Made in Europe:

Monetary–Fiscal Policy Mix with Financial Frictions*

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Abstract

We show that, in a financially constrained environment, relative to an active fiscal–passive monetary policy regime, an active monetary–passive fiscal policy amplifies technology shocks, neutralizes financial shocks, and mitigates the expansionary effects of fiscal shocks through a "debt deflation" and "real interest rate" channels. Several features of the data suggest that, during the last decade, the United States implemented an active fiscal–passive monetary policy, while the Euro area implemented an active monetary–passive fiscal policy, implying that the distinct post-crisis dynamics of the United States and the Euro area can be rationalized through different fiscal and monetary policy mixes.

Keywords: fiscal policy, monetary policy, monetary-fiscal policy interactions, financial frictions.

JEL Classification: E62, E63, E32, E44.

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1 Introduction

This paper studies the interaction between monetary and fiscal policies in the context of a financial crisis. Building on Leeper (1991) and Fernández-Villaverde (2010), we design a DSGE model with a non-trivial fiscal and monetary policy interaction and financial frictions, as in Bernanke, Gertler, and Gilchrist (1999). The model serves as a laboratory in which to understand the way different policy arrangements affect macroeconomic dynamics. We study the dynamic responses of output to technology and financial and fiscal policy shocks and find that policy arrangements are of first-order importance for the transmission of shocks and for recovery after a financial crisis.

Two main transmission mechanisms operate in our setup: the 'debt deflation channel' and the 'real interest rate channel.' Through the debt deflation channel, the interplay of monetary and fiscal policies is relevant in the context of financial frictions. The trade-off between taxes and inflation—which has no real effects in Leeper (1991)—now affects the stock of real private debt. In the case of passive monetary–active fiscal policy (fiscal dominance), higher surprise inflation reduces the stock of public debt but also reduces private debt, which increases entrepreneurs' net worth and allows them to invest more. This mechanism adds to the real interest rate channel already present in New-Keynesian models, shown, for instance, in Davig and Leeper (2011). An increase in inflation raises the real interest rate under active monetary–passive fiscal policy (monetary dominance) but lowers it under fiscal dominance, generating opposite effects on capital accumulation.[1]

We apply our model to the context of the 2007 financial crisis in United States (US) and the Euro area (EA), in which recovery in the Euro Area was weaker and slower than in the United States. According to our model, this divergence could be explained if the US had followed a fiscal dominance regime and the EA had followed a monetary dominance regime. There is evidence supporting the case that the two economies followed different policy mixes. At the onset of the 2007 crisis, while the United States quickly implemented interest rate cuts and large increases

[1] Leeper (1991) introduces the categories of 'active' and 'passive' policies. 'Active monetary policy' refers to cases in which the monetary authority responds strongly to inflation. 'Active fiscal policy' refers to cases in which fiscal policy does not respond to sovereign debt. Leeper (1991) shows that both monetary and fiscal dominance regimes can uniquely pin down the inflation path. In the monetary dominance regime, the Taylor principle guarantees the determinacy of a unique equilibrium, whereas the fact that taxes respond to debt guarantees that government debt is sustainable. Under fiscal dominance, taxes do not response to debt, but the path of inflation is pinned down such that the path of the real interest rate guarantees the sustainability of government debt. The terms 'active monetary–passive fiscal policy' and 'monetary dominance' are used interchangeably throughout this paper, as are 'active fiscal–passive monetary policy' and 'fiscal dominance.'

in the monetary base and debt levels, the Euro Area was substantially more conservative. As a consequence, a divergence of the real interest rate – a key variable that distinguishes the two regimes – occurred between the US and the EA in the early stages of the crisis. These episodes, shown in Figure 1, are described in detail in the next section. Beyond this suggestive evidence, two papers have found that the US followed a fiscal dominance policy regime even prior to the 2007 recession. First, Davig and Leeper (2011) estimate a New Keynesian model with a regime switching policy rules for the US and find that from early 2000s until the end of their sample in 2008, the US already had a passive monetary–active fiscal policy. Chang and Kwak (2017) estimate the two reduced-form policy rules with an endogenous switching model and find that the passive monetary–active fiscal policy was also in place during the financial crisis. We do not estimate the policy rules with regime switches. To maintain simplicity, we encapsulate these policies by estimating fiscal and monetary rules within our model, using a post-2007 sample, and confirm the finding that the EA followed an active monetary–passive fiscal policy (monetary dominance), whereas the US had a passive monetary–active fiscal policy (fiscal dominance).

Our main contribution is to develop a stylized model to understand how different policy mixes operate during periods of financial frictions. Specifically, we add to the literature on financial frictions and macroeconomic dynamics surveyed in Quadrini (2011). Jermann and Quadrini (2012) document cyclical properties of US firms' financial flows and develop a model that shows the importance of financial shocks, in particular during the recent crisis. Other contributions include Christiano, Motto and Rostagno (2008, 2010, 2014), Covas and Haan (2011), Cúrdia and Woodford (2010), Cooper and Ejarque (2003), and Leeper and Nason (2014). Most of these studies focus on the role of monetary policy and abstract from fiscal policy configurations, despite the fact that sovereign debt levels have been at the core of the policy discussion. This is an important gap in the literature that we aim to fill by considering fiscal and monetary policy arrangements together with financial frictions, in context of a financial crisis. In this sense, we relate this literature to that on the interaction between fiscal and monetary policies, such as Bianchi (2012), Bianchi and Ilut (2013), Leeper and Yun (2005), Leeper, Traum, and Walker (2015) or Davig and Leeper (2011). We find that a negative technology shock induces a deeper recession under monetary dominance, than under fiscal dominance. On the other hand, a negative financial shock induces a deeper recession under fiscal dominance, than under monetary dominance.

We also contribute to the recent literature on the effects of fiscal policy with financial frictions. Fernández-Villaverde (2010) studies the effects of fiscal policy in the presence of financial frictions in the spirit of Bernanke, Gertler, and Gilchrist (1999), focusing on the 2008–2009 recession. His main objective is very different from ours, as he focuses on the impact of distortionary taxation. Carrillo and Poilly (2013), who also use a financial accelerator model interacting with the zero-lower bound, reaffirm that government spending multipliers are substantially higher under credit market imperfections. In addition to the Fisherian debt-deflation channel, they highlight a capital-accumulation channel. During the liquidity trap, an expansionary government spending shock reduces the real interest rate, allowing entrepreneurs to accumulate more capital. Eggertsson and Krugman (2012) set up a model with financial frictions in the spirit of Kiyotaki and Moore (1997), arguing that because of debt-constrained agents, the Ricardian equivalence breaks down and, as a consequence, the government spending multipliers increase. Finally, Kollmann, Ratto, Roeger, and in't Veld (2013) set up a New-Keynesian model with a banking sector and study the effects of the government programs that supported banks during the Euro Area crisis. They find that the program contributed to output, consumption, and investment stabilization in the Euro area. While most of these papers focus on the size of government spending multipliers, less attention has been devoted to the role of debt and its financing. We show that both tax cuts and government spending shocks are more expansionary under fiscal dominance.

The paper is structured as follows. In Section 2, we present a first analysis of the US and EA data, showing their different post-crisis dynamics. In Section 3, we describe the simple model economy that combines financial frictions with fiscal and monetary policy configurations. Section 4 describes the empirical strategy we use to take the model to the data and confirms that the US followed an active fiscal–passive monetary policy arrangement, while the EA followed an active monetary–passive fiscal policy arrangement during and after the crisis. Section 5 describes the quantitative implications of these findings. We examine the responses of endogenous variables to technology, financial and policy shocks, as well as the size of fiscal multipliers under different policy configurations. In Section 6, we investigate the potential EA dynamics if it had implemented the US policy mix and find that output would have been higher. Section 7 concludes.

2 From crisis to recovery

Figure 1 shows time series of key macro, fiscal, and monetary variables for the United States and the Euro Area from the beginning of the financial crisis until 2015. The figure shows that major differences exist in the evolution of prices and output, as well as in the dynamics of key variables that characterize monetary and fiscal policy responses, such as the money supply, interest rates, debt, taxation, and government spending.

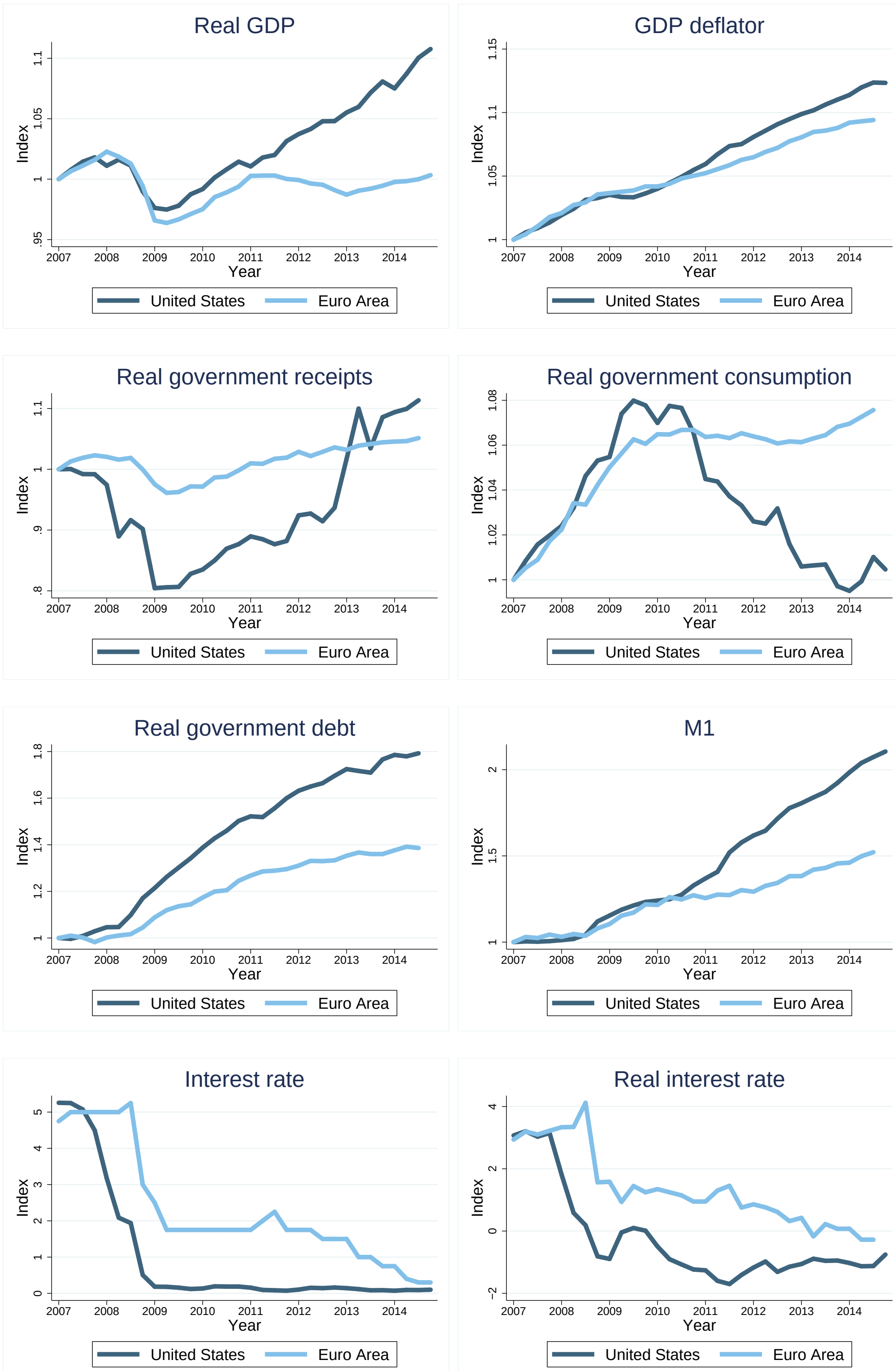
The US recovery has been more robust than the EA's. By the start of 2015, US real GDP was ten per cent above its value in 2007, while the EA real GDP matched the 2007 level. This faster recovery implied a five per cent cumulative higher price level in the United States, measured using the GDP deflator.

The US implemented expansionary monetary and fiscal policies. On the monetary side, interest rates quickly dropped to zero, and quantitative easing contributed to an increase in the money supply that more than doubled in seven years. On the fiscal side, the government followed a temporary counter-cyclical policy by both allowing for tax receipts to fall as much as 20 per cent and increasing government spending up to eight per cent. The financial counterpart of this policy is reflected in the 80 per cent increase in the real stock of government debt. In contrast, in the EA, the interest rate decline was slower and less sharp, and the monetary expansion was milder, with an increase in M1 of 50 per cent. The responses to the crisis on the fiscal side look ambiguous. On the one hand, receipts collected by the government were roughly constant. Despite the GDP drop during the crisis, governments increased tax rates, as they were concerned about the impact of sovereign spreads. On the other hand, an increase in government spending occurred that was smaller but more persistent than that in the US.

The real interest rates behaved similarly in the few first quarters of 2007 but quickly diverged. While the real interest rate became negative in the United States, it was slow to decline in Europe and reached negative values only by the end of the sample. This is in line with the hypothesis that the two economic areas implemented different policy mixes.

The next section develops a business cycle model and studies the implications of these different policy arrangements. We introduce a simple financial accelerator model to capture the role of financial frictions, augmented by fiscal and monetary policies, to understand the diverting dynamics

Figure 1: The anatomy of the recession



Note: Data is from St. Louis FED FRED dataset, IMF and Eurostat. Details about sources and additional figures are in Appendix A.

conditional on estimated policies. We use the model to understand the reasons behind the recovery (or the lack thereof).

3 A simple model with financial frictions

We design a financial accelerator model that combines ingredients in Leeper (1991) and Fernández-Villaverde (2010). The economy is populated by households; entrepreneurs; firms that produce a final good, intermediate inputs and capital goods; financial intermediaries; the government; and a central bank. The remainder of this section describes each agent, while all the optimality conditions are shown in Appendix B.

