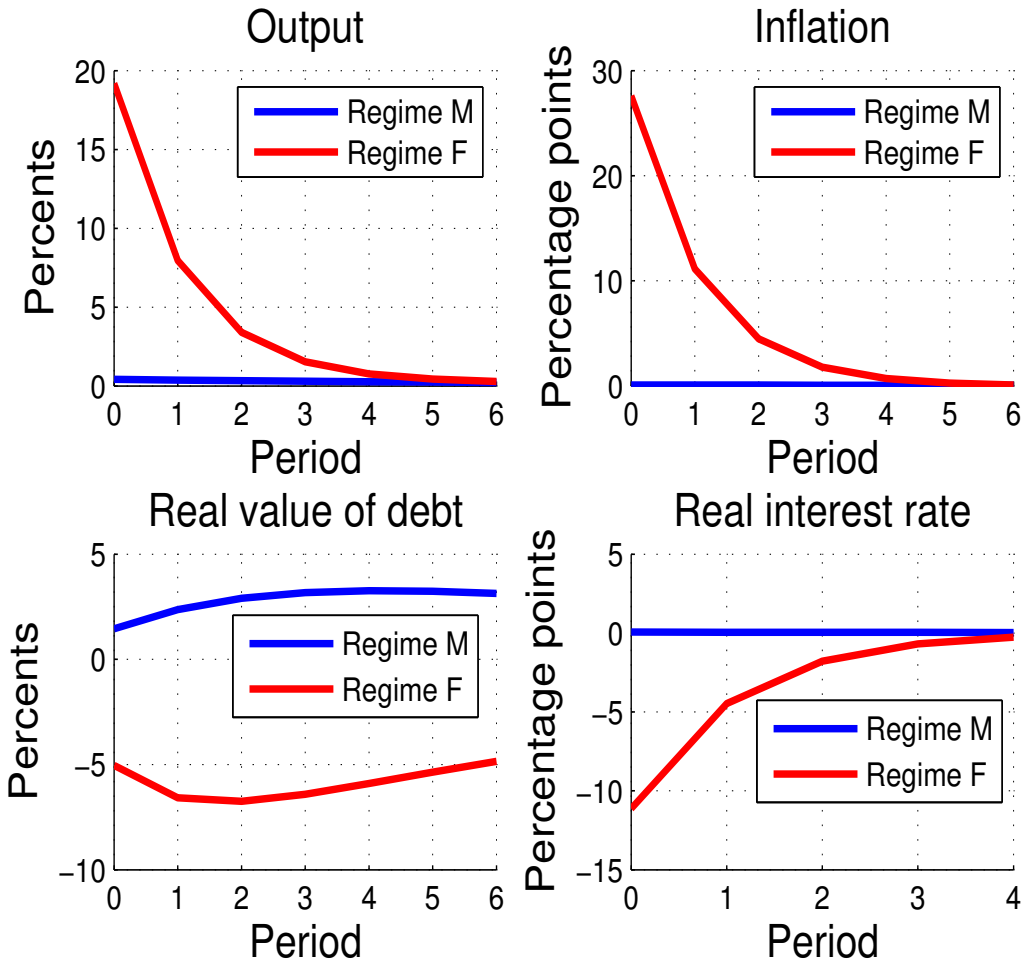

FIGURE 2.4: Response of output, inflation, real maturity value of debt and real interest rate to a one standard deviation shock to government purchases in regime M and regime F; no persistence; $\rho = 0.9$.

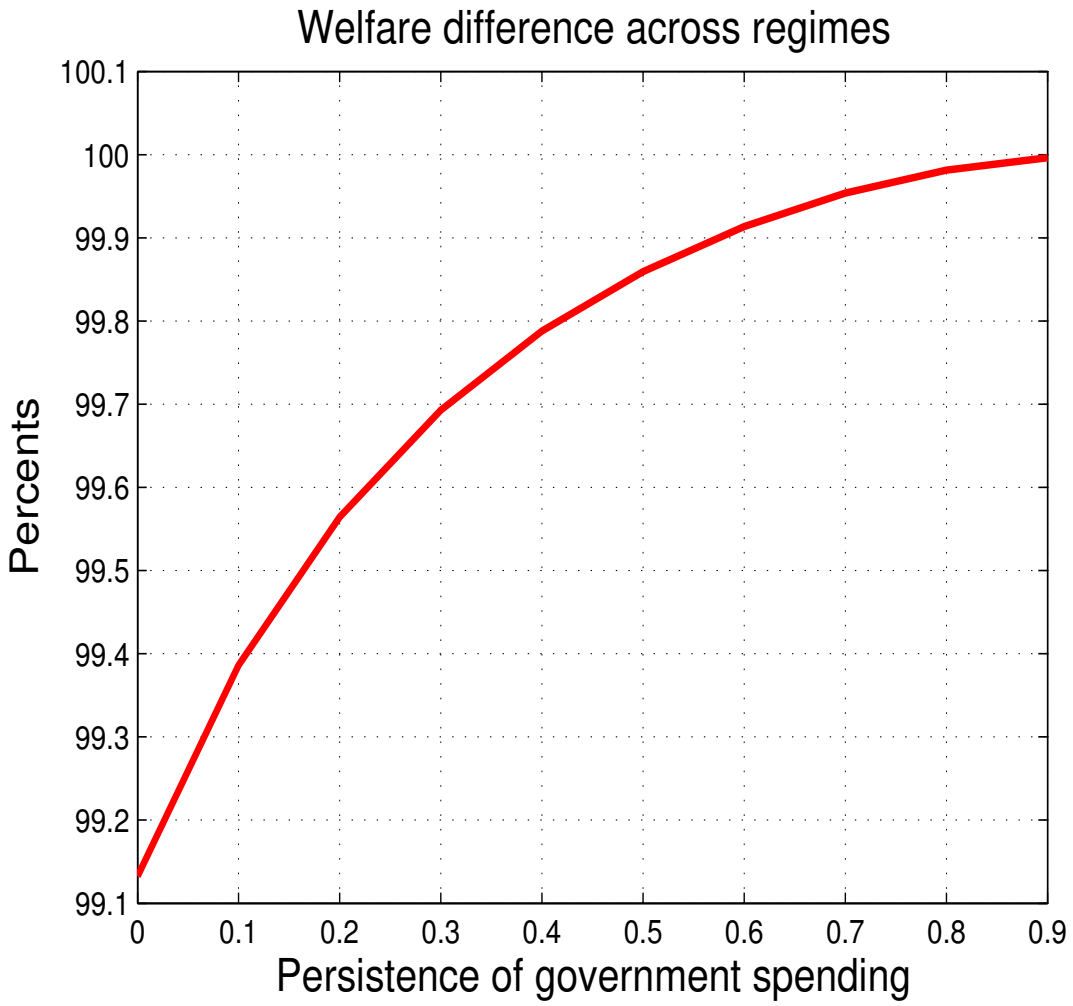

FIGURE 2.5: Differences in welfare multipliers of government spending between regime M and regime F as a function of persistence of government spending.

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Biography

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