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Abstract

This paper examines the effectiveness of public spending in different phases of the business cycle through a state-dependent macroeconomic model. We estimate a two-agent New-Keynesian (TANK) model with sticky wages in a Markov-switching framework for the U.S. economy (1960–2013). The model extends Galı, López-Salido, and Vallés 2007 by incorporating wage rigidity as in Colciago 2011. Our findings indicate that the share of hand-to-mouth agents (λ) plays a crucial role in determining fiscal multipliers, with higher λ values associated with recessions and stronger public spending effects. While monetary policy regime shifts influence outcomes, λ remains the key driver of multiplier heterogeneity. Our results suggest that temporary fiscal interventions during downturns yield the highest impact, reconciling elements of both neoclassical and New-Keynesian perspectives. These insights have important policy implications for the design of countercyclical fiscal policies.

Keywords: Fiscal multipliers, New-Keynesian model, Markov-Switching estimation, Hand-to-mouth consumers, Sticky wages.
JEL Classification: E32, E62, E12, C32, E52.

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1 Introduction

In recent years, the debate about the effectiveness of fiscal policy, and in particular of public spending as a tool for stabilizing the economy, has been given new life. The hitting of the Zero Lower Bound on the nominal interest rates forced the fiscal authorities to take substantial measures to trigger a recovery, both during the financial crisis of 2007-2008, and to an even greater extent following the outbreak of the global pandemic. In this context, a relevant question concerns the effectiveness of public expenditure in stimulating the economy during the various business cycle phases. Authors including Auerbach and Gorodnichenko 2012, Alloza 2017, Ramey and Zubairy 2018 have given different answers to that question. For the former, the consumption response following a government spending shock is countercyclical, i.e. positive during contractions and negative under expansionary states, for Alloza they are procyclical. Conversely, Ramey and Zubairy 2018 find no significant differences between the two phases of the business cycle. Another fundamental issue concerns the theoretical causes that justify and determine one outcome or another. While the neo-classical view prescribes a negative consumption response, the new-Keynesian framework sometimes involves positive consumption responses. In this contribution, we want to estimate the impact of public spending on the economy in a state-dependent macroeconomic model. In particular, a new-Keynesian model with two agents and sticky wages is re-proposed and estimated in Markov-Switching form. This model complements the two-agent framework proposed by Galı, López-Salido, and Vallés 2007 incorporating sticky wages as in Colciago 2011. In their model, alongside optimizing Ricardian agents, hand-to-mouth agents are introduced. The latter consume their entire disposable income in each period, thereby establishing a direct link between consumption and income. This approach aligns with the concept of excess sensitivity of consumption to income, following the tradition of Campbell and Mankiw 1989. The methodology for estimating the Markow-Switching model is borrowed from Farmer, Waggoner, and Zha 2009.

The purpose of this study is both empirical and theoretical. It is empirical in that we aim to contribute to the existing evidence on government spending multipliers and the response of private consumption to public expenditure. Our initial hypothesis is that the ambiguity present in the literature on this topic may at least in part be resolved through a state-dependent analysis. At the same time, this study is also theoretical, as we seek to provide an economic interpretation of the deep causes that determine that outcome.

To achieve this goal, we will estimate the TANK model with sticky wages for the U.S. economy over the period 1960–2013 entailing a Markov-switching model. The key parameters that make regime-dependent are, in order: λ, the share of hand-to-mouth agents that populate the economy; the Taylor rule coefficients of monetary policy; the standard deviation of the shocks. The three Markov chains associated with three sets of coefficients are assumed to be independent. This approach ensures flexibility in the estimation process, allowing us to identify—if present—the main reasons behind potential heterogeneity in fiscal multipliers.

Starting with the latter, the Markov-switching estimation of shock variance revealed the presence of two distinct regimes: one characterized by high volatility and the other by low volatility. These two are sharply delineated, with a significant decline in shock volatility beginning in the second half of the 1980s, followed by an increase during the 2007–2008 financial crisis.

Regarding λ, the share of hand-to-mouth agents, the results showed the presence of two regimes. In Regime 1, λ takes a value of 0.1, while in Regime 2, the value rises to 0.31. High λ appears to be associated with recessionary business cycle phases, such as the 1979–1981 oil crisis, the burst of the dot-com bubble in 2001, and the 2007–2008 financial crisis.

The percentage of agents who consume their entire available income in each period plays a

crucial role in determining the magnitude of the "Keynesian multiplier" and, consequently, the impact of public spending. Moreover, the presence of hand-to-mouth agents also affects the labour market and the wage bargaining mechanism. An increase in λ entails a variation in the relative bargaining power of different working classes, with consequent modification in the elasticity of the real wages to the other macroeconomic variables.

Finally, the third set of parameters pertains to monetary policy. Specifically, the coefficient linking the policy rate to inflation, income, and the autoregressive coefficient of monetary policy. More than monetary policy and variations in the parameters of the Taylor rule, the factor that most influences the size of fiscal multipliers accross the business cycle is λ. When it approaches its maximum value of 0.31, corresponding to periods of economic downturn, the impact of public spending on income is higher, with an increase ranging between 25% and 35%, compared to a case where it is low and equals 0.1. However, if the fiscal shock is persistent, the response of private consumption is never positive; thus, the effect observed is solely related to the degree of crowding out of private consumption. If the shock is temporary, private consumption increases following a public spending shock, pushing the multiplier above the unit threshold. This occurs regardless of the monetary policy regime in place. The key channel for understanding fiscal multipliers appears to be related to agents' heterogeneity and the magnitude of the Keynesian multiplier.

In the debate between neoclassical and new Keynesian economists, we position ourselves in the middle. The response depends on the phase of the business cycle: if we are in an expansion, the neo.classical view is more appropriate. Conversely, in a recession, the new Keynesian perspective may be valid, provided that the fiscal shock is not persistent. This latter point offers an important policy implication: income stabilization policies during recessions are more likely to succeed in stimulating the economy if they are temporary, that is, limited in duration.

The paper is structured as follows: chapter 2 reports some of the main contributions on the subject of fiscal multipliers, chapter 3 reports the model, chapter 4 discusses the estimation strategy of the DSGE model and presents the results of the Markov-Switching estimation of the model, Chapter 5 concludes.