3.1 Households

Households choose consumption c_t, hours worked l_t, and nominal financial assets – d_t are bonds issued by the government, and a_t are deposits in financial intermediaries. Households own firms (and obtain benefits derived from this ownership, given by F_t) and pay lump-sum taxes, T_t. They maximize the following utility function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ e^{\nu_t} \log(c_t) - \psi \frac{l_t^{1+\varrho}}{1+\varrho} \right\}.$$

The optimal plan is subject to the following infinite sequence of budget constraints:

$$c_t + \frac{a_t}{p_t} + \frac{d_t}{p_t} = w_t l_t + R_{t-1} \frac{a_{t-1}}{p_t} + R_{t-1}^d \frac{d_{t-1}}{p_t} + T_t + F_t + tre_t, \ t \geq 0,$$

where tre_t is a net transfer from entrepreneurs that is defined later. p_t denotes the price level and w_t the real wage. Two different nominal interest rates exist, one associated with sovereign debt, R_t^d, which is a monetary policy instrument, and the return associated with private assets, R_t. We follow Arias, Erceg, and Trabandt (2016) in considering a preference shock that affects the marginal utility of consumption, ν_t. We assume that this shock follows an AR(1) process given by

$$\nu_t = \rho_\nu \nu_{t-1} + \varepsilon_t^\nu.$$

3.2 Final-good Producer

The consumption good is the unique final good of the economy produced by competitive firms that combine intermediate goods using the following technology:

$$y_t = \left(\int_0^1 y_{it}^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}},$$

where y_{it} is a continuum of intermediate inputs, indexed using i, whose demand depends on the price of these differentiated goods:

$$y_{it} = \left(\frac{p_{it}}{p_t} \right)^{-\epsilon} y_t.$$

Here, ϵ characterizes the rate of substitution between varieties. This technology implies the following final-good price:

$$p_t = \left(\int_0^1 p_{it}^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}.$$

3.3 Intermediate-good producers

Intermediate good producers produce differentiated varieties i of the inputs, mixing labour and capital in a Cobb–Douglas production function:

$$y_{it} = e^{z_t} k_{it-1}^{\alpha} l_{it}^{1-\alpha},$$

where k_{it-1} is the capital that the firm rents from entrepreneurs. Productivity z_t follows an AR(1) process.

$$z_t = \rho^z z_{t-1} + \sigma^z \epsilon_t^z, \quad \epsilon_t^z \sim N(0,1).$$

The optimal input choice implies that

$$k_{t-1} = \frac{\alpha}{1-\alpha} \frac{w_t}{r_t} l_t$$

and that the marginal cost is given by

$$mc_t = \left(\frac{1}{1-\alpha} \right)^{1-\alpha} \left(\frac{1}{\alpha} \right)^{\alpha} \frac{w_t^{1-\alpha} r_t^{\alpha}}{e^{z_t}}.$$

Additionally, these firms operate as competitive monopolists and are able to fix prices, which can change according to a Calvo lottery with probability θ. In order to fix prices optimally, firms solve the following maximization problem:

$$\max_{p_{it}} \mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\theta)^{\tau} \frac{\lambda_{t+\tau}}{\lambda_t} \left\{ \left(\prod_{s=1}^{\tau} \frac{1}{\Pi_{t+s}} \frac{p_{it}}{p_t} - mc_{t+\tau} \right) y_{it+\tau} \right\}$$

subject to

$$y_{it+\tau} = \left(\prod_{s=1}^{\tau} \frac{1}{\Pi_{t+s}} \frac{p_{it}}{p_t} \right)^{-\epsilon} y_{t+\tau}.$$

Here, λ_t denotes the marginal value of wealth of the households (a Lagrangian multiplier on the household's budget constraint), and Π_{t+s} is the price ratio $\frac{p_{t+s}}{p_{t+s-1}}$.

3.4 Capital Producers

We assume that there is a set of competitive capital good producers that purchase installed capital (x_t), add new investment i_t to generate installed capital for next period, and sell the refurbished capital stock. Producers operate according to the following technology:

$$x_t = x_{t-1} + \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t.$$

Here, $S[\cdot]$ is an adjustment cost function given by $\frac{S_0}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2$. They sell their output at a price q_t to entrepreneurs. Consequently, they maximize the following profits function:

$$q_t \left(x_t + \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t \right) - q_t x_t - i_t = q_t \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t - i_t.$$

3.5 Entrepreneurs

The entrepreneurial section follows the costly state verification setup, as in Bernanke, Gertler, and Gilchrist (1999). Assume that entrepreneurs use their net worth, n_t, and issue debt to financial intermediates, b_t, to buy new installed capital at price q_t,

$$q_t k_t = n_t + \frac{b_t}{p_t}.$$

Assume a productivity shock ω_{t+1} drawn from a log normal distribution $F(\omega)$ that shifts the rented capital. $F(\omega)$ is such that $E_t(\omega_{t+1}) = 1$, while the dispersion $\varsigma_{\omega,t}$ follows,

$$\varsigma_{\omega,t} = (1-\rho^{\omega})\varsigma_{\omega} + \rho^{\omega}\varsigma_{\omega,t-1} + \sigma^{\omega}\epsilon_t^{\omega}, \quad \epsilon_t^{\omega} \sim N(0,1).$$

Following Christiano, Motto, and Rostagno (2014), we consider the shock to the entrepreneurial-level dispersion a financial shock. A higher dispersion implies that entrepreneurs default more often, and, hence, the external finance premium is higher. The average return of entrepreneurs

$$R_{t+1}^{k} = \frac{p_{t+1}}{p_t}\frac{r_{t+1} + q_{t+1}(1-\delta)}{q_t}.$$

The debt contract determines that the return R_{t+1}^{l} is a return that gives zero profits to financial intermediaries,

$$[1 - F(\bar{\omega}_{t+1})]R_{t+1}^{l}b_t + (1-\mu)\int_0^{\bar{\omega}_{t+1}} \omega dF(\omega) R_{t+1}^{k} P_t q_t k_t = \bar{s} R_t b_t,$$

where $1-\mu$ is the fraction of the return that can be captured by the financial intermediate in case of default. A higher μ implies stronger financial frictions. $\bar{s}$ is an average spread charged by financial intermediates. The problem of the entrepreneur is to pick a leverage ratio and a cut-off for default to maximize its expected net worth given the zero-profit condition of the intermediary.

Given such a contract, the law of motion of entrepreneurial net worth is given by

$$n_t = \gamma^e \frac{1}{\pi_t}\left[R_t^k q_{t-1}k_{t-1} - \bar{s}R_{t-1}b_{t-1} - \mu\int_0^{\bar{\omega}_{t+1}} \omega dF(\omega) R_t^k q_{t-1}k_{t-1}\right] + w^e,$$

where γ^e regulates the survival rate of entrepreneurs. Exiting entrepreneurs transfer their net worth to households, which fund incoming entrepreneurs by transferring w^e. The net of these operations is reflected in the term tre_t observed in the households' budget constraint, which is given by

$$tre_t = (1 - \frac{1}{1-e^{\bar{\gamma}^e}})n_t - w^e.$$

3.6 Financial Intermediary

Financial intermediaries operate in a competitive environment and channel resources from households to entrepreneurs. Specifically, the financial intermediaries collect deposits from households and make loans to entrepreneurs.

$$a_t = b_t.$$

Given the competitive assumption, these intermediaries obtain zero profits in equilibrium.

3.7 Government

The government is characterized by a monetary policy rule, a fiscal policy rule, a budget constraint, and a government spending shock. Monetary policy follows a simple Taylor rule:

$$R_t^d = R^d + \psi_\pi(\Pi_{t-1} - \bar{\Pi}) + \psi_y[\ln(y_t) - \ln(\bar{y})] + \varepsilon_t^r,$$

where $\bar{\Pi}$ is the inflation target, and ε_t^r is an autocorrelated monetary policy shock

$$\varepsilon_t^r = \rho^r \varepsilon_{t-1}^r + \epsilon_t^r \quad \epsilon_t^r \sim N(0,1).$$

The fiscal policy rule is, instead, defined over lump-sum taxation,

$$\ln(\tau_t) = \ln(\bar{\tau}) + \psi_d[\ln(d_{t-1}) - \ln(\bar{d})] + \varepsilon_t^\tau$$

with

$$\varepsilon_t^\tau = \rho^\tau \varepsilon_{t-1}^\tau + \epsilon_t^\tau \quad \epsilon_t^\tau \sim N(0,1).$$

Here, the government spending rule has a systematic component that responds to government debt and an exogenous autocorrelated shock.

$$\ln(g_t) = \ln(\bar{g}) - \psi_g[\ln(d_{t-1}) - \ln(\bar{d})] + \varepsilon_t^g,$$

with

$$\varepsilon_t^g = \rho^g \varepsilon_{t-1}^g + \epsilon_t^g \quad \epsilon_t^g \sim N(0,1).$$

The path of taxes and government spending implies a path for government debt through the government's budget constraint:

$$d_t = g_t + \frac{R^d_{t-1}}{\Pi_t} d_{t-1} - \tau_t.$$

Depending on the coefficients of the monetary and fiscal policy rules, $(\psi_\pi, \psi_y, \psi_d, \psi_g)$, we are in an active–passive regime.

3.8 Aggregation

Market clearing in the goods markets is

$$y_t = c_t + i_t + g_t + \mu G_{t-1}(\bar{\omega}_t)(r_t + q_t(1-\delta))k_{t-1},$$

where $G_t(\bar{\omega}_{t+1}) = \int_0^{\bar{\omega}_{t+1}} \omega dF(\omega)$. Furthermore, the aggregation of production across firms implies that

$$y_t = \frac{1}{v_t} e^{z_t} k^{\alpha}_{t-1} l^{1-\alpha}_{t-1},$$

where $v_t = \int_0^1 \left(\frac{p_{it}}{p_t}\right)^{-\epsilon} di$ is a price dispersion index. Finally, market clearing in the capital market is given by

$$x_t = k_t.$$

4 Empirical strategy

Our empirical strategy is to use the identifying restrictions imposed by the DSGE model to estimate the parameters in the fiscal and monetary policy rules for the Euro Area and the United States. To this end, we combine calibration together with Bayesian estimation of the DSGE model. Most structural parameters are fixed to standard values in the literature and are common to both economies. These parameters, shown in Table 1, are fixed to the standard calibration in Fernández-Villaverde (2010), with only two exceptions. Bankruptcy costs μ are set as in Bernanke, Gertler, and Gilchrist (1999), and a discount factor β is set to 0.99.

For the estimation of the policy rules and the shock processes, we follow a Bayesian full information approach as in An and Schorfheide (2007). Before estimation, prior information is introduced

Table 1: Calibration

Parameter	**Description**	**Value**
β	Discount factor	0.99
$\bar{\Pi}$	Target inflation	1.005
S_0	Adjustment costs of capital	4.75
ϱ	Frisch elasticity related parameter	0.5
δ	Capital depreciation rate	0.01
ς_ω	Average volatility of entrepreneur shock	0.5
α	Capital share intermediate production	0.22
θ	Calvo parameter	0.8
ϵ	Input substitution	10
$\bar{s}$	Average spread	1.0025
$\bar{\gamma}_e$	Entrepreneurs exit coefficient	3.67
$\bar{L}$	Labour in steady-state	1/3
$\bar{B}/\bar{K}$	Debt-to-capital ratio	1/3
$\bar{d}/\bar{y}$	Government debt over annual GDP	0.6
$\bar{g}/\bar{y}$	Government consumption over GDP	0.2
μ	Bankruptcy costs	0.12

Note: Parameters fixed for both US and EA calibration.

through prior distributions, as shown in the second column of Table 2. We consider the same priors for both economies, which intend to be agnostic about the policy arrangements. For this reason, we set the prior mean of $\psi_\pi = 1$ in both cases. As for the response of taxes to debt, we set it on the border of the two regimes, $\psi_d = 0.056$. The estimation strategy implies a first step with a maximization of the posterior mode, for which we use a simulated annealing algorithm and then a random walk Metropolis-Hastings, for which we target an acceptance rate of about 30% of the draws.

The observable variables for estimation are, in both the United States and the Euro Area, the following: output gap, measured as the deviations of the log of real GDP with respect to its linear trend of the period 1990-2015; inflation rate measured as the ratio of GDP deflator relative to the previous quarter; nominal interest rate; government spending to output ratio; government debt to output ratio; and private debt, measured as the log deviations with respect to its trend of the period 1990-2015 (1999-2015 for the Euro Area). Given that we want to identify differences in policy responses after the start of the financial crisis, our sample runs from 2007Q1 to 2015Q3.

