Fiscal Multipliers in Recessions*

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Abstract

The Great Recession, and the fiscal response to it, has revived interest in the size of fiscal multipliers. Standard business cycle models have difficulties generating multipliers greater than one. And they also cannot produce any significant state-dependence in the size of the multipliers over the business cycle. In this paper we employ a variant of the Curdia-Woodford model of costly financial intermediation and show that fiscal multipliers can be strongly state dependent in a countercyclical manner. In particular, a fiscal expansion during a recession may lead to multiplier values exceeding two, while a similar expansion during an economic boom would produce multipliers falling short of unity. This pattern obtains if the spread (the financial friction) is more sensitive to fiscal policy during recessions than during expansions, a feature that is present in the data. Our results are consistent with recent empirical work documenting the state contingency of multipliers.

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1 Introduction

Keynes advocated a fiscal stimulus during the Great Depression, and since then governments have at times implemented fiscal expansions during recessions as a means of stimulating economic activity. However, modern business cycle models – and until recently, most empirical evidence – suggest that these policies are ineffective. The theoretical argument is that an increase in government spending raises consumers' expected tax burden, and this negative wealth effect largely curtails the expansion of aggregate demand. The multipliers generated by these models are small, hovering at best around one. Moreover, their size does not vary over the business cycle which implies that fiscal policy is ineffective even during very severe downturns.[1]

Recent empirical work has addressed the existence –or, absence– of state dependence in fiscal multipliers. This literature –which is reviewed below– remains unsettled and is still evolving. Importantly, though, it has not been guided by theory as there is a shortage of standard macro models that can give rise to state dependent multipliers. The objective of this paper is to fill this gap. To this end, we have added countercyclical variation in bank intermediation costs to a banking model described by Curdia and Woodford [2009, 2010]);[2] the resulting model is capable of generating strong multipliers in recessions and weak multipliers in expansions. How does this work? The cyclical variation in bank intermediation costs makes the spread between the bank deposit rate and the bank loan rate fluctuate countercyclically, and this in turn creates a financial accelerator that is much stronger in recessions than in expansions. More precisely, the onset of a recession exacerbates the financial friction, and inhibits borrowing. But then, a fiscal stimulus turns the economy around and decreases the spread; this in turn encourages more borrowing and spending; this further expands the economy and decreases the spread again, encouraging more borrowing; and the process repeats itself. The same accelerator is present in an expansion; however, during good times, the spread is lower to begin with, and the accelerator is correspondingly weaker.[3]

It should be noted that the state dependence of the financial friction plays a key role for the ability of the model to produce state-dependent multipliers. It is insufficient cyclical variation in this friction that explains why models with financial frictions have trouble generating large, state dependent multipliers in spite of the fact that they give rise to a financial accelerator. For instance, Collard and Dellas [2008] calculate fiscal multipliers in the model of Bernanke et al. [1999]. They find that multipliers are small and exhibit limited cyclical variability over the business cycle. Similarly, in a

[1] As discussed below, some models imply large multipliers when interest rates are at the zero lower bound; however, the zero bound trap has not been typically reached during recessions.

[2] The countercyclicality of financial frictions has been long recognized in financial economics; see, for instance, the detailed discussion in Mishkin [2001], Chapters 8 and 25, about how the cyclicality of firm net worth, of household liquidity etc. induce countercyclical variation in moral hazard and adverse selection problems. However, the importance of this fact for fiscal multipliers has not been explored in the literature. One reason for this may be the popular practice of linearization in quantitative general equilibrium models.

[3] We present empirical evidence on state dependent effects of government spending on spreads in section 3.3.

model with financial frictions, Fernandez-Villaverde [2010] finds output multipliers of about 1.

As noted above, countercyclical fiscal policy can find little justification in the popular New-Keynesian models. Cogan et al. [2010] (CCTW hereafter) used the Smets and Wouters' [2007] model to compute consumption and output multipliers. They consider several alternative experiments: permanent vs temporary government spending increases, the particular case of the Obama administration American Recovery and Reinvestment Act, etc. They report that the maximum output multiplier is about unity (and typically much smaller) and consumption and investment multipliers are negative. More importantly from the point of view of this paper, and in line with the findings of Collard and Dellas [2008], CCTW do not find any significant variation in the multiplier over the business cycle (when solving the non-linear version of the model). In particular, using an output gap of 6.5%, and letting the zero lower bound for interest rates become endogenous, hardly affects the output multipliers; if anything, it made them slightly smaller.

We are not the first to study fiscal multipliers in a model with financial frictions. Fernandez-Villaverde [2010] found that the inflation accompanying an increase in government spending boosted entrepreneurial wealth and reduced the interest on loans. However, his model only generated multipliers of about one. And Angeletos and Panousi [2009] actually found that multipliers were smaller in a model with financing constraints.

There are two other kinds of model that can give rise to large multipliers: Models with deep habits (Ravn et al [2012]); and New Keynesian models with a binding lower bound on nominal interest rates.[4] It is not known whether the former can give rise to significant cyclical asymmetry in multipliers. The latter can do but the existing literature is not unanimous in its findings. Haltom and Sarte [2011] and Braun and Körber [2011] suggest that multipliers at the zero lower bound depend on a variety of factors so that the net effect is theoretically ambiguous. On the quantitative front, while CCTW find that the zero lower bound plays no role, Eggertsson [2010] and Christiano et al. [2011] find that it can make a big difference for the multipliers. Erceg and Linde [2010] fall in between CCTW and Christiano et al. [2011]. Bachmann, Berg and Sims [2012], Dupor and Li [2014] and Wieland [2014] take an indirect route by examining the effects of an increase in expected inflation on private spending (a key ingredient of the multiplier at the zero bound). They find no support for multiplier type of effects. Nonetheless, and independent of the effects of the zero bound on the fiscal multiplier, there seems to be a need for a supplementary or perhaps more general explanation of the large multipliers during recessions because nominal interest rates have not been at the zero bound for most of the recessions in the post World War II period.