2 Related Literature

The subject of government spending multipliers is a profoundly intricate issue, extensively explored in the macroeconomic literature yet still commanding attention in leading economic journals. This enduring relevance is no coincidence. Despite the vast body of research on the topic, no definitive consensus has been reached regarding the economy's response to fiscal stimuli—particularly, its reaction to an increase in government expenditure. The two primary variables under scrutiny are national income and private consumption. The former serves as the overarching measure of the aggregate impact of fiscal policy on the economy, while the latter is at the heart of the intellectual debate between competing schools of thought. Abstracting from other potential variables—such as employment, unemployment, stock prices, and other macroeconomic indicators investigated in related studies—this analysis will focus on these two key dimensions: GDP and consumption.

The existing literature can be categorized into three closely interconnected strands, each of direct relevance to this study. The first comprises the general body of research on fiscal multipliers, encompassing both theoretical and empirical perspectives, which seeks to determine whether private consumption responds positively or negatively to government spending and, consequently, whether the fiscal multiplier exceeds or falls short of unity. The second strand advances the notion that the effectiveness of fiscal policy is contingent upon external conditions, such as the exchange

rate regime, public debt levels, and monetary constraints—including the zero lower bound on the nominal policy interest rate. The third, and closely related, line of inquiry explores how the magnitude of fiscal multipliers varies across different phases of the business cycle, distinguishing between expansionary and recessionary periods.

In the course of this study, I will propose a novel resolution to the fiscal multiplier puzzle, engaging with all three strands of literature and offering a perspective that aims to contribute meaningfully to each of these intellectual debates.

From the late 1990s to the early 2000s, the macroeconomic debate was shaped by a fierce intellectual clash between two opposing schools of thought—Neoclassicals and New Keynesians—over the effects of government spending on the economy. This debate, initially empirical and later reinforced by theoretical contributions, revolved around the response of private consumption. Neoclassical economists provided evidence of a negative impact on consumption, implying a fiscal multiplier below one, whereas certain New Keynesian studies found the opposite result.

A pivotal contribution to this debate came from Ramey and Shapiro 1998, who applied a narrative approach to identify exogenous government spending shocks using major U.S. military events. Their findings showed a decline in private consumption, investment, and real wages, with a GDP multiplier below one. Edelberg, Eichenbaum, and Fisher 1999 reached similar conclusions, reinforcing the notion that fiscal expansions could crowd out private demand. However, these results, consistent with Real Business Cycle models, stood in sharp contrast to Keynesian predictions.

New Keynesian economists responded by refining theoretical models, incorporating price and wage rigidities, monopolistic competition, and labor market frictions. Ravn, Schmitt-Grohé, and Uribe 2006 demonstrated that these mechanisms could positively affect government spending on real wages by reducing firms' markups and stimulating labor demand. Rotemberg and Woodford 1992 reached similar conclusions by modeling oligopolistic pricing behavior.

Empirical work also challenged the Neoclassical perspective. Blanchard and Perotti 2002, using a Structural Vector Autoregression (SVAR) model, found that government spending increased both output and private consumption, yielding a multiplier greater than one. This stood in direct contrast to Ramey and Shapiro 1998 and underscored the importance of identification strategies. While Ramey's approach assumed exogeneity based on historical events, Blanchard's methodology accounted for decision lags—the delay between economic shocks and policy responses. Later research, such as Forni, Giannone, et al. 2009, highlighted an additional challenge: the time required to implement fiscal measures after their approval, which may affect empirical estimates.

The empirical debate previously discussed has a theoretical counterpart that predates 1998. The foundational theoretical contribution in modern macroeconomics on this matter can be attributed to Baxter and King 1993. Their model, one of the earliest Dynamic Stochastic General Equilibrium (DSGE) frameworks within the Real Business Cycle (RBC) tradition, stands out for its ability to differentiate the effects of government spending based on its nature. Public investment, by enhancing productivity, generates a positive impact on private consumption, whereas public consumption spending has the opposite effect.

At its core, the economic—more precisely, microeconomic—mechanism underlying the crowding out of private consumption is rooted in the optimizing behavior of agents under Ricardian equivalence: a temporary increase in public consumption must eventually be offset by higher future taxation. This mechanism, in the New Keynesian paradigm, is complemented (or even replaced) by the role of monetary policy. In response to the inflationary pressures induced by government spending, monetary authorities raise real interest rates, thereby suppressing consumption among Ricardian agents and triggering the crowding out of private demand. In one form or another, Ricardian equivalence remains the fundamental force driving this outcome in theoretical models.

On the New Keynesian front, a crucial theoretical contribution emerges to support the empirical findings of Blanchard and Perotti 2002. Here, an important clarification is warranted: the debate on fiscal multipliers is, in reality, a manifestation of a deeper and longstanding discussion concerning the relationship between consumption and income, as well as the characteristics of the representative agent. The assumption of an optimizing, rational, and affluent agent was challenged in the early 1980s by the excess sensitivity hypothesis proposed by Campbell and Mankiw 1989. Their work suggested that the intertemporal IS curve, which links consumption to the real interest rate, explains only a limited fraction of the data, whereas consumption appears to be strongly dependent on current income—rather than permanent income—aligning with a fully Keynesian perspective.

This fundamental debate has been carried forward into modern dynamic macroeconomics. Excess sensitivity was reintroduced in a New Keynesian setting by Galı, López-Salido, and Vallés 2007, who incorporated alongside the Ricardian agent a hand-to-mouth agent—one who does not optimize intertemporally but instead consumes their entire disposable income each period. This modification successfully replicated, in a theoretical framework, the increase in private consumption following a rise in public consumption that had been empirically documented by Blanchard and Perotti 2002.

The general debate on fiscal multipliers extends beyond the papers cited, which nonetheless serve as strong representatives of the broader perspectives. Over time, it has become evident that the economy's response to public spending is contingent on various factors, including the exchange rate regime, monetary policy constraints, and the level of public debt. This brings us to the realm of *state-dependent* fiscal multipliers.

One of the most widely studied contingencies is the presence of the zero lower bound (ZLB) on nominal interest rates, a liquidity trap famously described by Keynes and Krugman as potentially leading to a deflationary spiral. In a seminal contribution, Christiano, Eichenbaum, and Rebelo 2011 examined fiscal multipliers in a DSGE framework under such conditions, demonstrating that when nominal rates are constrained at zero, the real interest rate may remain excessively high, suppressing consumption and aggregate demand, and further exacerbating economic downturns. Within this context, fiscal policy takes on an amplified role: increased government spending raises prices, thereby lowering real interest rates and stimulating consumption and investment. The authors estimate multipliers as high as 2 to 5 in such settings. However, empirical evidence remains mixed—Ramey and Zubairy 2018 finds that even at the ZLB, fiscal multipliers rarely exceed 1.5.