The third column of Table 2 presents the posterior mode, mean and high probability density intervals of the coefficients in the fiscal and monetary policy rules for the United States. The fourth column does the same for the Euro Area. The parameters that characterize the US and EA fiscal and monetary policies are remarkably different. Conditional on our estimates, Figure 2 plots

Table 2: Estimation for United States and Euro Area

Parameter	Prior Density (mean, sd)	Posterior mode, (mean), [90% HPD interval] United States	Euro Area
Fiscal and Monetary policy coefficients			
ψ_y	Normal(0.15, 0.05)	0.119 (0.120) [0.080, 0.159]	-0.001 (0.001) [-0.022, 0.019]
ψ_π	Normal(1, 0.3)	-0.172 (-0.094) [-0.291, 0.095]	1.261 (1.455) [1.181, 1.790]
ψ_d	Normal(0.056, 0.03)	0.033 (0.035) [-0.000, 0.069]	0.070 (0.120) [0.074, 0.168]
ψ_g	Normal(0, 0.03)	0.024 (0.017) [-0.020, 0.055]	0.007 (0.040) [-0.029, 0.111]
Auto-regressive components			
ρ_ω	Beta(0.8, 0.1)	0.971 (0.973) [0.955, 0.992]	0.488 (0.435) [0.313, 0.566]
ρ_z	Beta(0.8, 0.1)	0.975 (0.961) [0.935, 0.990]	0.981 (0.859) [0.751, 0.979]
ρ_ν	Beta(0.8, 0.1)	0.993 (0.987) [0.976, 0.998]	0.939 (0.945) [0.910, 0.980]
ρ_r	Beta(0.8, 0.1)	0.923 (0.904) [0.840, 0.970]	0.655 (0.665) [0.594, 0.732]
ρ_τ	Beta(0.8, 0.1)	0.303 (0.273) [0.179, 0.363]	0.801 (0.683) [0.532, 0.863]
ρ_{gc}	Beta(0.8, 0.1)	0.957 (0.956) [0.949, 0.969]	0.976 (0.980) [0.951, 0.999]
Standard deviation of innovations			
σ_ω	Inverse Gamma(0.01, 0.1)	0.245 (0.254) [0.177, 0.327]	0.624 (0.560) [0.449, 0.665]
σ_z	Inverse Gamma(0.01, 0.1)	0.021 (0.025) [0.018, 0.031]	0.011 (0.007) [0.005, 0.010]
σ_ν	Inverse Gamma(0.01, 0.1)	0.031 (0.032) [0.025, 0.039]	0.015 (0.027) [0.019, 0.035]
σ_r	Inverse Gamma(0.01, 0.1)	0.002 (0.002) [0.001, 0.002]	0.003 (0.003) [0.003, 0.004]
σ_τ	Inverse Gamma(0.01, 0.1)	0.285 (0.324) [0.248, 0.399]	0.177 (0.178) [0.143, 0.211]
σ_{gc}	Inverse Gamma(0.01, 0.1)	0.012 (0.013) [0.010, 0.015]	0.006 (0.007) [0.005, 0.008]

Note: In brackets is the mean estimate and in square brackets is the 90% HPD interval

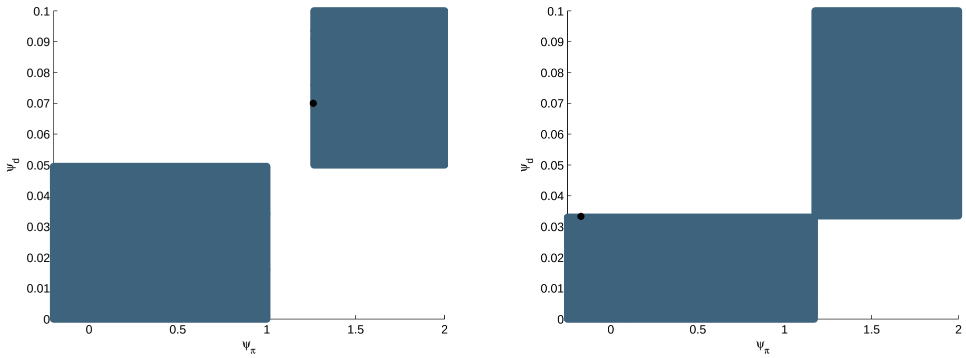
determinacy regions for different values of the Taylor rule coefficient, ψ_π, and the fiscal policy rule coefficient, ψ_d, for the two economies. There are two blocks in each figure, each associated with the monetary dominance regime (upper right) or the fiscal dominance regime (lower left).[2] The black points in each figure indicate the posterior mode.

Our estimates confirm that since the crisis, the United States has followed a passive monetary policy together with an active fiscal policy. While the point estimate of ψ_π is negative, the high posterior density interval includes the zero, suggesting that monetary policy has been rather non-responsive to inflation. Additionally, ψ_y is statistically larger than 0, meaning that the interest rate responds to the output gap. Given the negative output gap experienced during the recession, this can explain the quick drop in the nominal interest rates earlier. In other words, US monetary policy has been largely concerned about the output gap and non-sensitive to inflation.[3]

[2]As Ascari and Ropele (2009) and Arias (2014) discuss, the model with trend inflation (but without financial frictions) requires a more aggressive monetary policy to induce determinacy through active monetary policy. In this model, the determinacy regions also depend on the degree of financial frictions. The regions are different for the two areas, as they have different responses of nominal interest rate to output gap and of government spending to debt.

[3]These coefficients are consistent with the ones found in Davig and Leeper (2011), although we find that the interest rate responds less to inflation. In the model and estimation, we have not explicitly consider the zero lower bound in the interest rate. It is clear that such a low coefficient for inflation is driven by the fact that in the US, the nominal interest rate was at the zero lower bound for a substantial number of periods. From the perspective of purely determining the regime, it does not matter whether the interest rate was non-responsive to inflation because

Figure 2: Determinacy regions



(a) Euro Area (b) United States

Note: Figure (a) plots determinacy regions for the EA calibration. Figure (b) plots these regions for the US calibration. The black dots locate the estimated rules for the Euro area and the United States.

Regarding fiscal policy, the ψ_d point estimate is rather small, implying that taxes are not very responsive to debt accumulation. On the other hand, ψ_g, which captures the correction of government spending to debt accumulation, is positive, in line with, Leeper, Traum, and Walker (2015) . However, our estimates do not allow us to make a strong claim about his point, given that the high probability density interval includes the zero.

For the Euro Area, although the exercise imposed the same priors as for the United States, the data contain sufficient information to conclude that the EA has been running an active monetary policy with a passive fiscal policy since 2007. Specifically, monetary policy was non-responsive to the output gap, as the estimate of ψ_y is rather small. On the other hand, ψ_π is strongly positive and larger than one, suggesting that the monetary policy during and since the crisis has been concerned mainly with inflation growth. The fiscal policy coefficients, on the other hand, are in line with those of an economy that, overall, responds to a passive fiscal policy in which tax schedules respond to sovereign debt accumulation. As in the United States, a slight but statistically insignificant correction is made through government consumption.

of a policy rule or because it was limited by the zero lower bond. In fact, the model can sustain a zero lower bound for an infinite number of periods, as long as the fiscal rule is active. However, from an economic point of view, the existence of a zero lower bound affects the dynamics. In Appendix E, we extend the model to explicitly consider an occasionally binding zero lower bound and discuss how it interacts with the two regimes. On the one hand, several shocks imply opposite responses of the nominal interest rate in monetary and fiscal dominance regimes. On the other hand, other shocks induce different quantitative responses of the nominal interest rate, affecting the probability of hitting the zero lower bound, as well as the accompanying deflation.

4.1 Historical Variance Decomposition

The previous results show that the United States and the Euro Area had different policy regimes after the crisis. Different policy mixes, together with differences in the shocks received by each economy, determine the importance of each type of innovation in driving fluctuations. Figure 3 shows the historical variance decomposition of output for the two economies, to determine which shocks affected each economy in every period, given the implemented policies. In this sense, the figures provide information on the main shocks driving the crisis and behind the recovery.

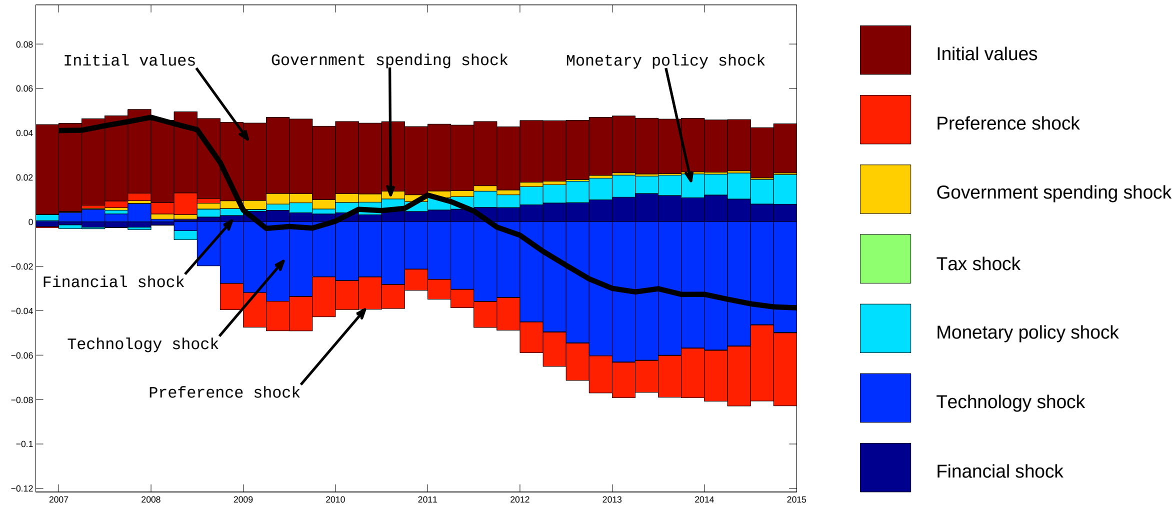
According to our estimates, the negative path of output in the Euro Area has been driven mainly by negative technology shocks. Policy shocks – in particular, tax and government spending shocks – have played only a small role in the output dynamics. Likewise, financial shocks have played a minor role in the EA. This was not the case in the United States, where financial shocks were the main drivers of output in the early stages of the crisis. Also, in the US, fiscal shocks have played a major role. Tax shocks have contributed positively to output throughout the last decade. Government spending shocks made a positive contribution to output in the first years of the crisis, but since 2011, the spending reversals have had a strong negative impact on output. Furthermore, there also has been an important negative effect of the preference shock.[4]

The results presented in this section support our interpretation of the data in Section 2. There is ample evidence that the US followed an active fiscal policy–passive monetary policy arrangement, while the EA imposed a monetary policy relatively non-responsive to output gaps and concerned mainly with price stability. The two economies have been subject to different shocks, with technology shocks more relevant in the EA and financial and policy shocks more prominent in the US. The US historical variance decomposition is in line with findings by Merola (2015) and Furlanetto, Ravazzolo, and Sarferaz (2014).

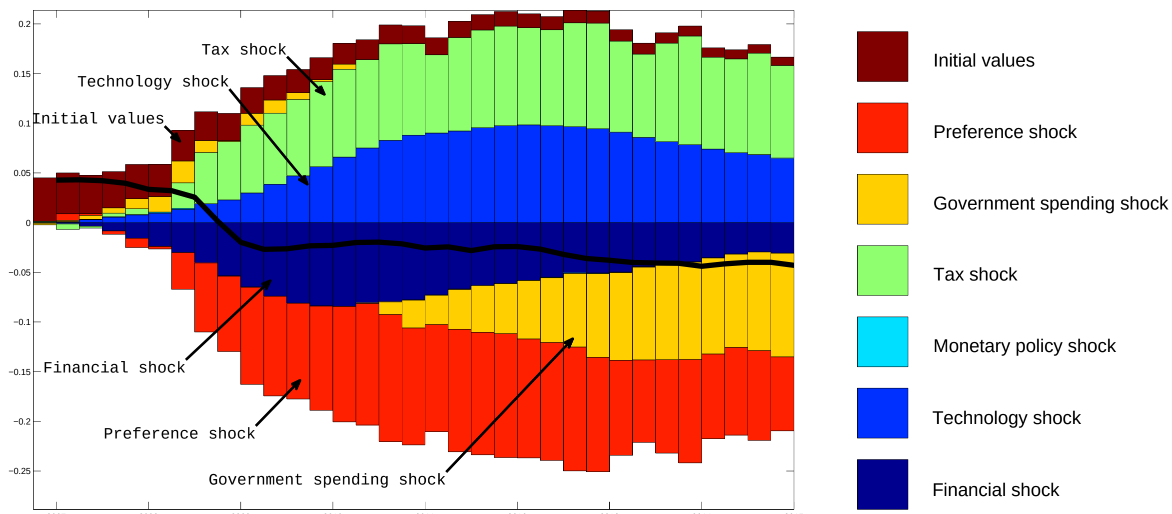
In what follows, we study the importance of these policy arrangements to the transmission of the most important shocks according to the historical variance and whether they could explain the

[4]In Appendix C, we show the historical variance decomposition for inflation and private and public debt. We also present a table with the unconditional variance decomposition. The unconditional volatility of output is lower in the Euro Area and is driven exclusively by technology shocks. On the other hand, in the fiscal dominance regime in the United States, fiscal policy shocks, technology and financial shocks account for roughly 15 percent of the variance of output each, while preference shocks account for one half. Without financial frictions and nominal rigidities, in both economies, output would be affected only by technology and preference shocks, with taxes and monetary policy shocks not having real effects.

Figure 3: Historical variance decomposition



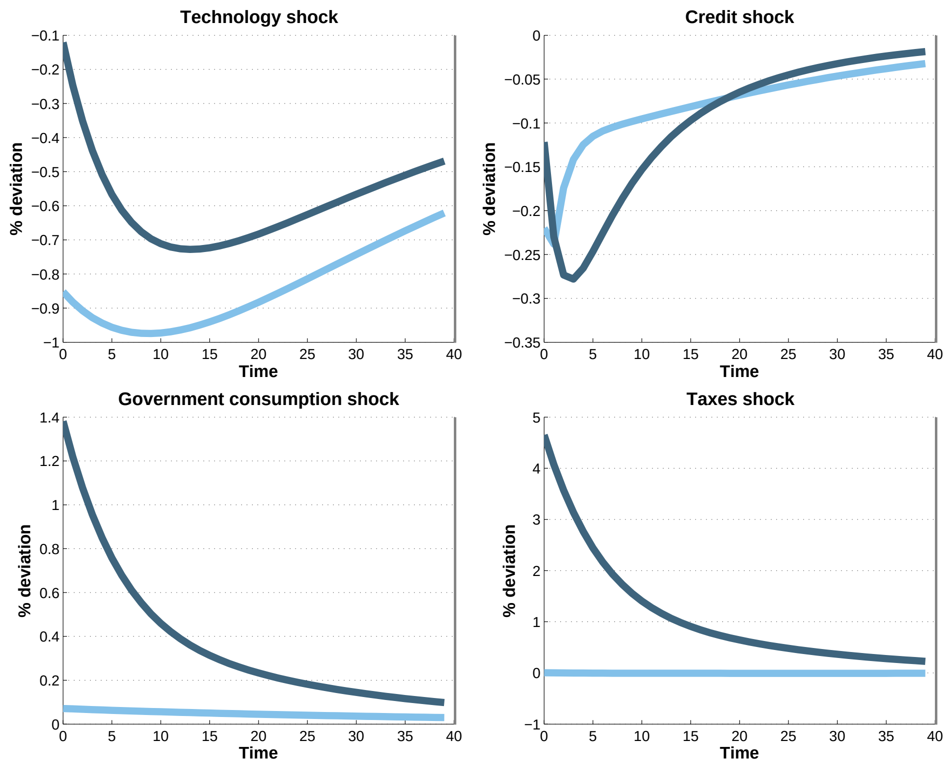
(a) Euro Area



(b) United States

diverging dynamics observed in United States and the Euro Area during the crisis and the recent recovery.