In addition to being able to generate large and state-dependent fiscal multipliers, our analysis has some other implications that may be of interest. For instance, it implies that the size of the

[4]The mechanism is as follows. Normally, nominal and real interest rates would rise following an increase in government spending, chocking off the expansion. But if the nominal interest rate is stuck at zero, this channel does not operate.

fiscal intervention matters for the magnitude of the multiplier. While a 1% increase in government purchases during a recession produces multipliers that are about 2, a larger stimulus (say, 5% or 10%) gives rise to multipliers that barely exceed 1. The reason large fiscal interventions are less effective than smaller ones is that the negative marginal wealth effect due to the higher tax liabilities is increasing in the size of the fiscal intervention while the positive marginal effect on the borrowers, from the reduction in the finance premium, is decreasing in the size of the fiscal expansion.

Another implication is that multipliers during recessions remain greater than one even when the government finances higher spending through taxes. But as in the IS-LM analysis, the multipliers are even bigger for debt financed spending. The reason is that while higher government spending sets in motion the financial accelerator, higher taxes partly counter this by reducing the quantity of funds available to financially constrained individuals.

How do our theoretical results square with the existing empirical evidence on multipliers? As is well known, the empirical estimation of fiscal multipliers is a hazardous affair due to identification and data problems.[5] There is no firm consensus in the profession regarding their size and their state dependence. There is some work that finds state dependence in the response of the economy to fiscal interventions. For instance, Tagkalakis [2008] finds that, in the OECD, fiscal policy has a larger effect on consumption in recessions than in expansions; and that this effect is more pronounced in countries that have a less developed consumer credit market. Similarly Auerbach and Gorodnichenko [2012], Bachmann and Sims [2012] and Riera-Crichton, Vegh and Vuletin [2014] find state dependent multipliers that are large during recessions. Auerbach and Gorodnichenko [2012] use regime switching SVAR's to show that output multipliers are countercyclical. They find that the point estimates of the maximum output multiplier (over the first 20 quarters) are 0.57 during expansions and 2.48 during recessions; these numbers are not far away from those computed in this paper. When they ignore the distinction between recessions and expansions they obtain an estimate close to 1, which is typical of estimates in most of the empirical literature. Riera-Crichton, Vegh and Vuletin [2014] offer a more careful analysis of state dependence by arguing that because government spending is not cyclical, the proper way to estimate the degree of state dependence is to condition not only on the state of the business cycle abut also to the sign/size of the fiscal intervention. They find that fiscal expansions in recessions are much more expansionary than fiscal expansions in booms.

The Auerbach and Gorodnichenko [2012] findings have been questioned. Ramey and Zubairy [2012] use a longer time sample and a different identification scheme and report the absence of any state dependence.[6] So one perhaps ought to view this empirical literature as unsettled and still evolving. Nonetheless, and while awaiting a more conclusive verdict on the degree and strength of state

[5] Blanchard and Perotti [2002], Hall [2009] and Ramey [2011] are classic studies in this literature.

[6] See `http://econweb.ucsd.edu/~vramey/research.html#govt` for an exchange of arguments between Gorodnichenko and Ramey-Zubairy about the potential sources of the differences in their results

dependence in empirical multipliers, it is undoubtedly valuable to explore how standard models –such as ours– can produce this type of effects and under what conditions, not least because the empirical literature needs theoretical guidance in its search for state dependence.

It is also worth mentioning that the regional fiscal multipliers literature has produced some evidence on state dependence. Nakamura and Steinsson [2014] compute US regional fiscal multipliers associated with military spending and find that they exhibit strong cyclical state-dependence. In particular, Nakamura and Steinsson [2014] report that the effects of government spending are not only substantial but they are also much higher during periods of high slackness (high unemployment) in comparison to other times.[7]

The rest of the paper proceeds as follows: In Section 2, we outline the model, and describe its calibration. Countercyclical bank intermediation costs are at the heart of our analysis; so, we present two different ways of deriving empirically the parameter that is relevant in this regard. In Section 3, we present our results for consumption and output multipliers. We show that they involve multipliers falling short of unity during expansion and exceeding unity during recessions. We also present empirical evidence that supports the multiplier process inherent in our model. In section 4, we show how our results fare under alternative specifications of the bank intermediation costs, and we perform other parameter robustness exercises. In Section 5, we conclude.

2 The Model

Our argument is that spending multipliers are strong during recessions because of a cyclical asymmetry in financial frictions. To illustrate this, we adopt a framework developed by Curdia and Woodford [2009, 2010], one with a continuum of borrowers and lenders and financial frictions. As we shall see, this setup allows us to reduce a model with heterogeneous agents to a model with effectively just two agents. We will, however, have to augment their framework to let the financial frictions be countercyclical. Since this departure from the original Curdia-Woodford framework is critical to our results, we will present empirical evidence to support it (see Section 2.5.2). The rest of the model is standard.