Beyond monetary constraints, the trajectory of fiscal adjustment plays a critical role in determining multipliers. The conventional view suggests that higher public spending necessitates future tax increases, thereby dampening private demand. However, Corsetti, André Meier, and Müller 2012 propose an alternative mechanism—if fiscal expansions are offset by future spending reductions rather than tax hikes, private consumption can rise due to lower expected long-term interest rates. Empirical support for this *spending reversal* hypothesis is provided by Forni and Gambetti 2010, who, using a VAR model, show that unanticipated spending shocks align with this theory, while anticipated shocks have the opposite effect, raising long-term interest rates and appreciating the real exchange rate.

The effectiveness of fiscal policy is also shaped by exchange rate regimes. The Mundell-Fleming framework suggests that fiscal expansions are largely neutral under flexible exchange rates, as currency appreciation offsets demand stimulus. Conversely, under fixed exchange rate regimes, fiscal multipliers tend to be higher, as monetary authorities accommodate spending shocks to prevent real exchange rate movements. Corsetti, Andre Meier, and Müller 2012 confirm this, showing that

fixed exchange rate regimes amplify fiscal multipliers and mitigate investment contractions.

Finally, debt levels—both public and private—significantly influence fiscal multipliers. High public debt often weakens multipliers, as documented by Perotti 1999 and Corsetti, André Meier, and Müller 2012, who find that in debt-burdened economies, rising government spending tends to crowd out private consumption. In contrast, private debt dynamics can have the opposite effect—Bernardini and Peersman 2018 demonstrate that during periods of excessive private indebtedness, fiscal multipliers tend to be exceptionally large, highlighting the asymmetric role of public and private leverage in shaping fiscal policy effectiveness. Ghassibe and Zanetti 2022 show that fiscal multipliers depend on the nature of economic fluctuations. In demand-driven recessions, public spending and consumption tax cuts are highly effective, while supply-side policies, like labor tax cuts, have little impact. The opposite holds in supply-driven downturns. Their empirical findings confirm that fiscal multipliers vary significantly across economic conditions.

Alongside the extensive body of literature on the subject, a particular form of state-dependence warrants special attention: business cycle dependence. The relationship between the phase of the economic cycle and the impact of public spending on the economy is a distinct type of state-dependence that holds a central place in the literature and is also a pivotal aspect of my own contribution to the field. Business cycle dependence differentiates not only the magnitude but, at times, the sign of the public spending multipliers during periods of expansion versus recession. This distinction is crucial not only for understanding the determinants of these multipliers but also for making informed policy decisions. Indeed, fiscal stimulus is one of the most widely used tools in times of economic contraction, aimed at triggering recovery.

In this context, Auerbach and Gorodnichenko 2012 developed an empirical model based on a Smooth Transition VAR to estimate the economy's response under varying business cycle conditions. By applying a seven-period centered moving average of log Real GDP deviations, the authors identified the cyclical states of the economy. Their findings revealed the countercyclical nature of the spending multipliers: output responds negatively during "good" times and positively during "bad" times.

This result aligns with other contributions, yet many studies present divergent or even opposing findings. For instance, Ramey and Zubairy 2018, using Jordà 2005 Local Projections, did not replicate the findings of Auerbach and Gorodnichenko (AG). In contrast, Alloza 2017 observed the opposite effect. More specifically, this discrepancy underscores the critical role of how the business cycle is defined in determining the outcome. Alloza's work clearly demonstrates that when the current level of output is used as a measure of the cycle, or when a backward-looking moving average of GDP growth is employed, the results differ in sign from those of AG. However, when the moving average is made forward-looking, AG's findings resurface. Furthermore, Alloza 2017 incorporated the unemployment rate and the uncertainty, as measured by the disagreement among professional forecasters, as interaction terms in a VAR model. This analysis found that the multipliers are, in fact, procyclical, contrary to the countercyclical argument put forth by AG.

In this contribution, I seek to make a meaningful contribution to the three segments of the literature. Starting with the latter, my work is deeply intertwined with the role of the economic cycle. While the Markov-switching analysis does not impose, a priori, any variation in coefficients that aligns with the economic cycle, the relationship becomes unmistakably apparent through the filtered probabilities of the estimated model. Furthermore, the key coefficient that exhibits a clear cyclical variation is lambda, representing the proportion of hand-to-mouth agents, who are directly responsible for the Keynesian (New Keynesian) multiplier. This aspect also enriches the literature on state-dependent fiscal multipliers by highlighting the impact of non-Ricardian behaviors on the private consumption response to public spending. Finally, with regard to the broader theoretical

framework, my contribution positions itself between neoclassical and New Keynesian models, attributing the phase of the economic cycle as the determining factor in justifying one perspective over the other.

3 The Model Economy

The model builds on Galı, López-Salido, and Vallés 2007 by introducing two types of households: Ricardian agents and hand-to-mouth consumers. Households supply labour to intermediate goods firms, which produce homogeneous goods. Final goods firms then use these intermediate goods as inputs to produce differentiated goods, which are sold in the market. The economy features Calvo-style pricing frictions, meaning that not all firms can adjust their prices in every period. The model also includes a monetary authority that sets the nominal interest rate each period according to the Taylor rule, as well as a fiscal policy that finances government spending through public debt issuance while maintaining budget balance.

We then include a non-perfectly competitive labour market with sticky wages, following Colciago 2011.

3.0.1 Households - Optimizing

Ricardians (optimizing agents) maximize their utility subject to an intertemporal budget constraint.

$$E_t \sum_{t=0}^{\infty} \beta^t U\left(C_t^o, L_t^o\right) \tag{1}$$

$$P_t C_t^o + R_t^{-1} B_{t+1}^o = L_t^d \int_0^1 W_t^j \left(\frac{W_t^j}{W_t}\right)^{-\epsilon_w} + B_t^o + D_t^o P_t T_t \tag{2}$$

$$L_t^j = L_t^d \left(\frac{W_t^j}{W_t}\right)^{-\epsilon_w} \tag{3}$$

Labour input is differentiated and indexed by j $\in [0, 1]$. Each labour type refers to a union indexed by j, that fixes the wage W_t^j and is ready to supply the required hours. ϵ^w is the elasticity of substitution between labour inputs. L_t^d is the aggregate labour demand and W_t is the prevailing wage at time t. Given that labor-type units are distributed uniformly across households, each household works the same amount of hours, so that:

$$L_t = L_t^d \int_0^1 \left(\frac{W_t^j}{W_t}\right)^{-\epsilon_w} dj. \tag{4}$$

In the budget constraint B_t^o represents the risk-free bonds purchased at time t. $P_t D_t^o$ is the nominal amount of dividends received for the ownership of a firm. $P_t T_t$ is the amount of nominal lump-sum taxes.

$$U(C_t, L_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{L_t^{1+\phi^w}}{1+\phi^w} \tag{5}$$

Where the utility function is separable between labour and consumption, and takes the form of CRRA for consumption (Constant Relative Risk Aversion) and where σ represents the coefficient of relative risk aversion.