Figure 4: Response output to different shocks



Note: The light blue line plots responses of the EA shocks under the EA policy parameters, and the dark line does so under the US calibration.

5 Dissecting the model

In order to better understand the dynamics under the two regimes, we analyze the impulse response of output to four key shocks under the EA calibration: technology, financial, government spending and tax shock. We then compare them to what their response would have been if the Euro Area had followed US policies (and, hence, a fiscal dominance regime).[5]

As Figure 4 shows, the fall of output after a negative technology shock at impact in the Euro Area is 0.9 per cent, nine times larger than under the US policy rules. At the trough of the recession, output falls by one per cent in the Euro Area, but would fall only 0.7 per cent under fiscal dominance. If technology shocks are mitigated by an active fiscal policy, financial shocks are mildly amplified. The recovery following an increased dispersion of projects is faster under monetary dominance.

The two main mechanisms behind the differing dynamics under fiscal and monetary dominance

[5]We show the responses of several variables to all 6 shocks in Appendix D.

are related to the changes in the real value of entrepreneurial debt following surprise inflation and through the real interest rate channel. Inflation responds differently to shocks in the two regimes and drives the differences in the degree to which the stock of private and public real debt is deflated (or inflated) after a shock. Furthermore, the paths of the ex-ante real interest rate diverge in the two regimes.

Following the technology shocks, the the smaller decline in output under fiscal dominance is related to a larger increase in inflation. Higher inflation decreases the real value of entrepreneurial debt, making debt repayment cheaper and ameliorating the decline in investment. Hence, under fiscal dominance, investment and employment fall by less than under monetary dominance. The differences in the evolution of sovereign debt under both regimes are caused by the real interest channel.

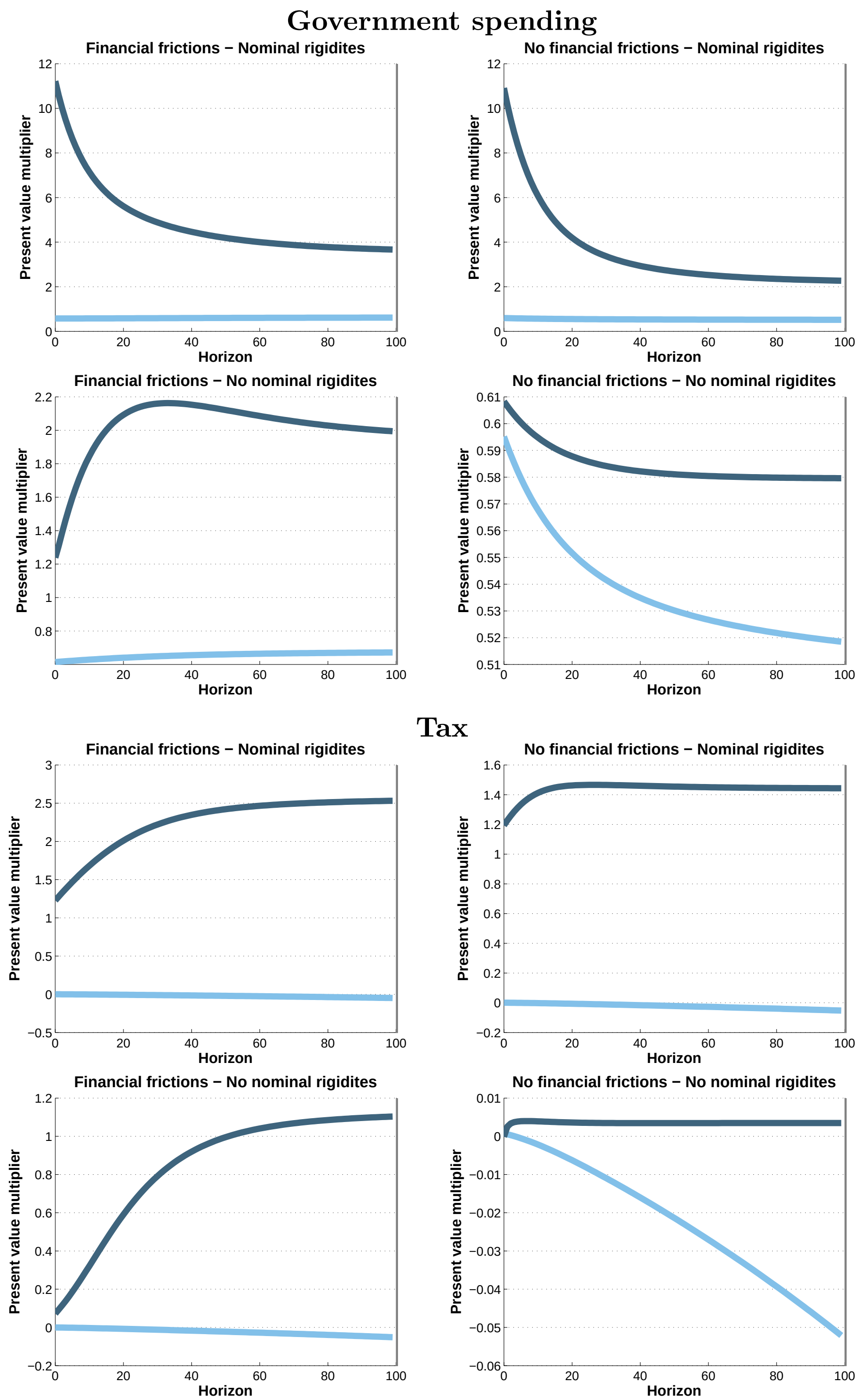
Figure 4 also presents the dynamics after a positive government spending and a negative tax shock. A positive government spending shock and a negative tax shock are expansionary under the two policy arrangements. However, the fiscal shocks are inflationary-financed under fiscal dominance (surprise inflation and lower path of the real interest rate), whereas they are covered by debt and the subsequent tax increase under monetary dominance. Under financial frictions and active fiscal policy, the impact of government spending is exacerbated, as inflation reduces the real value of private debt, which translates to higher investment and lower private debt and spreads. In addition, it lowers the real interest rate, stimulating investment. However, under monetary dominance, a higher real interest rate counteracts these dynamics.

We quantify the differences across regimes by computing the government spending present value multiplier as

$$PVM_k = \frac{E_t \sum_{j=0}^{k} \beta^j (y_{t+k} - \bar{y})}{E_t \sum_{j=0}^{k} \beta^j (g_{t+k} - \bar{g})},$$

and analogously for tax cuts. Figure 5 shows the present value multipliers for different combinations of presence or absence of financial or nominal frictions. Under the baseline scenario with both financial frictions and nominal rigidities, both spending's and tax's present value multipliers are higher under fiscal dominance, with the spending multiplier converging to 3 in the long run. Under monetary dominance, the multiplier is below 1. We can also see that financial frictions contribute to amplification of the multipliers. Without financial frictions, the government spending multiplier

Figure 5: Present value multipliers for different combinations of frictions



Note: Each curve indicates the degree of PVM_k calculated at different horizons in the horizontal axis. The light blue line plots the PVM under the EA calibration, and the dark blue line plots the PVM under US policy rules.

under fiscal dominance would converge to 2, the same as when only financial frictions are present. Without both nominal rigidities and financial frictions, the multipliers are below 1 in both regimes. This result is consistent with Canova and Pappa (2011) empirical evidence showing that government spending multipliers are larger for the subset of episodes that were accompanied by a fall in the real interest rate.

6 Counterfactual policies during the crisis

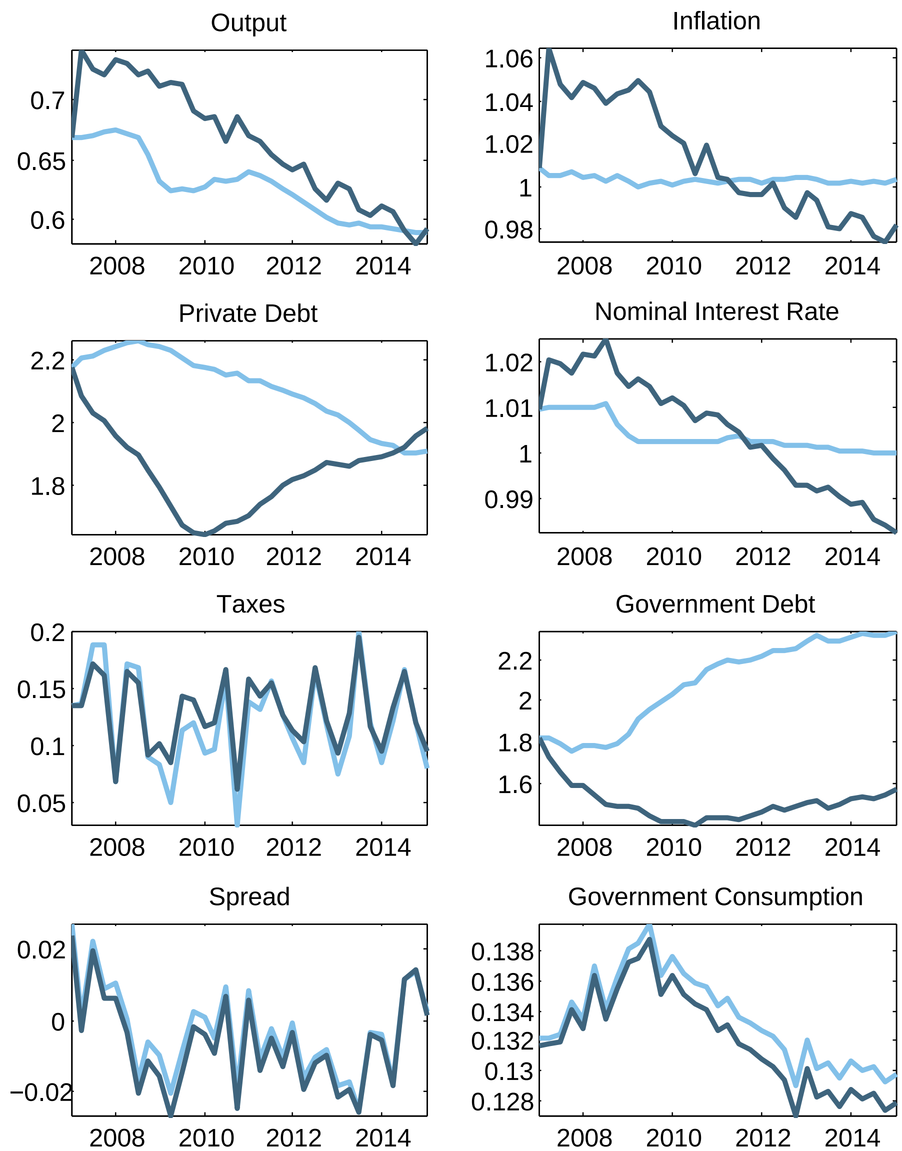
How important is the policy regime in generating the post-crisis recoveries observed in the Euro Area? This section presents the observed dynamics in the EA and the counterfactual dynamics implied by the model that would have been observed if the EA had implemented the US policy rules.

The exercise is designed as follows: as a by-product of the estimation strategy, we recover the smoothed estimates of unobserved states and shocks for the Euro Area. Then, we assume that the fiscal and monetary policy rules used are those of the United States, and we feed the smoothed shocks to simulate a new set of counterfactual variables. The fiscal and monetary policy rules coefficients that we modify for the counterfactual exercises are those of the interest rate, tax and government spending policies. Figure 6 presents the observed and counterfactual dynamics.

The figure shows that approaching the crisis using the active fiscal policy arrangement would have generated substantially different dynamics. In particular, it would have mitigated the fall in output, especially during 2008. Additionally, fiscal policy variables – taxes and government spending – would not have changed much in the EA case if the economy had implemented an active fiscal policy arrangement. Moreover, the impact on private spreads would also have been similar to the baseline case. However, the higher inflation during the period 2008-2012 and the lower real interest rate would have implied a lower real value of both sovereign and private-sector debt. The counterfactual interest rate is higher due to the response of monetary policy to the output gap in the US.

The dynamics of inflation and the effect on eroding the real value of debt of different agents would have contributed to a less dramatic output fall and more room for maneuver for the monetary policy, as it would have reduced the risk of hitting the zero lower bound until 2012.

Figure 6: A counterfactual crisis and recovery



Note: The light line represents actual EA data. The dark line shows the counterfactual economy simulated by imposing US fiscal and monetary policies.

7 Conclusion

This paper shows that the post-crisis recoveries in the United States and the Euro Area can be rationalized by a different combination of fiscal and monetary policies. The data suggest that, after 2007, the United States followed a fiscal dominance regime, whereas the Euro Area implemented a monetary dominance regime. We present a stylized model to understand whether the differences in dynamics after the financial crisis can be accounted for by the monetary and fiscal policy mix and to isolate the main transmission channels.

We find that dynamics and transmission channels following technology and financial shocks are substantially different, depending on whether fiscal policy or monetary policy induces determinacy. Moreover, our model produces a stylized framework to understand why a more solid recovery could have occurred in the United States rather than in Europe, due to different policy mix.