2.1 Households

There are two types of households – borrowers and savers – indexed by $\mu(i) \in \{b, s\}$; an individual household's type may vary from period to period in a manner that is described below. In period t,

[7] Other studies of regional government spending multipliers have produced more mixed results. For instance, Brückner and Tuladhar [2011] find small multipliers in the case of Japanese regions.

a household of type i has utility

$$\mathbb{E}_t \left[\sum_{j=0}^{\infty} \beta^{t+j} \left(u^{\mu_{t+j}(i)} \left(c_{t+j}^{\mu_{t+j}(i)}(i); \xi_{t+j} \right) - \int_0^1 v^{\mu_{t+j}(i)} \left(h_{t+j}^{\mu_{t+j}(i)}(i,f); \xi_{t+j} \right) \mathrm{d}f \right) \right] \tag{1}$$

where c is consumption and h is hours worked. ξ is the vector of shocks including specific shocks to the preferences of borrowers and savers, and an aggregate shock to the disutility of hours worked. We assume that

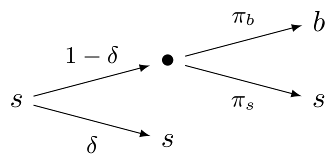
$$u_c^b(c,\xi) > u_c^s(c,\xi) \tag{2}$$

for all c and all ξ; so in equilibrium, type b households will borrow from type s households. Finally, the consumption good is a CES aggregate of the outputs of a continuum of firms, indexed by f. Members of household i work at all of these firms, and $v^{\mu}(\cdot,\cdot)$ is the disutility of the hours worked at each firm.

2.1.1 The Evolution of Household Types, and the Curdia-Woodford Insurance Agency

Following Curdia and Woodford, the evolution of a household's type is governed by a stochastic process. At the beginning of time, each household draws a type; with probability π_b it starts as a borrower, and with probability $\pi_s = 1-\pi_b$ it starts as a saver. In subsequent periods, the household keeps its type with probability $\delta \in [0,1)$, or it draws a new type with probability $1-\delta$. In the latter event, no matter what the household's previous type was, it draws type b – and becomes a borrower – with probability π_b, or it draws type s – and becomes a saver – with probability $\pi_s = 1-\pi_b$. The law of large numbers implies that π_b and π_s will always be the fractions of borrowers and savers in the economy. The type drawing process for a household that starts as a saver is illustrated in Figure 1 (a similar process applies to a current borrower).

Figure 1: Evolution of Types



Since households may switch type in any given period, the number of household histories will grow without bound. If households with different histories make different savings and consumption decisions there may be a serious aggregation problem. However, Curdia and Woodford [2009] develop an insurance scheme that makes the decisions of all households of a given type the same.[8]

[8]Krusell and Smith [1998] and others have developed techniques for analyzing fluctuations in the distribution of wealth, but it is beyond the scope of this paper to use them. We think the insights presented here suggest that our basic results are robust.

How does the insurance scheme work? At the beginning of time, and before the initial drawing of types, all households are identical; they do know, however, that their types, and therefore their preferences, will probably shift over time. So, they sign an insurance contract that is contingent upon whether they become borrowers or lenders. Curdia and Woodford show that the contract maximizes the household's expected utility over future fluctuations in its marginal utility of consumption. Operationally, the household visits the insurance agency when it is selected to draw a new type. If the household was a borrower, the insurance agent pays off the household's accumulated debt. If the household was a lender, it pays its accumulated savings to the insurance agent. Then, the household draws its new type. All of the new borrowers will be identical, and all of the new lenders will be identical. Their past histories will be irrelevant for their savings and consumption decisions.

2.1.2 The Household's Budget Constraint

Savers can only hold two financial assets: government bonds that pay a rate i_t^g, and bank deposits that pay a rate i_t^d. Since these assets are perfect substitutes, their rates of return will equalize in equilibrium. Borrowers cannot borrow from savers directly; they can only borrow from banks at the rate i_t^b.

The net wealth of household i at the end of period t is

$$B_t(i) = A_t(i) - P_t c_t^{\mu_t(i)}(i) + \int_0^1 W_t(f) h_t^{\mu_t(i)}(i,f)\mathrm{d}f + \Pi_t^{\mathrm{F}}(i) + \Pi_t^{\mathrm{B}}(i) - P_t \tau_t^g(i) \tag{3}$$

where $\Pi_t^{\mathrm{F}}(i)$ and $\Pi_t^{\mathrm{B}}(i)$ are the profits received by the household as an owner of firms and banks, $\tau_t^g(i)$ is a real lump sum tax, and $A_t(i)$ denotes the household's nominal assets at the beginning of period t; that is,

$$A_t(i) = (1 + i_{t-1}^d)\max(B_{t-1}(i), 0) + (1 + i_{t-1}^b)\min(B_{t-1}(i), 0) \tag{4}$$

Household i maximizes (1) subject to (3) and (4).

2.2 Bank Intermediation

Banks issue one period deposits to households that save and make one period loans to households that borrow. Unlike the operation of the insurance agency, bank intermediation is costly: a bank expends real resources to make loans. We assume that these costs can be represented by

$$\Psi_t(b_t, y_t) = \xi_{\Psi,t} b_t^{\eta} \exp\left(-\alpha \widetilde{y}_t\right) \text{ with } \eta \geqslant 1, \alpha \geqslant 0 \tag{5}$$

where $\widetilde{y}_t = \frac{y_t - y^\star}{y^\star}$ denotes the output gap, stars indicate the steady state values, b_t is the (real) value of loans made, and $\xi_{\Psi,t}$ is a cost shock. Like Curdia and Woodford, we assume that the costs are convex in b_t, and that $\xi_{\Psi,t}$ can be used to capture exogenous variations in the costs. But, we also assume that intermediation costs vary inversely with the business cycle (or the output gap). We use this as a proxy for agency problems that become more severe during a recession; for example, banks have to undertake greater screening and monitoring efforts when times are bad, and good borrowers are harder to find.[9] There is also strong empirical support for our assumption; we will discuss the empirical evidence at some length in the sub-section on calibration. We will also discuss alternative modelings of the countercyclicality of the intermediation costs in a Section 4.1.