The maximization of equation (5) subject to equation (2), brings to the consumption Euler equation, that links variations of consumption of optimizing households with the nominal interest rate, and to the expected inflation rate.

$$\mathbb{E}_t \left\{ \beta \frac{(1+i_t)}{(1+\pi_{t+1})} \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \right\} = 1 \tag{6}$$

3.0.2 Households - Hand to Mouth

While the fracion $1-\lambda$ of Ricardian optimizing agents smooth consumption over time by demanding bonds, the remaining fraction λ consumes all their income net of taxes in every period. The consumption of hand-to-mouth agents is:

$$P_t C_t^r = L_t^d \int_0^1 W_t^j \left(\frac{W_t^j}{W_t} \right)^{-\epsilon_w} dj - P_t T_t^r, \tag{7}$$

that implies that hand-to-mouth agents take the wage as given and predetermined by the union.

3.0.3 Aggregating

Aggregating yields:

$$C_t = \lambda C_t^r + (1-\lambda) C_t^o; \tag{8}$$

$$D_t = (1-\lambda) D_t^o; \tag{9}$$

$$T_t = \lambda T_t^r + (1-\lambda) T_t^o; \tag{10}$$

$$B_t = (1-\lambda) B_t^o; \tag{11}$$

Where the aggregate consumption is a weighted average of the private consumption of the two types of agents. The same occurs for overall lump-sum taxes, which amount to a weighted average of the taxes payed by the two. Only Ricardians own firms and hold bonds.

3.0.4 Wage Setting

In this model economy, wages are set by a continuum of unions that represent a continuum of workers. Moreover, unions set the wages according to a Calvo-style rule. They cannot choose at every period the optimal wage, given that each of them faces a constant probability of being able to re-optimize. Furthermore, the unions represent both Ricardian and non-Ricardian agents, so that they maximize a weighted average of the two types of agents' lifetime utilities. The maximization process takes the following form.

$$\max_{\tilde{W}_t} E_t \sum_{k=0}^{\infty} \beta^k \left\{ [(1-\lambda)u(C^o_{t+k} + \lambda u(C^r_{t+k})] - v(L_{t+k}) \right\} \tag{12}$$

The first order condition for $\tilde{W}_t$ is:

$$E_t \sum_{k=0}^{\infty} (\beta\lambda_w)^{t+k} \Phi_{t,t+k} \left\{ \left(\lambda \frac{1}{MRS^r_{t+k}} + (1-\lambda) \frac{1}{MRS^o_{t+k}} \right) \frac{\tilde{W}_t}{P_{t+k}} - \mu^w \right\} = 0 \tag{13}$$

Where $\Phi_{t,t+k} = v_l(L_{t+k}) L^d_{t+k} W^{\epsilon_w}_{t+k}$ and $\mu^w = \frac{\epsilon_w}{\chi(w-1)}$.

The variables MRS^r_t and MRS^o_t represent the marginal rate of substitution between labour and consumption, respectively for the hand-to-mouth agents and the optimizing ones.

3.0.5 Firms

We assume that there are two kind of firms, the final goods producers and the intermediate goods producers. The latter are perfectly competitive.

Final goods are produced according to the following production technology:

$$Y_t = \left(\int_0^1 X_t(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} dj \right)^{\frac{\epsilon_p}{\epsilon_p - 1}} \tag{14}$$

So that X_t is the amount of intermediate goods used as a production input. Costs minimization by final goods producers, taking the price P_t as given, brings to the following demand schedule:

$$X_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\epsilon_p} Y_t, \tag{15}$$

$$P_t = \left(\int_0^1 P_t(j)^{1-\epsilon_p} dj \right)^{\frac{1}{1-\epsilon_p}} \tag{16}$$

firms produce through a decreasing return production function by using labour as the only input.

$$Y_t(j) = A_t L_t(j)^{\alpha} \tag{17}$$

Where A_t is the level of technology.

From equation (17), the labour marginal productivity is:

$$MPL_t = \alpha A_t L_t^{\alpha - 1}. \tag{18}$$

And the marginal cost can be defined as follows:

$$MC_t = \frac{W_t}{MPl_t} \tag{19}$$

Intermediate firms are supposed to not be able to adjust the selling price every period, but instead they face a constant probability of setting the price. According with Calvo, this probability is $1 - \theta_p$. That means that in every period a constant fraction of firms is allowed to set the price, while the remaining fraction θ keeps the price level unchanged.

$$\max_{p_t^*} \sum_{k=0}^{\infty} \theta^k E_t \left\{ Q_{t,t+k} \left(p_t^* Y_{t+k|t} - \Psi_{t+k}(Y_{t+k|t}) \right) \right\} \tag{20}$$

Subject to the sequence of demand constraints

$$X_{t+k}(j) = \left(\frac{P_t(j)^*}{P_{t+k}} \right)^{-\epsilon_p} Y_{t+k}. \tag{21}$$

Which brings to the following First Order Condition:

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{ \Lambda_{t,t+k} Y_{t+k}(j) \left(\frac{P_t^*}{P_{t+k}} - \mu^p MC_{t+k} \right) \right\} = 0 \tag{22}$$

That leads to the aggregate price level:

$$P_t = \left[\theta P_{t-1}^{1-\epsilon_p} + (1-\theta)(P_t^*)^{1-\epsilon_p} \right]^{\frac{1}{1-\epsilon_p}} \tag{23}$$

3.0.6 Fiscal Policy

Following Galı, López-Salido, and Vallés 2007 we include into the model economy a fiscal authority that imposes lump-sum taxes on households, buys final goods and issues public bonds to finance public debt.

The government budget is defined by the following constraint:

$$P_t T_t + R_t^{-1} B_{t+1} = B_t + P_t G_t \tag{24}$$

Where:

$$T_t = \lambda T_t^r + (1-\lambda) T_t^o \tag{25}$$

$$g_t = (G_t - G)/Y \tag{26}$$

$$t_t = (T_t - T)/Y \tag{27}$$

$$b_t = ((B_t/P_{t-1} - (B/P))/Y. \tag{28}$$

The fiscal Policy rule takes the following form:

$$t_t = \phi_b b_t + \phi_g g_t \tag{29}$$

And the government spending takes the form of an autoregressive process of order 1:

$$g_t = \rho_g g_{t-1} + \epsilon_t \tag{30}$$

Where $\rho_g \in [0, 1]$.