Whether our hypothesis is true depends on how do economic agents perceive the regimes and their duration. We have focused on the crisis and post-crisis periods to tackle our question using a parsimonious model that is easily comparable with the existing literature, with the caveat that we assume that economies will be forever in the same regime. A better approach would be to consider a Markov switching model in the policy rules, as in Bianchi (2012), Bianchi and Ilut (2013) or Davig and Leeper (2011), in which agents anticipate the switches between regimes. However, the complexity of such a setup would divert attention from the key dynamics implied by financial frictions and policy mix interaction, so we leave it for future work.

While we considered only lump-sum taxes, the presence of distortionary taxes would amplify the divergencies across regimes. The relative stability of tax revenue in the Euro Area in the last decade was achieved by increasing tax rates that have distorted the economy, further amplifying the recession. This effect would have been mitigated under fiscal dominance, in which higher inflation and a lower real interest rate would have contributed to financing government debt.

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COMPANION APPENDIX

Made in Europe: monetary–fiscal policy mix with financial frictions

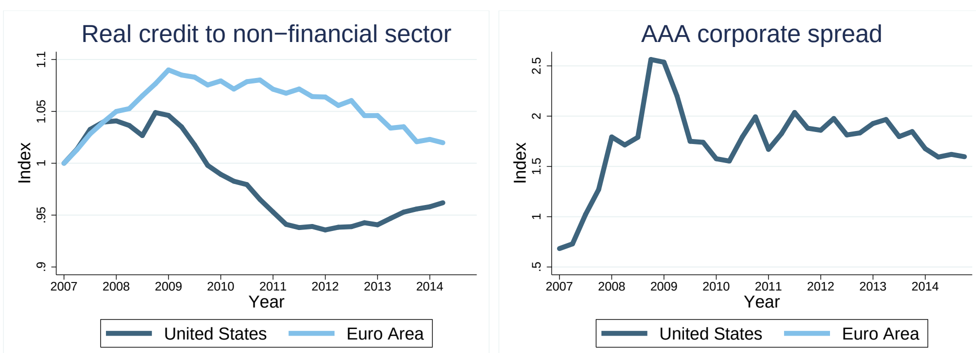
Pedro Gomes and Hernán D. Seoane

Appendix A: Data

Table A1: Variables and sources

Variable	Area	Description	Source
Interest rate	US	Effective Federal Funds Rate	FRED
	EA	Discount Rate for Euro Area	IMF
Deflator	US	Gross Domestic Product: Implicit Price Deflator	FRED
	EA	Price index (implicit deflator) GDP	Eurostat
GDP	US	Real Gross Domestic Product	FRED
	EA	Gross domestic product (chain linked volume)	Eurostat
M1	US	M1 Money Stock	FRED
	EA	M1 for Euro Area	IMF
Gov. debt	US	Federal Debt: Total Public Debt	FRED
	EA	Quarterly government debt General government)	Eurostat
Gov. consumption	US	Real Government Consumption Expenditures and Gross Investment	FRED
	EA	Final consumption expenditure of general government (Chain linked volumes)	Eurostat
Gov. receipts	US	Federal government total receipts	FRED
	EA	Total general government revenue	Eurostat
Credit	US	Total Credit to Private Non-Financial Sector, Adjusted For Breaks, for United States	BIS
	EA	Credit to Private Non-Financial Sector, Adjusted For Breaks, for Euro area	BIS
Spread	US	Moody's Seasoned Aaa Corporate Bond Yield Relative to Yield on 10-Year Treasury Constant Maturity	FRED
	EA		

Figure A1: The anatomy of the recession, additional variables



Note: Data is taken from FRED dataset, IMF and Eurostat.

Appendix B: Optimality conditions

FOC households

$$\frac{\exp(\nu_t)}{c_t - hc_{t-1}} - \mathbb{E}\beta \frac{h\exp(\nu_{t+1})}{c_{t+1} - hc_t} = \lambda_t$$
$$\lambda_t = \beta\mathbb{E}_t\left\{\lambda_{t+1}\frac{R_t}{\Pi_{t+1}}\right\}$$
$$\lambda_t = \beta\mathbb{E}_t\left\{\lambda_{t+1}\frac{R_t^d}{\Pi_{t+1}}\right\}$$
$$\psi l_t^{\varrho} = w_t\lambda_t$$

FOC intermediate good prod

$$k_{t-1} = \frac{\alpha}{1-\alpha}\frac{w_t}{r_t}l_t$$
$$mc_t = \left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha} w_t^{1-\alpha}r_t^{\alpha}$$

Price setting IGP

$$\max_{p_{it}} \mathbb{E}_t \sum_{\tau=0}^{\infty}(\beta\theta)^{\tau}\frac{\lambda_{t+\tau}}{\lambda_t}\left\{\left(\prod_{s=1}^{\tau}\frac{\Pi_{t+s-1}^{\chi}}{\Pi_{t+s}}\frac{p_{it}}{p_t} - mc_{t+\tau}\right)y_{it+\tau}\right\}$$

subject to

$$y_{it+\tau} = \left(\prod_{s=1}^{\tau}\frac{\Pi_{t+s-1}^{\chi}}{\Pi_{t+s}}\frac{p_{it}}{p_t}\right)^{-\epsilon} y_{t+\tau}$$

FOC Price setting IGP

$$\epsilon f_t^1 = (1-\epsilon)f_t^2$$
$$f_t^1 = \lambda_t mc_t y_t + \beta\theta\mathbb{E}_t\left(\frac{\pi_t^{\chi}}{\pi_{t+1}}\right)^{-\epsilon} f_{t+1}^1$$
$$f_t^2 = \lambda_t \pi_t^* y_t + \beta\theta\mathbb{E}_t\left(\frac{\pi_t^{\chi}}{\pi_{t+1}}\right)^{1-\epsilon}\frac{\pi_t^*}{\pi_{t+1}^*} f_{t+1}^2$$

Price dynamics

$$1 = \theta\left(\frac{\pi_{t-1}^{\chi}}{\pi_t}\right)^{1-\epsilon} + (1-\theta)\left(\pi_t^*\right)^{1-\epsilon}$$

FOC Capital good producers

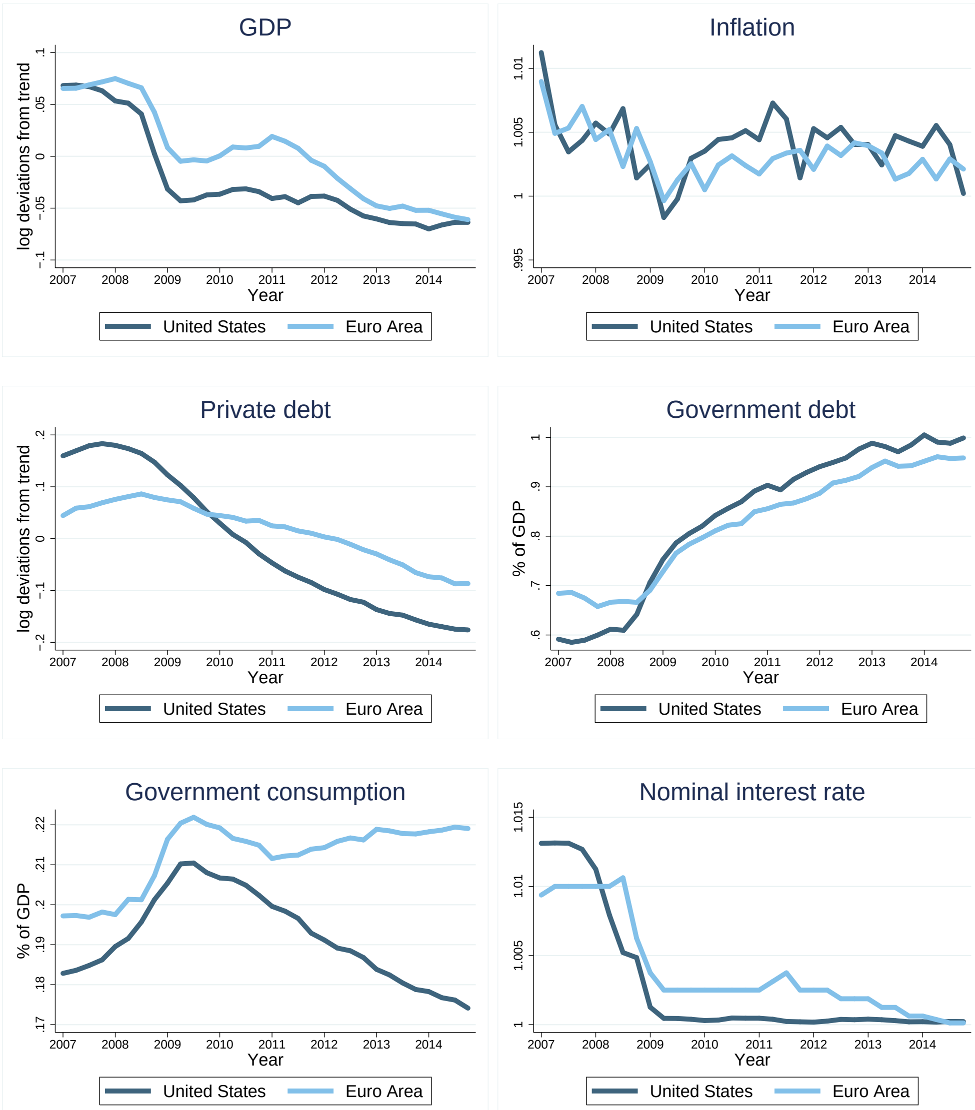
$$q_t\left(1 - S\left[\frac{i_t}{i_{t-1}}\right] - S'\left[\frac{i_t}{i_{t-1}}\right]\frac{i_t}{i_{t-1}}\right) + \beta\mathbb{E}_t\frac{\lambda_{t+1}}{\lambda_t}q_{t+1}S'\left[\frac{i_{t+1}}{i_t}\right]\left(\frac{i_{t+1}}{i_t}\right)^2 = 1$$
$$k_t = k_{t-1} + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right)i_t$$

FOC entrepreneurs

$$\mathbb{E}_t\frac{R_{t+1}^k}{s_t R_t}\left(1 - \Gamma_t(\bar{\omega}_{t+1})\right) = \mathbb{E}_t\eta_t(\bar{\omega}_{t+1})\frac{n_t}{q_t k_t}$$
$$n_t = \gamma_t^e\frac{1}{\pi_t}\left[(1 - \mu G_{t-1}(\bar{\omega}_t))R_t^k q_{t-1}k_{t-1} - s_{t-1}R_{t-1}\frac{B_{t-1}}{P_{t-1}}\right] + w^e$$

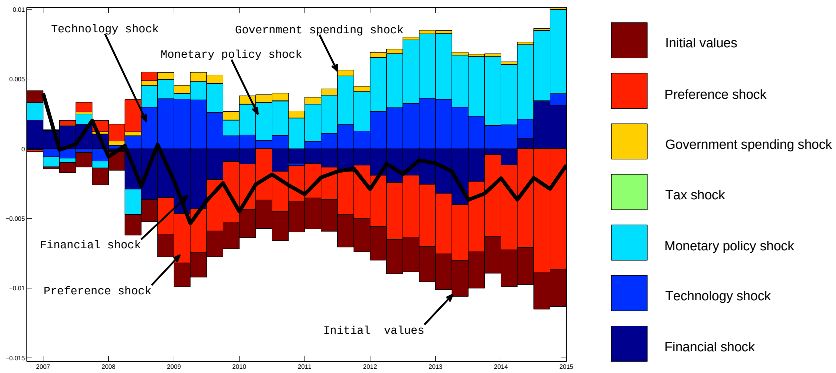
Appendix C: Further estimation results

Figure A2: Observable variables used in estimation

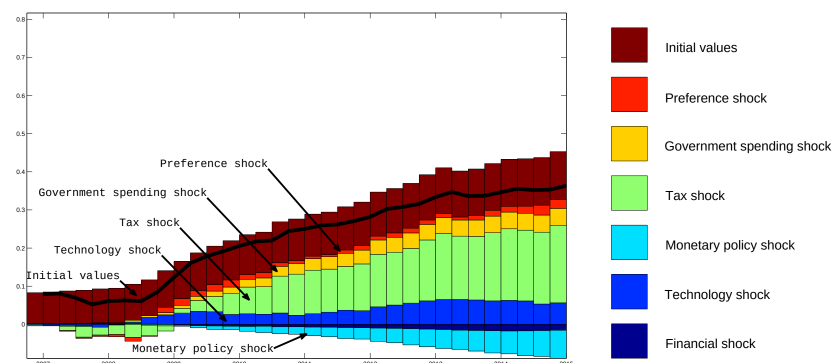


Note: GDP and private debt is the log deviation from their 1990-2015 linear trend. Government spending and debt is given in fraction of GDP. Inflation rate is the ratio of GDP deflator relative to the previous quarter.