We generally follow Curdia and Woodford [2009] in our modeling of banks.[10] Banks are perfectly competitive and fully fund themselves with deposits. Deposits issued at time t, d_t, must cover loans, b_t, plus the costs of banking (all are expressed in real terms):

$$d_t \geq b_t + \Psi_t\left(b_t, y_t\right) \tag{6}$$

And the bank's objective is to maximize profits:

$$\left(1+i_t^b\right) b_t - \left(1+i_t^d\right) d_t = \left(1+i_t^b\right) b_t - \left(1+i_t^d\right)\left[b_t + \Psi_t\left(b_t, y_t\right)\right] \tag{7}$$

where the last equality incorporates the fact that the constraint will be binding as long as the interest rate on deposits is positive. The optimality condition for b_t gives

$$1+i_t^b = \left(1+i_t^d\right)\left(1+\omega_t\right) \tag{8}$$

where

$$\omega_t = \frac{\partial \Psi_t(b_t, y_t)}{\partial b_t} \tag{9}$$

The cost of increasing the loan by one unit (the RHS) is equal to the benefit (the LHS). Using (5), the markup factor ω_t can be written as

$$\omega_t = \eta \xi_{\Psi,t} b_t^{\eta-1} \exp\left(-\alpha \widetilde{y}_t\right) \tag{10}$$

2.3 Firms

A continuum of monopolistically competitive firms, indexed by $f \in (0,1)$, produce intermediate goods using the technology

$$y_t(f) = \xi_{y,t} h_t(f)^{\frac{1}{\varphi}} \tag{11}$$

where $h_t(f)$ is a CES aggregate of the households' labor and $\xi_{y,t}$ is an aggregate productivity shock. Competitive retailers buy the intermediate goods at price $P_t(f)$ and bundle them into the

[9] See Mishkin [2001], for a detailed discussion of how reductions in net worth and cash flows exacerbate adverse selection and moral hazard problems in lending to firms. Unfortunately, the existing ways of modeling these agency problems in macroeconomics do not easily extend to models with heterogeneous agents.

[10] We have made a minor change in the timing of dividend payments. This does not change the bank's first order conditions, but it does make their derivation easier to motivate.

final good, y_t, using a CES aggregator with elasticity θ. The final good is then sold, at price $P_t = \left(\int_0^1 P_t(f)^{1-\theta}\mathrm{d}f\right)^{\frac{1}{1-\theta}}$, to households and the government.

Wages are flexible, but prices are not. In particular we employ the standard Calvo price setting scheme. In each period, an intermediate good firm gets the opportunity to re-set its price with probability $1-\gamma$. As is well known, a dispersion of intermediate good prices distorts household consumption patterns and the efficient use of labor. So, aggregate output is

$$y_t = \frac{\xi_{y,t}}{\Delta_t}\int_0^1 h_t(f)^{\frac{1}{\varphi}}\mathrm{d}f \tag{12}$$

where $\Delta_t = \int_0^1 \left(\frac{P_t(f)}{P_t}\right)^{-\theta}\mathrm{d}f > 1$ when $\gamma > 0$. When $\gamma = 0$, prices are flexible and there is no price dispersion; that is, $\Delta_t = 1$.

In equilibrium

$$y_t = \pi_b c_t^b + \pi_s c_t^s + g_t + \Psi_t(b_t, y_t) \tag{13}$$

where g_t is government spending, c_t^b is the consumption of a borrowing household, and c_t^s is the consumption of a saving household. Intermediation costs are real resource costs that detract from public and private consumption.

2.4 Government

The consolidated government budget constraint is

$$\tau_t^g + b_t^g = \frac{1+i_{t-1}^g}{1+\pi_t}b_{t-1}^g + g_t \tag{14}$$

where b_t^g is the real supply of government bonds. Government spending follows an exogenous, AR(1) process

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1-\rho_g)\log(g^\star) + \xi_{g,t} \tag{15}$$

where $\xi_{g,t}$ is an innovation and a $\star$ denotes the steady state value.[11] $g^\star$ is calibrated to the steady state government spending to output ratio. Increases in government spending are initially bond financed, but lump sum taxes increase over time to stabilize the debt

$$\tau_t = \tau^\star + \varrho\frac{b_{t-1} - b^\star}{y^\star} \tag{16}$$

where $b^\star$ is the steady state of debt (corresponding to the steady state b/y ratio).

Monetary policy follows a standard interest rate rule

$$i_t^g = \rho_i i_{t-1}^g + (1-\rho_i)\left[i^{g^\star} + \kappa_\pi(\pi_t - \pi^\star) + \kappa_y\left(\frac{y_t - y^\star}{y^\star}\right)\right] + \xi_{i,t} \tag{17}$$

where π_t is the rate of inflation and $\xi_{i,t}$ is a policy shock.

[11] Parameters will be chosen such that output is equal to one in the deterministic steady state.

2.5 Model Calibration

In calibrating the financial sector, we will generally follow the Curdia and Woodford [2009, 2010] methodology, often adopting their own parameter values. However, Curdia and Woodford did not allow for countercyclical intermediation costs; that is, the gap term in equation (5) is missing in their model. Since the value of the parameter α is crucial to our results, we will have an extended discussion of how we arrived at its value. The other parameters are for the most part either standard in the literature or borrowed from Curdia and Woodford, and our discussion of them can be brief. All of the parameter values are listed in Table 1.