3.0.7 Monetary Policy

To close the model we include a monetary authority that set the nominal interest rate.

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)(\phi_\pi \pi_t + \phi_x x_t) + \epsilon_r \tag{31}$$

Where phi_π is the Taylor coefficient and it represents the response of the policy rate to variations in the inflation rate.

3.0.8 Market Clearing

The model is closed by assuming the two following market clearing conditions:

$$Y_t(j) = X_t(j) \forall j \in [0, 1], \tag{32}$$

$$Y_t = C_t + G_t \tag{33}$$

4 Estimation

We first estimate the DSGE model in its unconditional form. The model in its matrix form is:

$$\Gamma_0 X_t = \Gamma_1 X_{t-1} + \Psi Z_t + \Pi \eta_t \tag{34}$$

It can be solved under the Rational Expectation hypothesis. We here adopt the method proposed by Jordà 2005 and named Gensys solution method. The application of the Gensys algorithm brings to the reduced-form VAR.

$$X_t = G(\Phi) X_{t-1} + A(\Phi) Z_t \tag{35}$$

Where Φ is the set of the model parameters. The observation equation takes the following form:

$$Y_t = \mu + H X_t \tag{36}$$

Where Y_t is the matrix of observed variables. Applying a Kalman Filter we can find the estimated parameters.

The shocks whose state-dependent volatility is to be estimated are technological, monetary, fiscal, consumption and price ones, respectively. Even the coefficients of the Taylor rule are left free to vary the basis of the definition of two different regimes. An innovative element of this analysis is the Markov-Switching estimate of the aggregation equations of the model. The parameter λ, the share of hand-to-mouth consumers, is left free to vary between the two regimes. This can have fundamental consequences on fiscal multipliers, caused by the different reaction that the two types of agents, Ricardians and non-Ricardians record following an innovation in public spending.

The first step to the Markov-Switching estimation consists in disentagling the parameters vector Φ into three separate components.

$$\Phi = \left\{ \Phi^S; \Sigma^s; \Phi^0 \right\} \tag{37}$$

Where Φ^s represents the state-dependent coefficients, Σ^s the state-dependent variances of the stochastic processes and Φ^0 the unconditional parameters. The vector Φ^s includes the regime-switched values of the coefficients of the monetary policy rule and of λ, the share of hand-to-mouth consumers that populate the economy. The superscripts S and s represent respectively the states of the world associated with the differing values of the state-dependent coefficients and the state-dependent variances. Recall that even in Φ^s, the Taylor rule coefficients evolve independently from λ. This implies that S can be divided into S_{TR} and S_λ

The state variables are assumed to follow a first-order Markov-chain with transition probabilities like the following.

$$P_{TR} = \begin{Bmatrix} P_{TR11} & P_{TR12} \\ P_{TR21} & P_{TR22} \end{Bmatrix} \tag{38}$$

$$P_\lambda = \begin{Bmatrix} P_{\lambda 11} & P_{\lambda 12} \\ P_{\lambda 21} & P_{\lambda 22} \end{Bmatrix} \tag{39}$$

$$Q = \begin{Bmatrix} Q_{11} & Q_{12} \\ Q_{21} & Q_{22} \end{Bmatrix} \tag{40}$$

Where $P_{kij} = P(S_{kt} = j|S_{kt-1} = i)$ and $Q_{ij} = Q(s_t = i|s_{t-1} = i)$. Moreover, P_TR is the transition matrix for the Taylor rule, P_λ is the transition matrix for the share of hand-to-mouth consumers (λ) and Q is the transition matrix for the shocks volatility.

The Markov-Switching model for a generic regime S can be expressed in the following way.

$$\begin{pmatrix} \Gamma^S_{0,1} \\ \Gamma_{0,2} \end{pmatrix} X_t = \begin{pmatrix} \Gamma^S_{1,1} \\ \Gamma_{1,2} \end{pmatrix} X_{t-1} + \begin{pmatrix} \Psi^S_1 \\ 0 \end{pmatrix} Z_t + \begin{pmatrix} 0 \\ \Pi \end{pmatrix} \eta_t \tag{41}$$

To solve the model, we follow Farmer, Waggoner, and Zha 2009, and rewrite the model as an expanded state vector.

$$\hat{\Gamma_0} \hat{X}_t = \hat{\Gamma_1} \hat{X_{t-1}} + \hat{B} u_t + \hat{\Pi}_t \eta_t \tag{42}$$

As is Farmer, Waggoner, and Zha 2009, if a minimum state variable exists as the solution of this model, then the solution is unique and it is possible to write the solution itself as a Markov-Switching VAR.

$$X_t = G^s X_{t-1} + A^s Z_t \tag{43}$$

When combined with an observation equation, it brings to a state-space model with Markov-switching parameters.

The impossibility to observe the states X_t entails a limitation in using the Kalman filter in its standard form. We follow Kim and Nelson 2006 applying their solution algorithm. A new state variable is defined S^*_t as a four-states transition matrix P^*. As in Kim and Nelson 2006, we consider three state matrices for each iteration like $S^*_t, S^*_{t-1}, S^*_{t-2}$. This brings to 64 potential paths for the model's output. Finally, the strategy implies the running of the Kalman filter for every possible path and then collapsing them into a weighted average with the weights given by the filtered probabilities, as proposed in Hamilton 2010.

Unconditional Estimated-Calibrated Parameters

Coefficient	Description	Value
β	Discount Factor	0.99
σ^*	Relative Risk Aversion	4.498
ϕ	Inverse Labrof Frisch Elasticity	1
θ^*	Calvo Price Coeff.	0.75
θ_w^*	Calvo Wage Coeff.	0.919
ϕ_π^*	Taylor Coeff - Inflation	1.267
ϕ_x^*	Taylor Coeff - Output Gap	0.54
ρ_v^*	Taylor Autocorr.	0.844
λ^*	Rule of Thumb Share	0.139
ρ_a^*	Autocorr. Technology Shock	0.896
ρ_c^*	Autocorr. Preference Shock	0.830
ρ_π^*	Autocorr. Cost Push Shock	0.896
ρ_w^*	Autocorr. Wage Shock	0.784
σ_a^*	Vol. Technology Shock	0.0019
σ_c^*	Vol. Preference Shock	0.0071
σ_p^*	Vol. Cost-Push Shock	0.0006
σ_w^*	Vol. Gov. Spending Shock	0.0003
σ_v^*	Vol. Monetary Shock	0.0020

Table 1: Estimated Parameters Unconditional Model

4.1 Empirical Results

Table **??** presents the estimated model parameters, including the calibrated fiscal policy parameters and two key estimated values: the intertemporal discount factor, which is set at 0.99, and labor supply elasticity, equal to 1. The coefficient of relative risk aversion is estimated at 4.49, implying an intertemporal elasticity of substitution for Ricardian agents of approximately 0.22, just slightly above one-fifth of the value associated with logarithmic preferences.