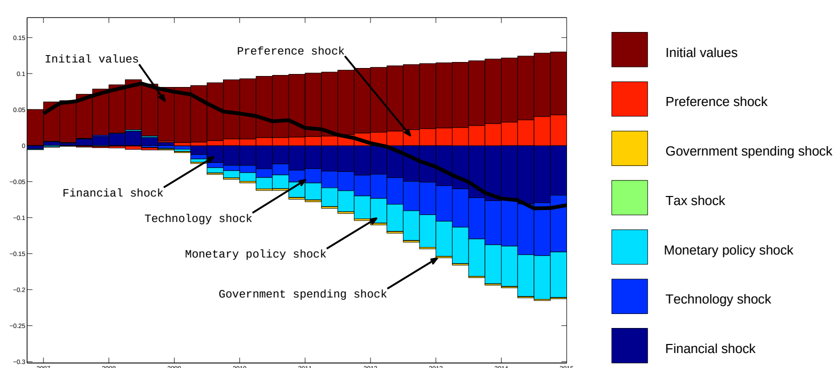
Figure A3: Historical variance decomposition - Other variables - Euro Area



(a) Inflation

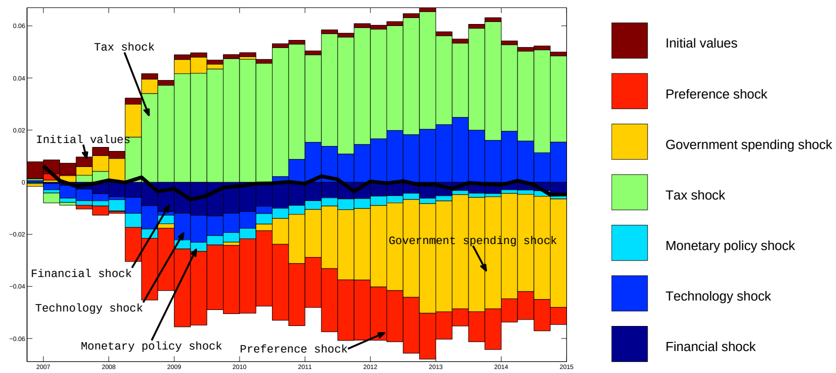


(b) Government debt

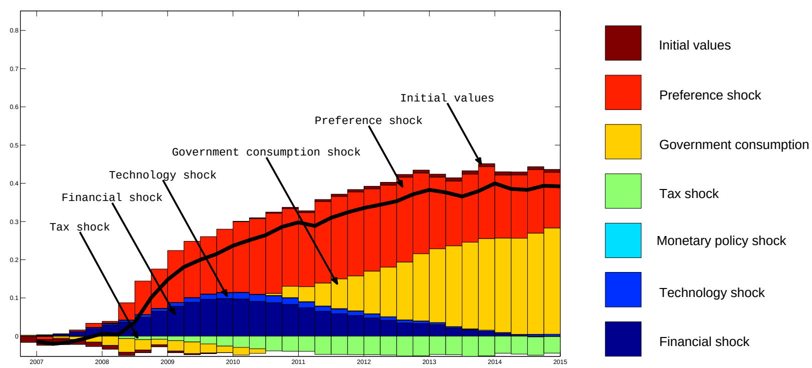


(c) Private debt

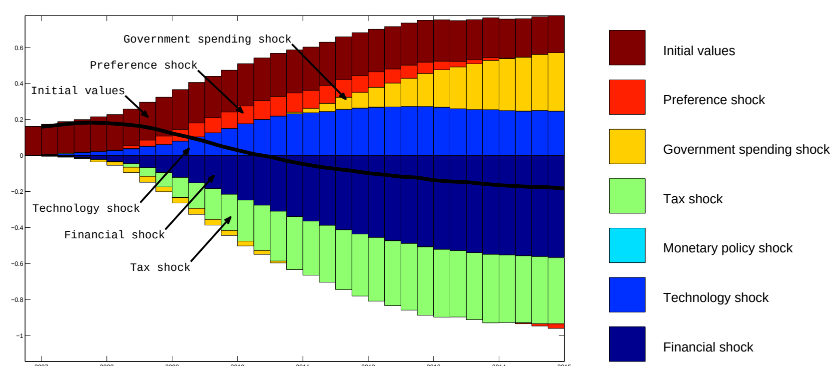
Figure A4: Historical variance decomposition - Other variables - United States



(a) Inflation



(b) Government debt



(c) Private debt

Table A2: Volatility and variance decomposition of key variables

	Output	**Inflation**	**Private debt**	**Public debt**
United States				
Volatility	0.172	0.027	0.590	0.161
Variance decomposition				
ϵ_ω	17.4	5.2	86.3	10.3
ϵ_z	15.1	10.9	8.2	26.1
ϵ_ν	55.7	29.5	1.8	42.9
ϵ_r	0.0	1.9	0.0	0
ϵ_τ	7.2	35.0	2.4	4.9
ϵ_g	4.6	17.5	1.3	15.8
Euro Area				
Volatility	0.065	0.005	0.111	1.395
Variance decomposition				
ϵ_ω	0.8	16.0	4.1	0.0
ϵ_z	90.3	36.1	88.2	1.5
ϵ_ν	7.3	31.8	4.1	0.3
ϵ_r	1.3	15.7	3.6	0.8
ϵ_τ	0.0	0.0	0.0	90.7
ϵ_g	0.3	0.4	0.0	6.8

Note: Simulations under baseline calibration. Volatility and the variance explained by each of the shocks are noted in percentages.

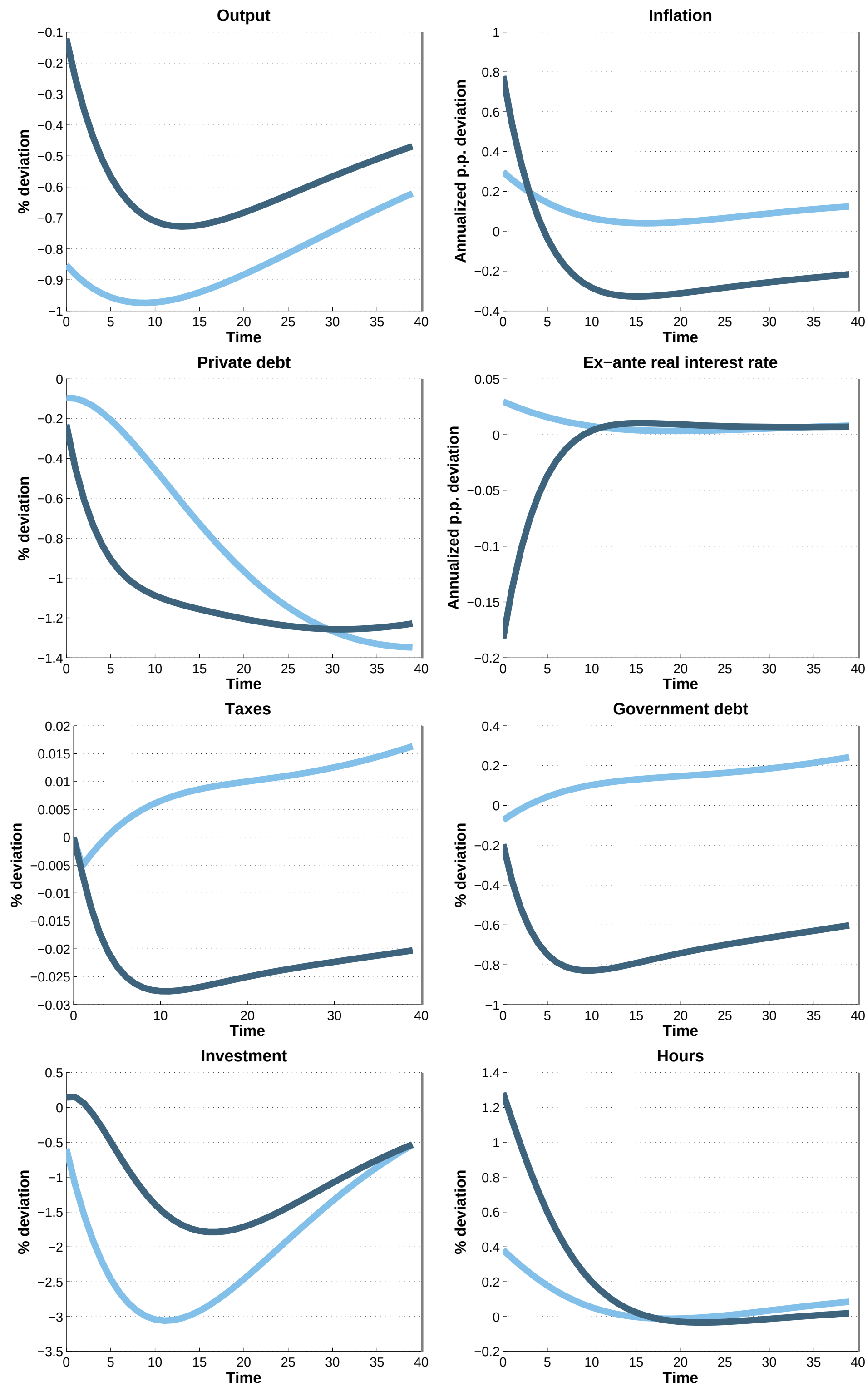
Table A3: Volatility and variance decomposition of output and inflation under different combination of frictions

	Financial frictions $\mu = 0.12$		*No financial frictions* $\mu = 0$	
	Euro Area	**United States**	**Euro Area**	**United States**
Panel A - Output				
Nominal rigidities $\theta = 0.8$				
Volatility	0.0652	0.1724	0.0733	0.1587
Variance decomposition				
ϵ_ω	0.8	17.4	0.0	0.0
ϵ_z	90.3	15.1	94.3	30.8
ϵ_ν	7.3	55.7	4.7	59.6
ϵ_r	1.3	0.0	0.8	0.0
ϵ_τ	0.0	7.2	0.0	5.9
ϵ_g	0.3	4.6	0.2	3.7
No nominal rigidities $\theta = 0.0$				
Volatility	0.0657	0.1798	0.0725	0.1722
Variance decomposition				
ϵ_ω	7.4	17.7	0.0	0.0
ϵ_z	84.9	23.3	95.5	40.9
ϵ_ν	7.3	57.7	13.5	59.1
ϵ_r	0.1	0.0	0.0	0.0
ϵ_τ	0.0	0.6	0.0	0.0
ϵ_g	0.3	0.7	0.2	0.1
Panel B - Inflation				
Nominal rigidities $\theta = 0.8$				
Volatility	0.0053	0.0265	0.0043	0.0254
Variance decomposition				
ϵ_ω	16.0	5.2	0.0	0.0
ϵ_z	36.1	10.9	45.4	15.8
ϵ_ν	31.8	29.5	34.5	29.6
ϵ_r	15.7	1.9	19.7	2.0
ϵ_τ	0	35.0	0.0	35.2
ϵ_g	0.4	17.5	0.4	17.4
No nominal rigidities $\theta = 0.0$				
Volatility	0.0158	0.0546	0.0082	0.055
Variance decomposition				
ϵ_ω	73.2	2.8	0.0	0.0
ϵ_z	5.9	22.3	21.3	23.8
ϵ_ν	4.1	10.5	13.5	10.2
ϵ_r	16.9	0.5	65.0	0.5
ϵ_τ	0.0	43.2	0.0	44.4
ϵ_g	0.0	20.6	0.1	21.1

Note: Simulations under baseline calibration. Volatility and the variance explained by each of the shocks are noted in percentages.