Table 1: Parameters

Parameter		Value
Household		
Discount Factor	β	0.9874
Intertemporal Elasticity (Borrowers)	σ_b	12.2209
Intertemporal Elasticity (savers)	σ_s	2.4442
Inverse Frisch Labor Elasticity	ν	0.1048
Disutility of Labor Parameter (Borrowers)	ψ_b	1.1492
Disutility of Labor Parameter (Savers)	ψ_s	0.9439
Probability of Drawing Borrowers type	π_b	0.5000
Probability of Keeping Type	δ	0.9750
Debt Share	$b^\star/y^\star$	4×0.8
Preference Shock (Average, Borrowers)	$\log(\bar{\xi}_c^b)$	8.0133
Preference Shock (Average, Savers)	$\log(\bar{\xi}_c^s)$	0.8123
Production		
Elasticity of Substitution between Goods	θ	7.6667
Inverse Labor Elasticity	$1/\varphi$	0.7500
Financial Costs		
Elasticity of Loans	η	5.000
Output Gap (deviation from SS) Elasticity	α	23.0000
Constant	$\bar{\xi}_\Psi$	1.2720e-06
Nominal Aspects		
Annual Premium (Gross)	$(1+\omega)^4$	1.0200
Degree of Nominal Rigidities	γ	0.6667
Persistence (Taylor Rule)	ρ_i	0.8000
Reaction to Inflation (Taylor Rule)	κ_π	1.5000
Reaction to Output Gap –deviation from SS– (Taylor Rule)	κ_y	0.0500
Shocks		
Government Shock (Persistence)	ρ_g	0.9700
Government Share	$g^\star/y^\star$	0.2000
Persistence (Other shocks: x)	ρ_x	0.9500
Debt feedback	ϱ	0.0200

2.5.1 The Curdia-Woodford Financial Sector

In what follows, we let

$$u^{\mu}(c^{\mu}, \xi) = \frac{\xi_c^{\mu\,\frac{1}{\sigma_\mu}} c^{\mu\,1-\frac{1}{\sigma_\mu}}}{1 - \frac{1}{\sigma_\mu}} \text{ and } v^{\mu}(h^{\mu}, \xi) = \psi_\mu \frac{\xi_h^{-\nu} h^{\mu\,1+\nu}}{1+\nu} \tag{18}$$

where ξ_c^b and ξ_c^s are preference shocks. Their steady state values, $\overline{\xi}_c^b$ and $\overline{\xi}_c^s$, are set in a way that guarantees that borrowers always have a higher marginal utility than the savers, as required by Equation (2). The curvature parameters of the utility functions, σ_b and σ_s, are set so that the average curvature parameter is 6.25 and the ratio of the curvature parameters is $\sigma_b/\sigma_s = 5$. Households' access to the insurance agency is infrequent: $\delta = 0.975$. But once there, the household has a 50–50 chance of changing type: $\pi_b = \pi_s = \frac{1}{2}$. All of these parameter values are taken from Curdia and Woodford.[12]

2.5.2 The Bank Intermediation Costs

In the next section, we will show that the government spending multipliers generated by our model are big during recessions and small during expansions; this cyclical variation in the multipliers comes from the countercyclical variation in bank intermediation costs. In our baseline model, these costs are represented by

$$\Psi_t(b_t, y_t) = \xi_{\Psi,t} b_t^{\eta} \exp\left(-\alpha \widetilde{y}_t\right) \tag{19}$$

where $\widetilde{y}_t = \frac{y_t - y^\star}{y^\star}$ denotes the output gap. We follow Curdia and Woodford in setting η at the value specified in Table 1.[13] We set $\overline{\xi}_\Psi$ to a value so that the steady state gross annual premium is 2%.

As noted above, our gap term is missing in their models. And the value of α is crucial to our results. Below we explain how we set it.

The bank's first order condition (8) implies

$$\frac{1 + i_t^b}{1 + i_t^d} = 1 + \xi_{\Psi,t} \eta b_t^{\eta-1} \exp\left(-\alpha \widetilde{y}_t\right) \tag{20}$$

First, we will set α by looking at average interest rate spreads over the business cycle. Then, we will show that our choice is supported by additional empirical analysis.

More precisely, we set the value of α so that the cyclical behavior of the interest rate spread in our model is in line with the spread in the data. For this exercise, the spread is defined empirically as the difference between the corporate bond (AAA) rate and the 3-month Treasury Bill rate, and

[12] We have also carried the analysis out with shares of borrowers in the population that differ from 0.5. The important factor for the size of the multipliers is not the share per se but the total amount of debt.

[13] This value implies that a 10 percent increase in the volume of lending increases the equilibrium credit spread by about 1 percentage point.

expansions (recessions) are defined as quarters in which output is above (below) trend. Trend output is computed using an HP filter with a smoothing parameter of 1600. Over the period 1960:I–2008:IV, the average (annualized) spread during expansions was 1.65%, and the average spread during recessions was 2.8%. Output was on average 1.16% above (below) trend during expansions (recessions).

How was this data used to determine the value of α? For each shock in the vector ξ, we found the size of the shock that would generate an initial expansion (or recession) of 1.16%. Then, for each shock, we solved the model for the equilibrium value of debt, b. And finally, for each shock, we searched for the value of α that produced an interest rate spread (in the first period) that would match the corresponding spread in the data, 1.65% for expansions (say α_{iE}) and 2.8% for recessions (say α_{iR}). We found that all the αs so computed were similar and clustered around 23 so we used a single $\alpha = 23$. Table (2) shows the interest rate spreads generated for initial output displacements of 1.16%, 1% and 1.9% (which is the average decline in output during recessions as defined by the NBER). As can be seen, the spreads are very similar across shocks. The intermediation cost shock, ξ_Ψ, generates the biggest spreads over the business cycle; this may not be too surprising since this shock enters directly the intermediation cost equation.