With regard to nominal rigidities, price stickiness is estimated at 0.75, meaning that price contracts, on average, last three quarters. Wage rigidity appears to be even more pronounced, with a coefficient of 0.91, suggesting that wage contracts tend to persist longer than price contracts.

Turning to monetary policy, the estimated Taylor Rule coefficients indicate a strong reaction to inflation, with a coefficient of 1.26, while the response to the output gap is lower but still significant, at 0.54. The interest rate rule exhibits a high degree of persistence, as reflected in an autoregressive component of 0.84, which suggests that monetary policy tends to be quite persistent over time, with a stronger focus on inflation stabilization rather than output stabilization.

Table **??** presents the parameter estimates under the Markov-Switching framework. Compared to the baseline estimates, the risk aversion coefficient decreases to 3.87, which leads to a slightly higher intertemporal elasticity of substitution of 0.258. Price stickiness increases substantially to 0.94, indicating greater rigidity in price adjustments, while the Calvo wage coefficient remains high at 0.89, reinforcing the idea of significant nominal wage rigidity.

Table 2

Markov-Switching Estimated Parameters			
Coefficient	**Description**	**Value**	
		Regime 1	Regime2
β	Discount Factor	0.99	
σ^*	Relative Risk Aversion	3.87	
ϕ	Inverse Labrof Frisch Elasticity	1	
θ^*	Calvo Price Coeff.	0.941	
θ_w^*	Calvo Wage Coeff.	0.894	
ϕ_π^*	Taylor Coeff.	0.841	1.558
ϕ^*	Taylor Coeff.	0.719	0.581
ρ_v^*	Taylor Autocorr.	0.907	0.51
P_ϕ^*	Transition Probability	0.05	0.123
λ^*	Rule of Thumb Share	0.105	0.312
P_λ^**	Tansition Probability	0.095	0.113
ρ_a^*	Autocorr. Technology Shock	0.994	
ρ_c^*	Autocorr. Preference Shock	0.874	
ρ_π^*	Autocorr. Cost Push Shock	0.183	
ρ_w^*	Autocorr. Gov. Spending Shock	0.665	
σ_a^*	Vol. Technology Shock	0.0034	0.0149
σ_c^*	Vol. Preference Shock	0.0062	0.0074
σ_p^*	Vol. Cost Push Shock	0.0009	0.0007
σ_w^*	Vol. Gov. Spending Shock	0.0005	0.0004
σ_v^*	Vol. Monetary Shock	0.0008	0.0026
Q^*	Transition Probability	0.0667	0.0820

Table 2: Estimated Parameters Markov-Switching model

Since these three groups of parameters evolve independently, the model allows for eight different regime combinations. These include configurations such as a scenario characterized by high rule-of-thumb consumers, low volatility, and high persistence, or alternatively, a regime marked by low rule-of-thumb consumers, high volatility, and low persistence.

Figure 1 illustrates the evolution of the smoothed probability of being in Regime 1, characterized by a lower share of rule-of-thumb consumers, from 1960:Q1 to 2014:Q3. This probability drops to near zero during three key periods: the oil crisis of 1980-1981, the dotcom crash and 9/11 shock between 1999 and 2002, and the financial crisis of 2007-2008. These recessions saw a surge in borrowing-constrained consumers, highlighting shifts in the economy's structure. Additionally, moderate transitions toward Regime 2 occurred in various other periods, such as 1961, 1966, 1973-1974, and 1977-1979.

Figure 4 presents the impulse response functions of output, aggregate consumption, and wages following a 1% GDP public spending shock. The results show that the economy reacts more strongly when fiscal shocks are less persistent. The fiscal output multiplier reaches a value close to 1 only in the regime characterized by a high share of rule-of-thumb consumers and low persistence, combined with a persistent shock. In most cases, however, the multiplier hovers around 0.5,