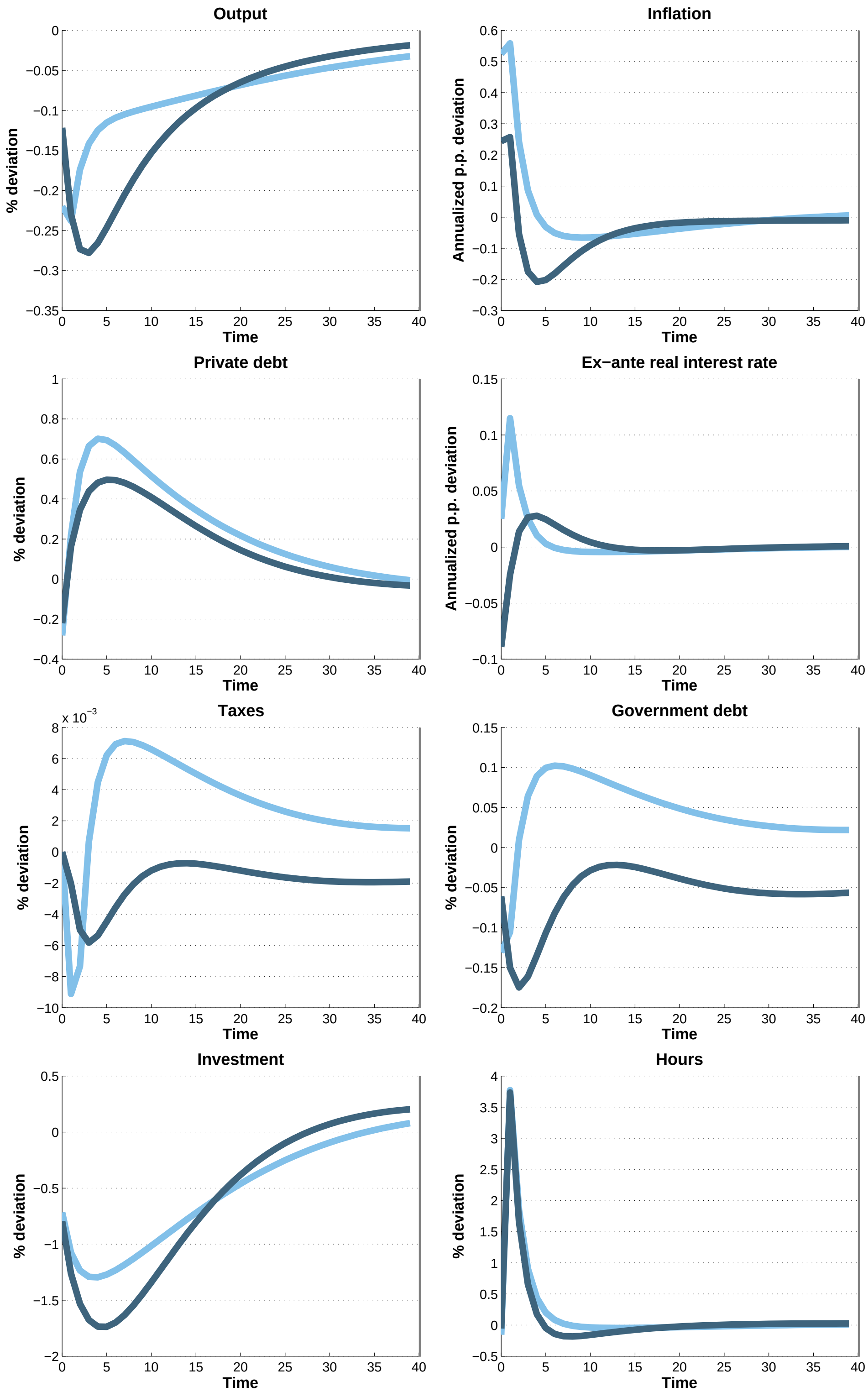
Appendix D: Additional results

Figure A5: Response to a 1 standard deviation negative technology shock



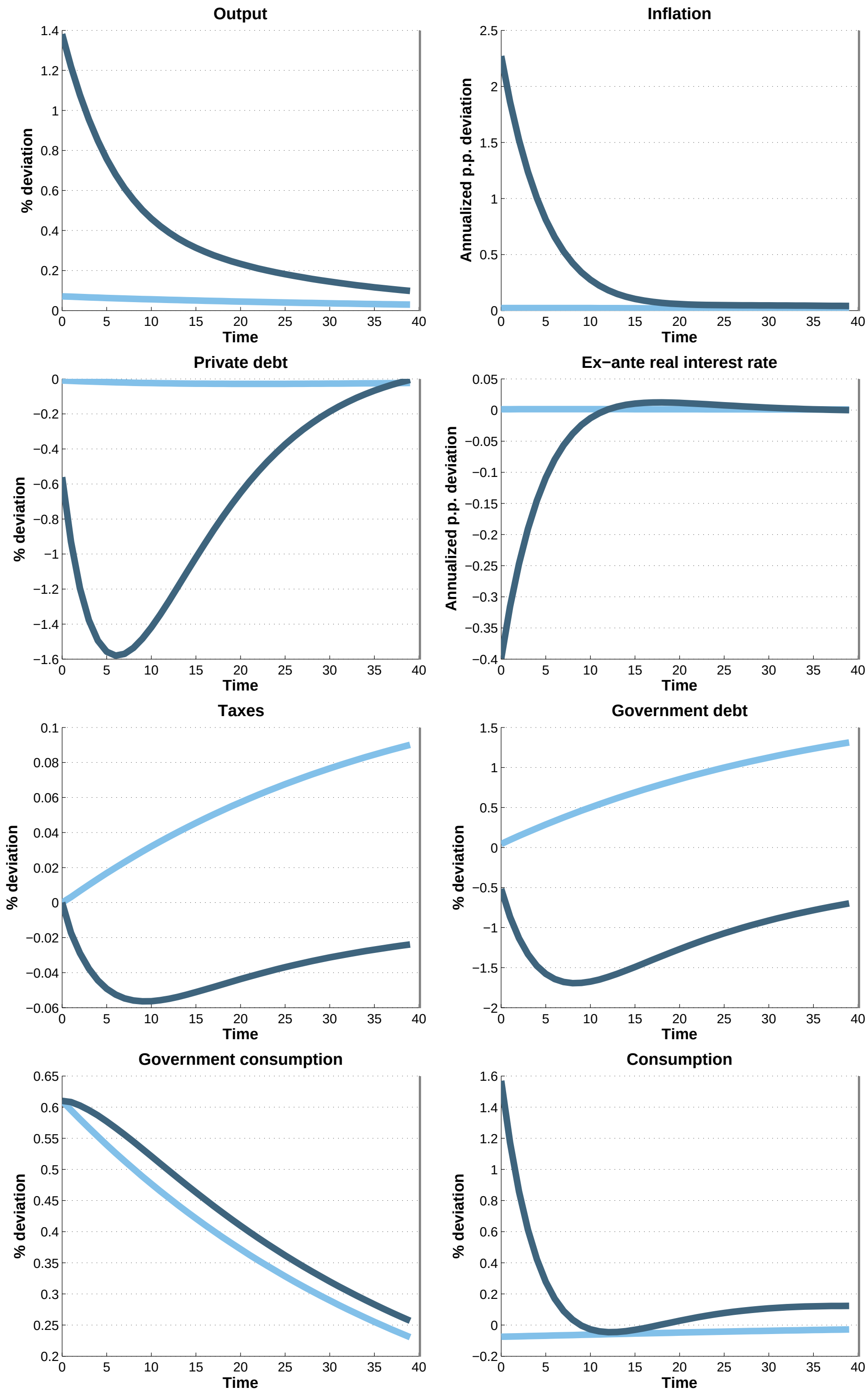
Note: The light blue line plots the responses under the EA calibration and the dark line plots the counter-factual response with US policies. The negative technology shock of 0.007 with autocorrelation 0.859.

Figure A6: Response to a 1 standard deviation shock in the dispersion of projects



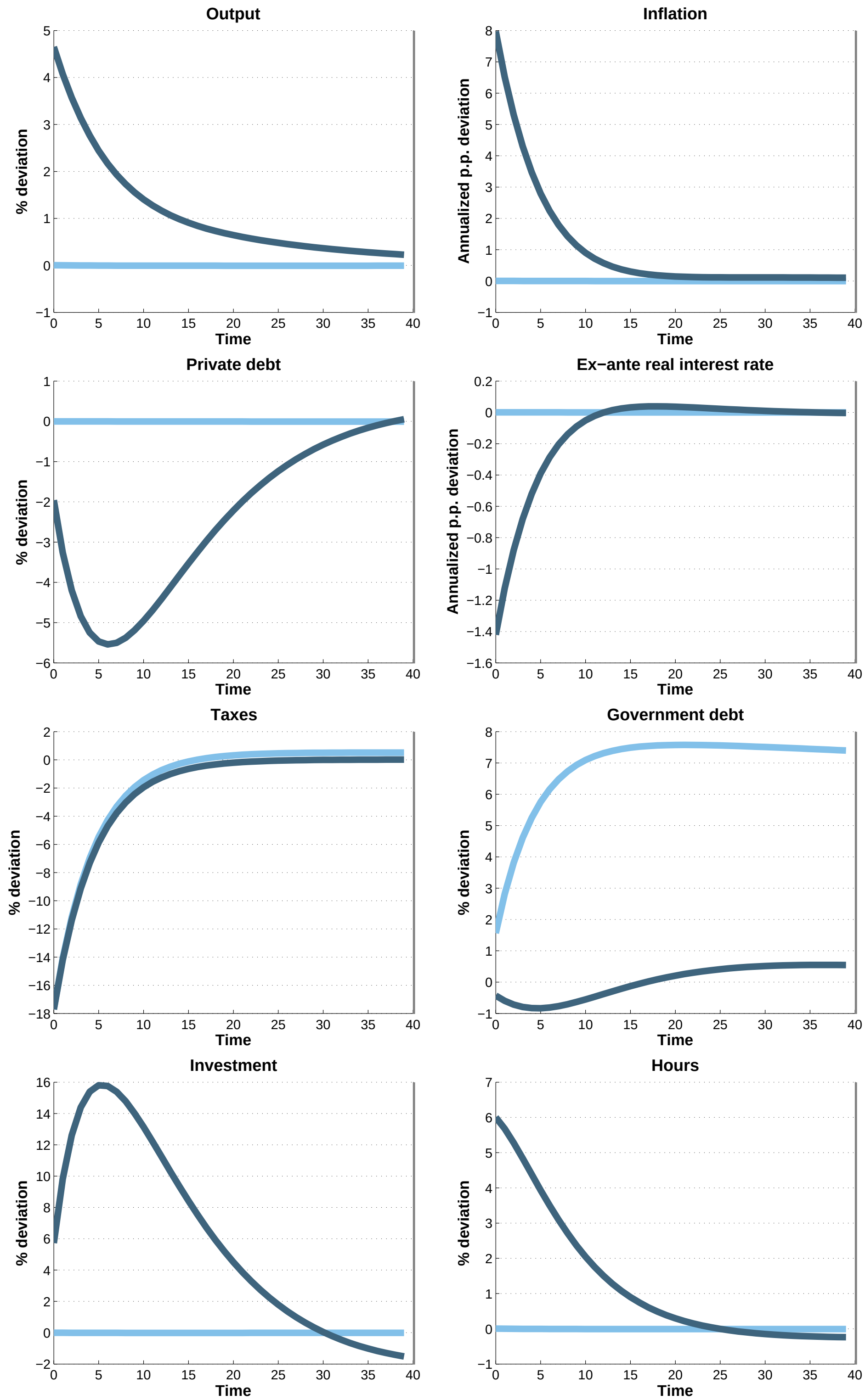
Note: The light blue line plots the responses under the EA calibration and the dark line plots the counterfactual response with US policies. The financial shock of 0.560 with autocorrelation 0.435.

Figure A7: Response to a 1 standard deviation government spending shock



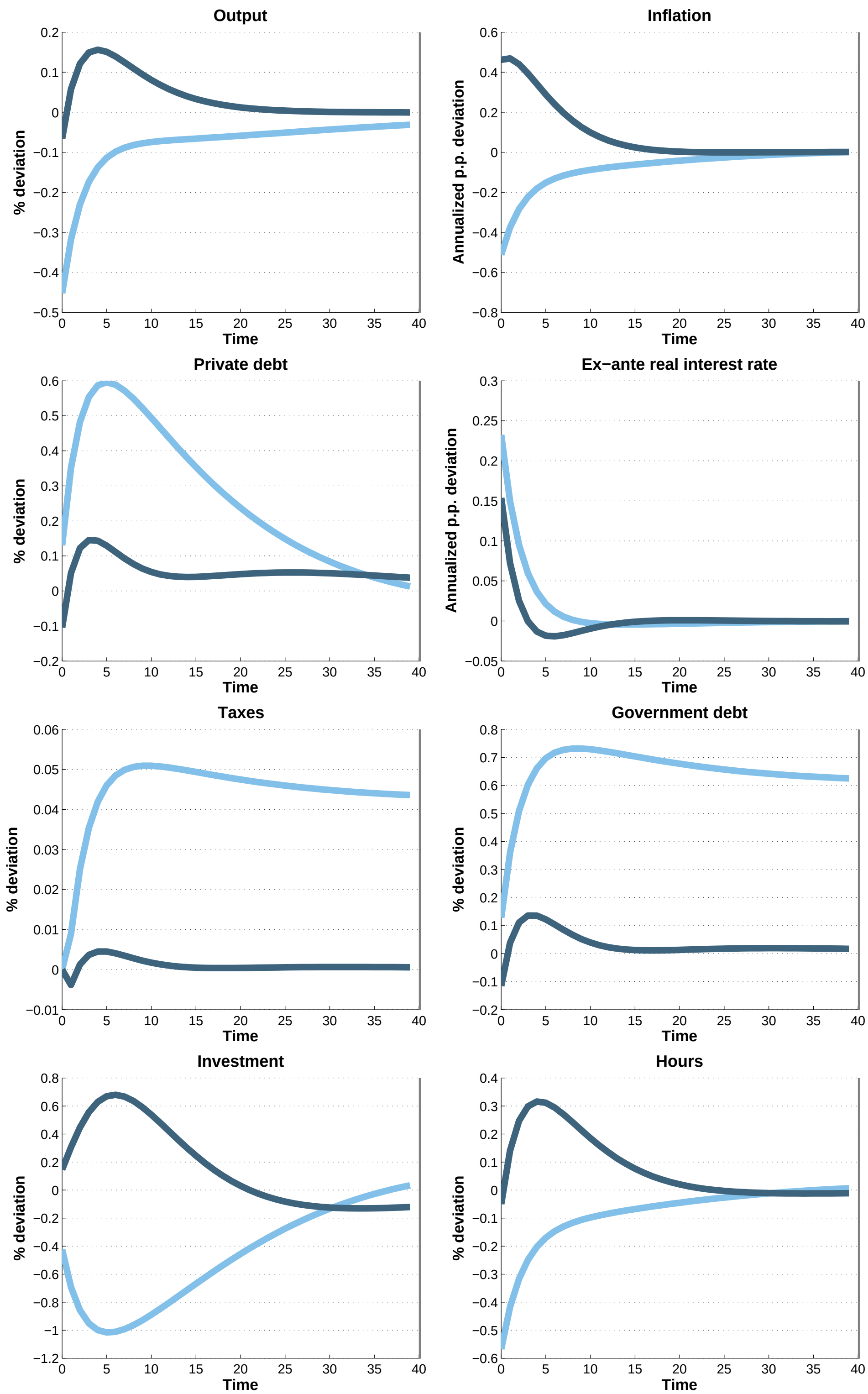
Note: The light blue line plots the responses under the EA calibration and the dark line plots the counterfactual response with US policies. The government spending shock of 0.007 with autocorrelation 0.980.