Table 2: The source of the business cycle and spreads

	1.16%		1.0%		1.9%	
Shock	E	R	E	R	E	R
ξ_c^b	1.54	2.55	1.60	2.46	1.31	2.98
ξ_c^s	1.53	2.56	1.59	2.47	1.31	2.98
ξ_h	1.55	2.54	1.60	2.46	1.32	2.97
ξ_Ψ	1.41	2.72	1.48	2.61	1.12	3.30
ξ_y	1.55	2.54	1.60	2.46	1.32	2.97
ξ_i	1.53	2.56	1.59	2.47	1.30	3.00

Note: E denotes an expansion and R denotes a recession.

Because of the importance of this parameter, we sought corroborating evidence for our choice of $\alpha = 23$. This evidence comes from instrumental variable estimation of the parameters of the intermediation cost function. Table 3 reports the estimates of the elasticities of the spread with respect to total loans, η, and the output gap, α, obtained from the regression

$$\widehat{\omega}_t = \theta_b \widehat{b}_t - \theta_y \widehat{y}_t + u_t$$

where u_t is the error term. The spread is measured by the difference between a corporate bond rate (either AAA or BAA) and a money market rate (either the federal funds rate or the Treasury bill rate).[14] Output is measured by real GDP and loans correspond to total loans at commercial

[14]Data sources are reported in the Appendix to the paper.

banks.[15] The output gap uses HP–filtered output ($\lambda = 1600$). We used a variety of instruments such as the real price of oil and various fiscal variables (the growth rate in defense spending, the Ramey [2011] estimate of exogenous changes in government spending and the Forni and Gambetti [2014] measure of fiscal news shocks). In some of the estimations we also used the lagged values of the RHS variables, that is, of the output gap and debt. As the results were quite similar across the various specifications, we are reporting here only a subset of the results.

The elasticities were obtained as

$$\eta - 1 = \theta_b \quad (21)$$

$$\alpha = \theta_y \quad (22)$$

As can be seen, the estimation produces values for α that are similar to the calibrated value used.

Table 3: IV Regressions of the spread

	AAA-FFR		BAA-FFR		AAA-TBILL		BAA-TBILL	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
η	0.01	5.04	1.45	5.76	1.01	4.84	2.06	5.54
	(0.69)	(1.69)	(0.58)	(1.39)	(0.56)	(1.30)	(0.49)	(1.13)
α	32.88	23.52	28.69	24.69	25.05	20.76	23.23	22.50
	(4.47)	(14.12)	(3.72)	(11.60)	(3.59)	(10.87)	(3.13)	(9.46)

Note: The regressions use as instruments current and lagged values (4 lags) of the changes in real price of oil prices. In addition, (I) uses current and lagged values of Ramey's fiscal news variable while (II) uses instead the current and lagged values of the growth rate in defense spending.

2.5.3 The Other Parameters

The value of the labor elasticity parameter is set as in Curdia and Woodford. On the firm side, the inverse labor elasticity is set to $\psi = 0.75$, and the elasticity of substitution between intermediate goods is set so that the markup rate is 15%. The Calvo parameter and the production parameters are standard in the literature. Setting $\gamma = 2/3$ means that price settings last 3 quarters on average. The parameters of the interest rate rule and the process for government spending are also representative of those used in the literature.

[15] Using instead either consumer loans or business loans produces very similar results, but leads to higher estimates of the degree of countercyclicality of spreads, α.

3 Cyclical Government Spending Multipliers

We can compute multipliers for recessions or expansions that are generated by any one of the shocks in the model. We compute both consumption and output multipliers, and study their cyclical variations. We solve the model under perfect foresight using the non-linear method proposed by Laffargue [1990] and Boucekkine [1995], as implemented in DYNARE; this solution method captures the non-linearities that are necessary for our arguments.

Let ξ_x denote a shock to the exogenous variable x, and let ξ_x^R and ξ_x^E denote shocks that trigger a recession or an expansion. In our benchmark experiment, we choose an ξ_x^R that is large enough to make output fall by 1.9%, and we choose an ξ_x^E that is large enough to make output rise by 1.9%. The two shocks need not be of the same size in absolute value since the model is not linear, and 1.9% is the average decline in output during recessions identified by the NBER. Then, we induce an immediate fiscal response –a positive government spending shock, $\xi_{g,t}$, of 1%. Finally, we calculate the corresponding multipliers.

More precisely, let $M_h^z(\xi_x)$, $z \in \{c, y\}$, denote a consumption or output multiplier at horizon h when the economy is hit by shock ξ_x. Let $z_{t+i}(\xi_x, g)$ denote the path of z when the shock to the exogenous variable x is accompanied by a fiscal response, and let $z_{t+i}(\xi_x)$ denote the path in the absence of a fiscal response. Then, the cumulative multiplier h quarters after the shock is computed as

$$M_h^z(\xi_x) = \frac{\sum_{i=0}^{h}(z_{t+i}(\xi_x, g) - z_{t+i}(\xi_x))}{\sum_{i=0}^{h}(g_{t+i} - g^\star)} \tag{23}$$

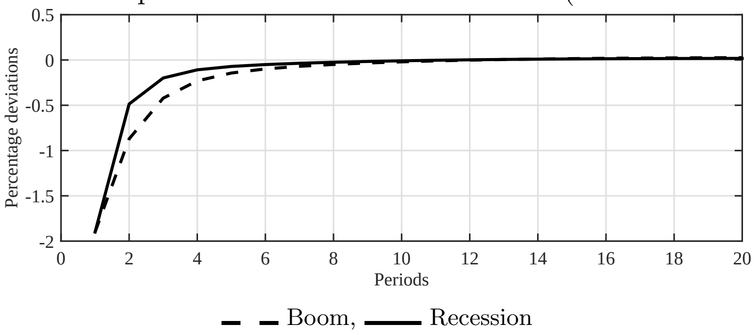
We begin with our benchmark simulations in which the recession and the expansion are generated by the financial intermediation cost shocks. Then, we show that the other shocks produce similar multipliers. And finally, we present some additional empirical support for the way the multiplier process works in our model.