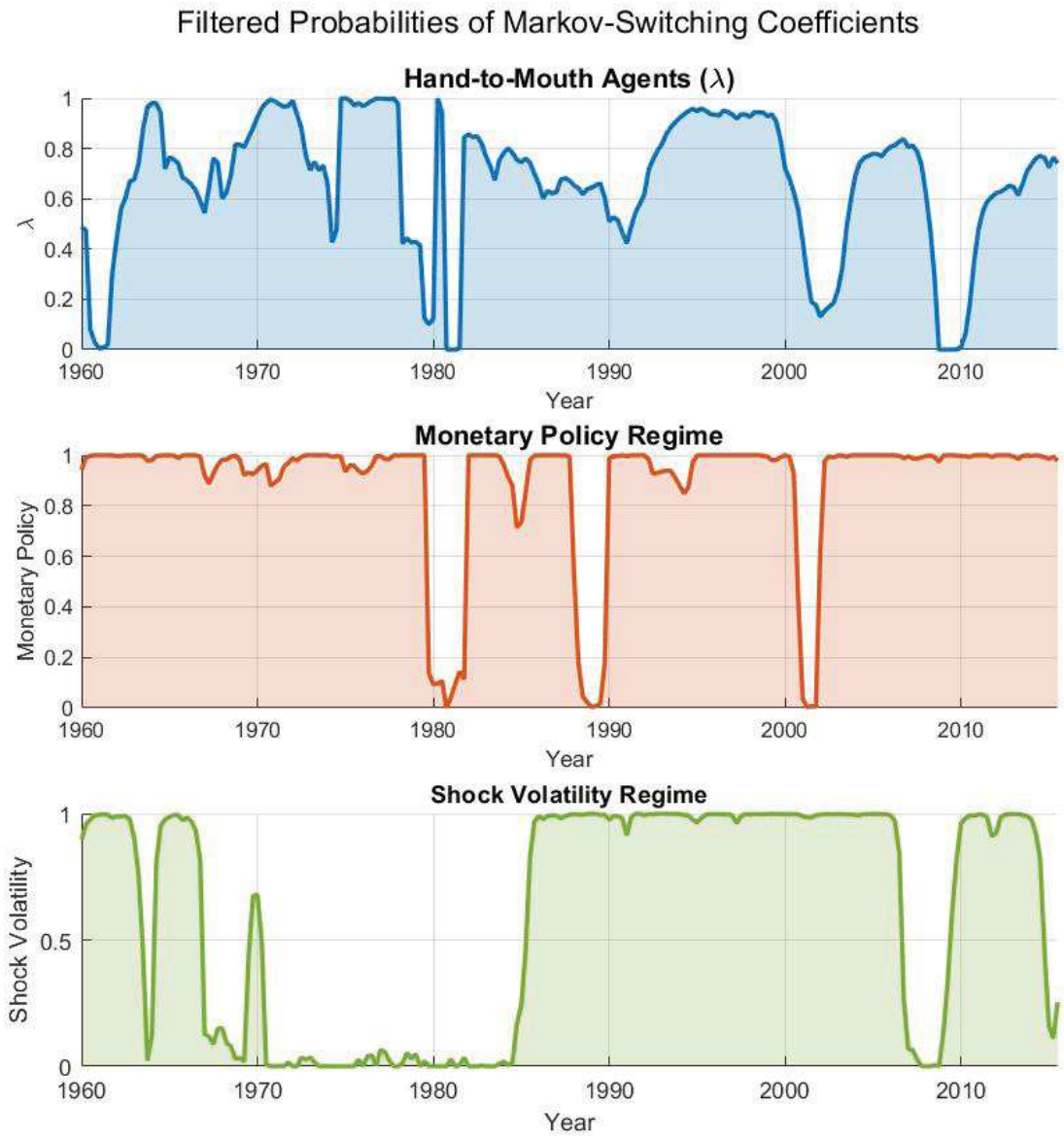

Figure 1: Filtered probabilities of the three Markov chains. Blue line: transition probability for Markov-switching λ parameter, where P is the probability of being in Low λ regime. Red line is the filtered probability for Monetary Policy. Green line is the filtered probability for shocks volatility regimes, where P is the probability of being in a low volatility regime.

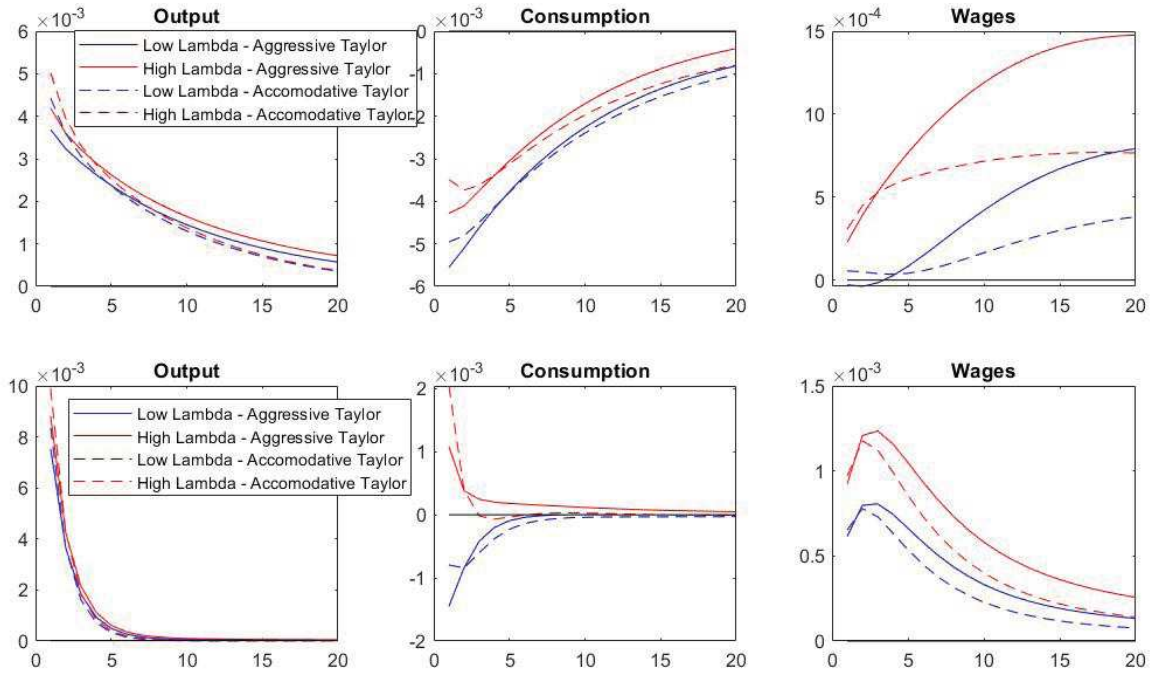

Figure 2: Impulse Response Function: Government Spending Shock. Upper panel $\rho_g = 0.9$, bottom panel $\rho_g = 0.2$.

aligning with the Neo-Classical perspective that suggests public spending has a relatively limited effect on output.

The response of output varies considerably across regimes, with a 25% difference between the scenario featuring high rule-of-thumb consumers and low persistence, and the opposite regime marked by low rule-of-thumb consumers and high persistence. Aggregate consumption generally declines following persistent fiscal shocks, in line with the crowding-out effect. However, when the share of rule-of-thumb consumers is high, consumption increases even after a public spending shock, supporting the Neo-Keynesian argument of a crowding-in effect. Wage dynamics also differ significantly depending on the regime: wages tend to respond more strongly when the share of borrowing-constrained households is high, as these households rely more heavily on labor income.

These findings highlight the dual structure of the U.S. economy. During normal times, economic dynamics align with the Neo-Classical framework, where fiscal policy has limited effects due to the predominance of crowding-out. However, in periods of economic crisis, when the share of rule-of-thumb consumers increases significantly, the economy behaves more in accordance with Neo-Keynesian principles, with fiscal policy playing a crucial role in stimulating aggregate demand.

This regime-switching behavior offers an explanation for the mixed empirical evidence on fiscal multipliers. The effectiveness of public spending depends on the prevailing macroeconomic regime, emphasizing the importance of accounting for these nonlinear dynamics when designing fiscal policy interventions.

4.2 Discussion

Based on the obtained results, it is possible to outline economic implications regarding the key determinants influencing the magnitude of fiscal multipliers in the United States. Consequently,

valuable insights can be extrapolated for policymakers.

First and foremost, the findings indicate that the parameter whose variability most significantly drives the fluctuations in fiscal multipliers is λ. This parameter, representing the share of hand-to-mouth agents, plays a crucial role in determining the multiplicative effect of increased public spending, both through its impact on consumption and via a critical effect on the labor market. The latter aspect warrants particular attention, as it underscores the relevance of modeling the labor market as imperfectly competitive. In the presence of an expanding cohort of hand-to-mouth agents following a public spending shock, the proportion of individuals who increase consumption rises, while the share of Ricardian agents (who would otherwise reduce consumption in response to the fiscal shock) declines. Through union mechanisms, this dynamic translates into an increase in real wages, which, reinforced by the growing presence of non-Ricardian agents, leads to a rise in aggregate consumption—or, at the very least, a less pronounced decline in aggregate consumption. This effect manifests regardless of whether the income multiplier is greater or less than one.