Figure A8: Response to a 1 standard deviation negative tax shock



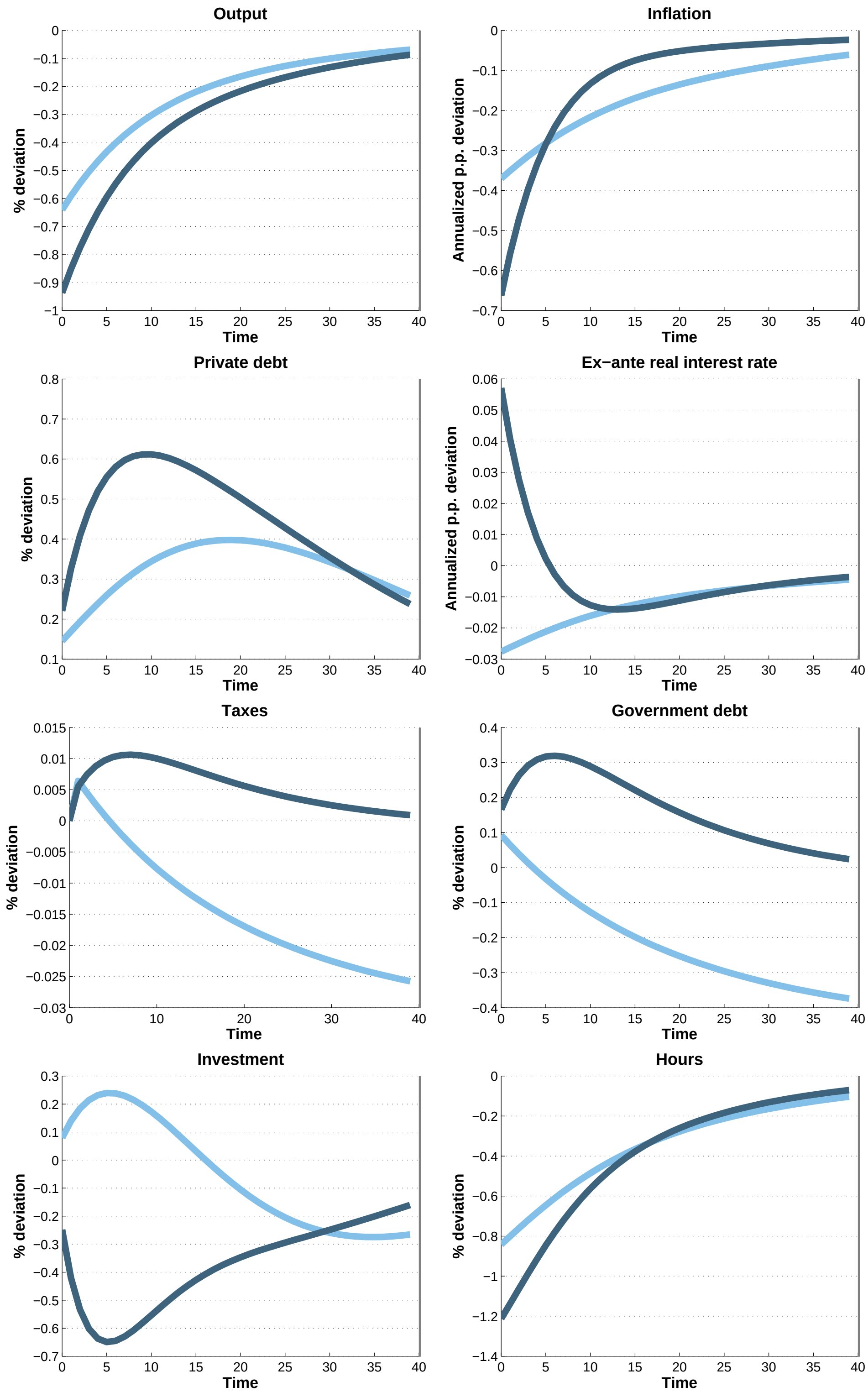
Note: The light blue line plots the responses under the EA calibration and the dark line plots the counterfactual response with US policies. The negative tax shock of 0.178 with autocorrelation 0.683.

Figure A9: Response to a 1 standard deviation positive interest rate shock



Note: The light blue line plots the responses under the EA calibration and the dark line plots the counterfactual response with US policies. The positive interest rate shock 0.003 with autocorrelation 0.665.

Figure A10: Response to a 1 standard deviation negative preference shock



Note: The light blue line plots the responses under the EA calibration and the dark line plots the counter-factual response with US policies. The negative preference shock of 0.027 with autocorrelation 0.945.

Appendix E: The zero lower bound

The results in the paper indicate that a monetary dominance regime leads to opposing dynamics compared to a fiscal dominance regime. The counterfactual analysis rise a concern though, specifically, the counterfactual scenario violates the zero lower bound of interest rates (ZLB) in the later years of the sample. This section studies to what extent the existence of a ZLB affects the implications of different fiscal–monetary policy mixes and how this challenges the main findings of this paper using a setup with occasionally binding ZLB under perfect foresight. We consider the nominal interest rate process as

$$R_t^d = \max\{R^d + \psi_\pi(\Pi_{t-1} - \bar{\Pi}) + \psi_y[\ln(y_t) - \ln(\bar{y})] + \varepsilon_t^r, 1\}.$$

That is, the government implements the same Taylor rule as the one estimated for the baseline model while $R_t^d > 1$ and when the economy hits the zero lower band, $R_t^d = 1$ regardless the evolution of inflation and output gap.

The ZLB and deflation dynamics

In this setup, we shock the economy with a negative two periods preference shock, i.e. agents value consumption less, by -0.075 per period, that makes the economy hit the zero lower bound and study the perfect foresight equilibrium. Figure A11 presents the dynamics after this shock for various endogenous variables for the EA calibration (light blue) and for the counterfactual economy where the Euro Area implements the US fiscal and monetary policy rules (dark blue).

The qualitative dynamics are similar to the baseline model. However, there is a striking difference between the two regimes. In the absence of other shocks, the economy with monetary dominance regime is more likely to be affected by the ZLB, compared to an fiscal dominance regime. When households reduce their demand for consumption, firms that cannot adjust prices reduce hours and production, while other firms lower prices putting a downward pressure on inflation. Under the fiscal dominance regime, the nominal interest rate falls, essentially responding to the fall of output gap. Under the monetary dominance, the nominal rate falls in response to the fall of inflation. Comparing the two, we can see that the monetary dominance leads to a larger response of the nominal interest rate which hits the ZLB for 2 periods. This allows a mild increase of investment and avoids a larger fall in output and a bigger deflation.

The deflation unravel a new set of effects. In particular, the deflation increases the real cost of debt issuance, which is more dramatic for the fiscal dominance regime and is reflected in the higher response of spread and the larger output drop. Here, the drop in inflation makes harder to repay the debt of entrepreneurs which worsens the dynamics during the crisis, rising spreads, dragging investment, and inducing a more dramatic crisis.

Summing up, the results of the preference shock under ZLB suggests that the two regimes might lead to different type of macroeconomic problems: on the one hand, fiscal dominance reduces the likelihood of hitting the ZLB; on the other hand, it might drive the economy into a larger deflationary dynamics as compared with the monetary dominance regime.

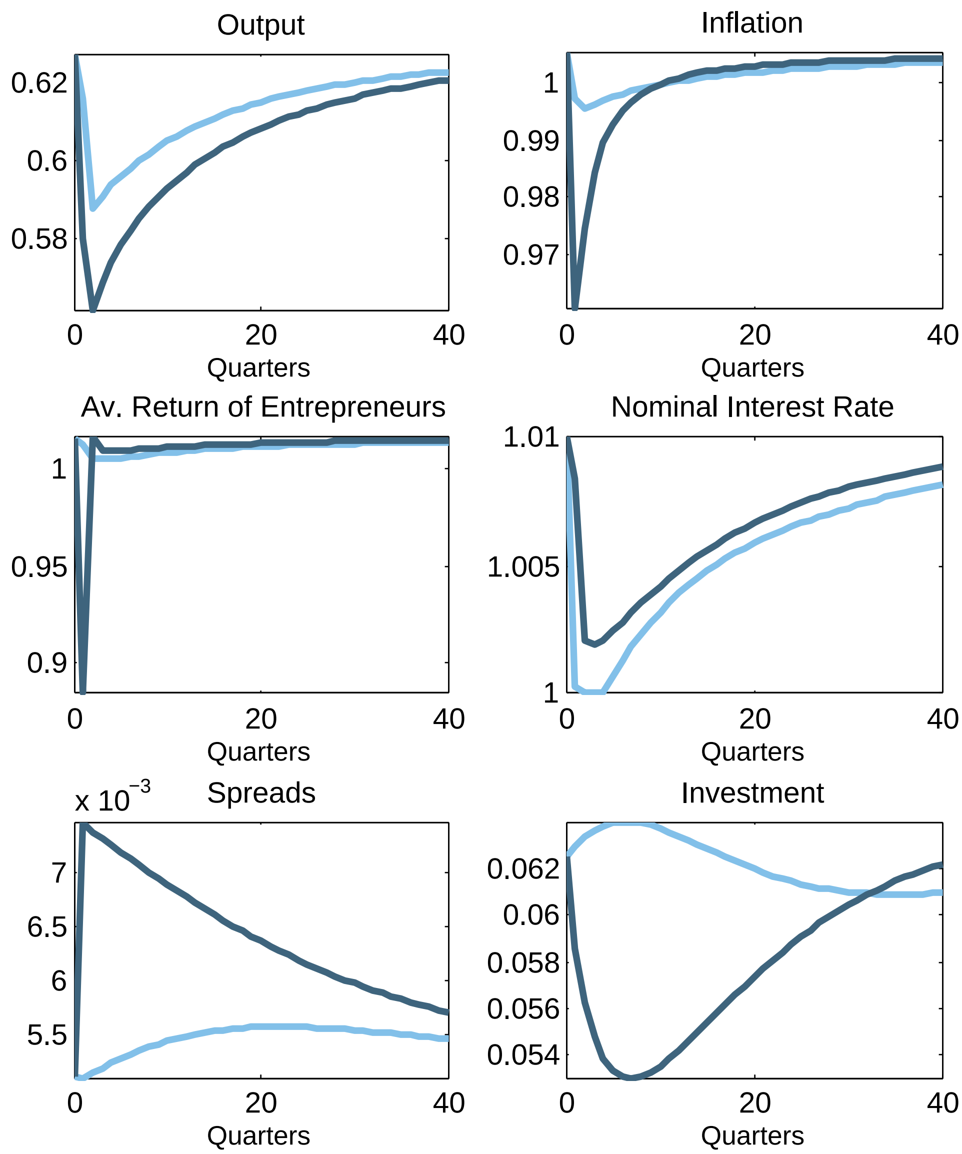
Dissecting the model with the ZLB

Figure A12 compares the dynamics of output and the nominal interest rate after three types of shocks: a negative technology or financial shock, or a positive government spending shock. We focus on these shocks because they are the key ones analyzed in previous sections.

There are two main findings from the figure. First, the same shock is likely to induce a different qualitative response of the nominal interest rate under different policy arrangements, given that in the EA rules the interest rate mainly respond to inflation while in the US rules it mainly responds to output gap. This is true for the technology and financial shock. Consequently, shocks are likely to induce a hit of the ZLB are heterogeneous across regimes. A government spending shock, moves the nominal interest rate in the same direction in both regimes, but a positive shock to government spending moves it away from the ZLB much more under fiscal dominance.

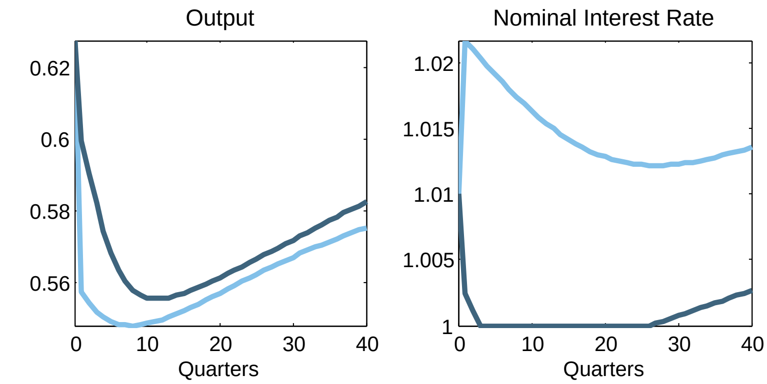
Second, the qualitative response of output to each shock under each policy arrangement is the same to the one in our baseline model. Perhaps the biggest difference occurs in the technology shock. Under fiscal dominance, the ZLB is hit for more than 20 quarters. This inability to further reduce the interest rate, makes the recession worse when compared to the case where the nominal interest rate is able to adjust. Still the fall of output is smaller than under monetary dominance.

Figure A11: Preference shock under ZLB

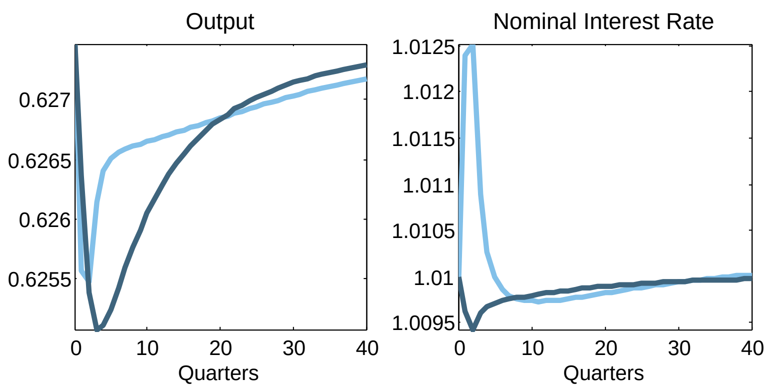


Note: The light blue line plots the responses under the EA calibration and the dark line plots the response with US policies.

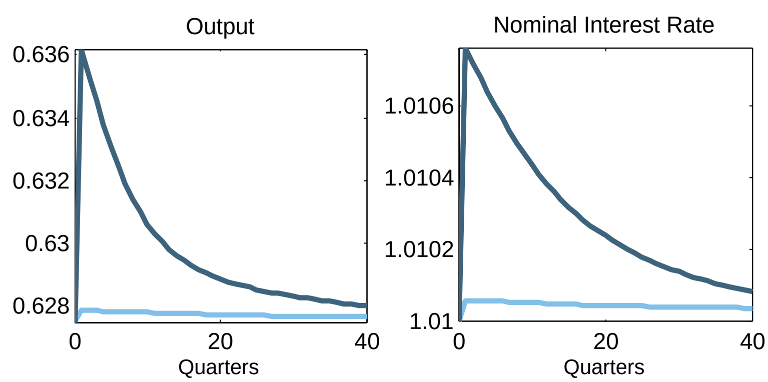
Figure A12: Shocks in a ZLB model



(a) TFP shock



(b) Financial shock



(c) Government consumption shock

Note: The light blue line plots the responses under the EA calibration and the dark line plots the response with US policies. The technology shock takes the value -0.15 for 1 period. The financial shock takes the value 0.5 for 1 period. The government spending shock takes the value 0.005 for 1 periods.