3.1 Multipliers Generated in Response to Intermediation Cost Shocks

In our benchmark simulations, we study business cycles caused by intermediation cost shocks. These are essentially shocks to the spread between the borrowing rate and the deposit rate, $i^b - i^d$; this spread is a measure of the severity of the financial friction. Figure 2 shows impulse response functions (IRF's) for output in the *absence* of a fiscal response. The unbroken IRF line is generated by the recessionary shock ξ_Ψ^R, while the dashed IRF is generated by the expansionary shock ξ_Ψ^E. The graph for the expansion has been inverted for easier comparison with the graph for the recession.

The IRF's are clearly not symmetric; output reverts to its steady state value more quickly in the case of a recession.[16]

Figure 2: IRF of Output to a Financial Market Shock (Benchmark Experiment)



What accounts for the differing speeds of reversion to the steady state? There is a financial accelerator embodied in the interest rate spread, and this accelerator is stronger in recessions than in expansions, because of the countercyclicality of bank intermediation costs. Consider first the recovery from a recession. The recessionary shock immediately *increases* the spread (since $\alpha > 1$), and the severity of the financial friction. As the economy starts to recover, the spread narrows and the lower borrowing rate stimulates borrowers' consumption, which in turn increases output. And the process continues: the increase in output narrows the spread, which stimulates consumption, which increases output, which narrows the spread, and so on. The same accelerator works in reverse in the case of an expansion. However, the expansionary shock initially *lowers* the spread (since $\alpha > 1$), and the financial friction; so, the accelerator process is weaker in an expansion.

Figure 3: Output Multipliers (Benchmark Experiment)

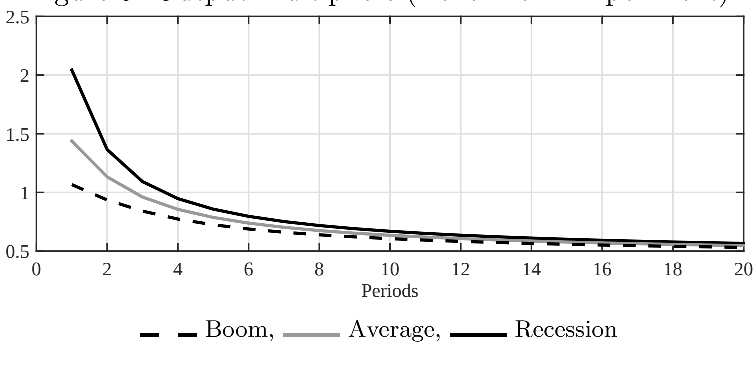


Figure 2 shows the response of output to the shocks without any fiscal response. Figure 3 shows the cumulative output multipliers generated with the fiscal responses to the shocks. The unbroken dark line shows multipliers during a recession; the dashed line shows multipliers during an expansion.[17]

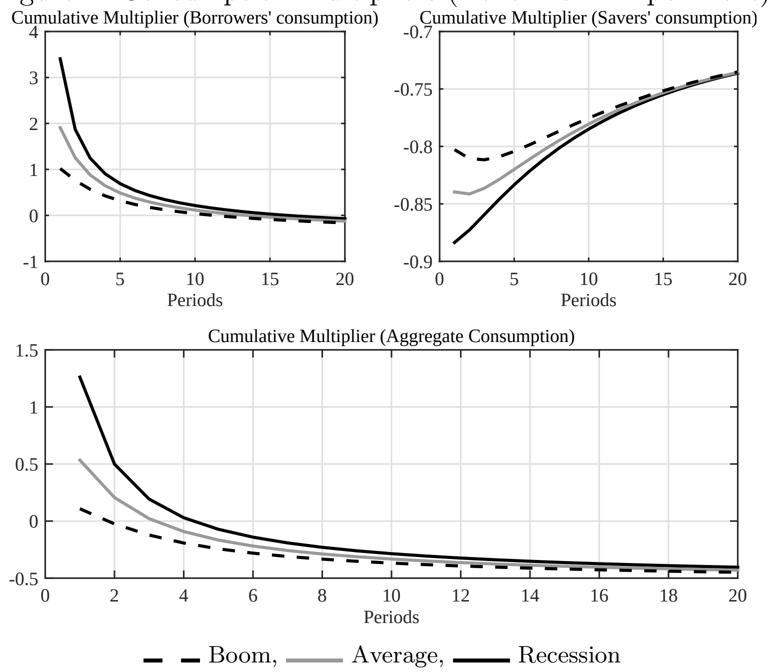
[16] This result is consistent with the empirical evidence (see Hamilton [1989], Beaudry and Koop [1993], Acemoglu and Scott [1997]).