Furthermore, smoothed probabilities suggest that the expansion of the hand-to-mouth cohort tends to coincide with economic downturns, such as the oil crisis of the late 1970s and early 1980s, the bursting of the dot-com bubble, and the onset of the 2007–2008 financial crisis. Therefore, irrespective of whether the fiscal multiplier exceeds unity, during adverse economic conditions—when the share of hand-to-mouth agents increases—fiscal multipliers tend to be larger compared to other phases of the business cycle. The logical implication is that public spending policies have a stronger stimulative effect on the economy during recessions. This result aligns with the findings of Auerbach and Gorodnichenko 2012, while at the same time tempering their conclusions (which suggest the possibility of even negative multipliers during expansionary phases) in the spirit of Ramey and Zubairy 2018.

As for the response of private consumption—and, consequently, the likelihood that income multipliers exceed or fall below unity—this largely depends on the persistence of the fiscal shock. As persistence decreases, the crowding-out effect on Ricardian agents weakens, thereby amplifying the expansionary impact through the positive response of hand-to-mouth agents. This, in turn, leads to an increase in the private component of consumption.

The second aspect that requires clarification concerns the role of monetary policy regimes. The results obtained from the Markov-switching estimation are ambiguous and not conclusive for two main reasons. First, the two regimes do not exhibit significant differences in how policy interest rates respond to inflation: in one regime, there is greater persistence but a less pronounced Taylor coefficient, whereas in the other, persistence is lower but the coefficient is higher. This distinction does not translate into a meaningfully different monetary policy stance.

Second, filtered probabilities indicate that the less persistent regime occurs only for a few quarters over the entire sample period, suggesting that regime shifts represent sunspot fluctuations rather than structural changes. This result appears to contrast with the findings of Mumtaz and Bilbiie, who attribute differences in fiscal multipliers before and after the 1980s—between the pre-Volcker era and the Volcker-Greenspan era—to structural shifts in monetary policy.

However, the structural difference between the pre- and post-1980s period seems, instead, to be captured by a regime shift in the volatility of shocks. Across all considered shocks, the period from the mid-1960s to the mid-1980s is characterized by high volatility, whereas the subsequent period—except for the 2007–2008 crisis—exhibits lower volatility. The paradigm shift in the economic system is indeed present, but it pertains not to monetary policy itself, but rather to the volatility of shocks. This evidence of the Great Moderation challenges the notion that monetary policy regimes drive fiscal multipliers and instead reinforces the idea that lambda, as the key parameter behind the New Keynesian multiplier, is the primary determinant of their magnitude.

Moreover, the role of shock volatility appears to be a crucial factor in aligning the model estimates with the data and should not be overlooked in any macroeconomic Markov-switching analysis.

Regarding the broader debate between New Keynesians and Neoclassicals, the findings of this study place it in a middle ground: the perspective that best represents economic reality depends on the phase of the business cycle. During an expansionary phase, the Neoclassical view is more likely to prevail, whereas in a recessionary phase, the Keynesian perspective on the impact of public spending on the economy appears to be more relevant.

From a policy perspective, however, an important clarification must be made regarding the magnitude of this impact. As the results indicate—confirming what was already widely recognized—the duration of the fiscal shock, or more precisely, its persistence, is a key determinant of the effectiveness of fiscal stimulus. A public spending shock is more likely to result in a multiplier greater than one—driven by a positive response in private consumption—only if it is sufficiently temporary and not persistent. This insight should not be underestimated when considering public spending as a tool for economic stimulus, particularly during recessions when such intervention is most urgently needed.

5 Concluding Remarks

In this chapter, a Markov-Switching estimation of the model proposed by Colciago 2011 for the United States was implemented. This neo-Keynesian model with two types of agents assumes that a portion of households are borrowing constrained and consume all their available income each period, while the remaining households behave according to representative agent theory. This approach was chosen to estimate potential structural changes in the U.S. economy and identify heterogeneous impacts of public spending policy over time. It is important to note that Colciago's model differs from Galı, López-Salido, and Vallés 2007 due to the inclusion of wage stickiness.

After reviewing key contributions in the field of fiscal multipliers, we outlined the structure of Colciago's model and conducted a Bayesian estimation in a Markov-Switching context. Here, some of the key parameters were allowed to take two sets of values depending on two distinct regimes.

The state-dependent parameters considered were lambda (the share of borrowing-constrained agents), the coefficients of the monetary policy rule, and the volatility of the stochastic shock processes driving the economy. The three groups of state-dependent parameters were studied independently using three separate Markov chains, allowing each group to evolve independently.

The results show significant variation in the estimated parameters over U.S. history from 1960 to 2013. The share of borrowing-constrained agents (lambda) exhibits a strong cyclical pattern, fluctuating between two extremes (0.1 and 0.31). During major economic downturns, such as the 1979-1982 oil crisis, the early 2000s crisis, and the 2007-2008 global financial crisis, the share of borrowing-constrained agents increases threefold, reaching the higher value of 0.31 with near certainty. Conversely, during "normal" economic cycles, lambda tends to remain closer to the lower value of 0.1.

Monetary policy also shows a clear dependence on the business cycle. The two identified monetary policy regimes can be categorized as high persistence and low persistence. Contractions in GDP growth are linked to more persistent monetary policies, while expansions correlate with less persistent policies. Regarding the volatility of shocks, a structural break occurred around the mid-1980s, marking a transition from a high-volatility regime to a low-volatility regime. Notably, the 2007-2008 financial crisis represents an exception to the low volatility seen during the Great

Moderation.

The model estimation reveals that fiscal multipliers are larger for less persistent fiscal shocks, higher lambda regimes, and less persistent monetary policies. Furthermore, the two lambda regimes, in response to short-lived public spending shocks, can lead to opposite effects on consumption: in the high-lambda regime, consumption responds positively, whereas in the low-lambda regime, it responds negatively, regardless of monetary policy.

In conclusion, during periods of profound economic crisis (such as the three major episodes analyzed), the economy behaves in line with New-Keynesian theory, with a higher probability of observing a positive response in consumption. In contrast, during "normal" times, the economy tends to follow the predictions of the neo-Classical synthesis, with consumption responding negatively to fiscal shocks.

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