[17] For comparison, the light line shows the response of output to a fiscal shock that starts from the steady state;

For the recession, the first quarter multiplier is about 2; for the expansion, it is about 1. These multipliers are in line with the empirical results of Auerbach and Gorodnichenko [2012].[18]

To gain a better understanding of these results, we generated consumption multipliers – multipliers for borrowers and savers individually, and for aggregate consumption. These multipliers are shown in Figure 4. We also calculated reactions in the financial markets, shown in Figure 5.

Figure 4: Consumption Multipliers (Benchmark Experiment)



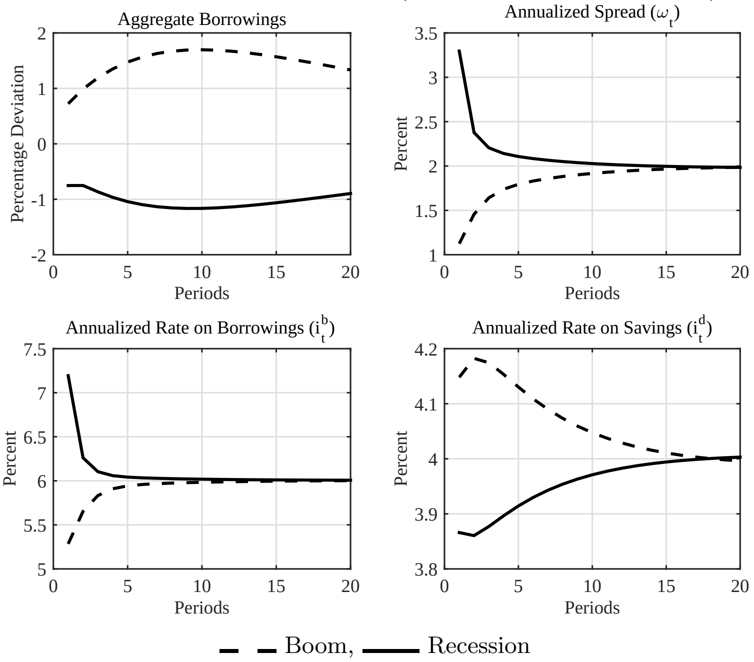
The increase in government spending is ultimately financed by higher taxes, and this increases the tax burden on both borrowers and savers. This by itself has a *negative* wealth effect on household consumption. In a model with no financial frictions and lump sum taxes, this is the only wealth effect. Households respond by working harder and/or consuming less, and the timing of the tax increases does not matter.

In our model, however, there is a second wealth effect. The financial frictions imply that borrowers discount future tax liabilities at a rate that exceeds the interest rate on public debt; that is, $i_t^b > i_t^d = i_t^g$. The fiscal response to a recession brings an additional increase in household income, and this creates a *positive* wealth effect for the impatient borrowers. If this second wealth effect

interestingly, it falls almost half way in between the other two.

[18]More precisely, they find that the maximum output multiplier (over the first 20 quarters) during a recession is 2.48, with the 95% confidence interval given by [1.93;3.03]. Note, though, that our IRF show quick tapering off and thus cannot match the shape of theirs. We return to the issue of tapering off in Section 4.5. Naturally, as we show in the technical appendix– available online at `http://fabcol.free.fr/index.php?page=research`– adding real rigidities such as habit persistence delays the peak in the multiplier.

Figure 5: Financial Markets (Benchmark Experiment)



is large enough, it can increase the consumption of borrowers and aggregate consumption. Figure 4 shows that this is what happens under our calibration. These wealth effects complement the financial accelerator that was described earlier. The unbroken lines in Figure 5 show what happens in financial markets for recessionary shocks. As can be seen, the spreads come down quickly following the fiscal intervention and the recovery is relatively fast.

In expansions, the reversion to the steady state is slower. The reason for this, once again, is the cyclical variation of the spread. As can be seen in Figure 5, the spread, $i_t^b - i_t^g$ $(=i_t^b - i_t^d)$, widens disproportionately during a recession while it contracts in an expansion. That is, any amelioration in the financial friction is much more stimulating for the borrowers – who play the crucial role for the multiplier – in bad times than in good times. The increase in borrowers' consumption is smaller, and in our calibration, aggregate consumption falls; output multipliers are less than one.

3.2 Multipliers Generated in Response to the Other Shocks

Business cycles can be initiated by any of the shocks in our model, and one might think that the size of the multipliers would depend on the shock that is postulated.[19] Or, in other words, how representative are our benchmark simulations? Table 4 reports cumulative output multipliers for different shocks: the first three are preference shocks (to the marginal utility of consumption for borrowers and lenders, and to the disutility of labor), the fourth is the financial shock used in the benchmark scenario, the fifth is a productivity shock, and the sixth is a monetary policy shock. In

[19] Hereafter and unless clearly specified, we will refer to output multipliers as multipliers

all cases the size of the shock is such that it generates a recession (or expansion) of 1.9%.

Table 4: Multipliers: Sensitivity to the source of the business cycle

Shock	1 Quarter		1 Year		2 Years		5 Years	
	E	R	E	R	E	R	E	R
Benchmark								
$\xi^b_{c,t}$	1.17	1.85	0.80	0.92	0.65	0.70	0.54	0.56
$\xi^s_{c,t}$	1.11	1.94	0.78	0.94	0.64	0.72	0.53	0.56
$\xi_{h,t}$	1.10	1.92	0.77	0.94	0.64	0.72	0.53	0.56
$\xi_{\Psi,t}$	1.07	2.04	0.77	0.95	0.64	0.72	0.53	0.57
$\xi_{y,t}$	1.10	1.92	0.77	0.94	0.64	0.72	0.53	0.56
$\xi_{i,t}$	1.22	1.82	0.82	0.90	0.66	0.70	0.54	0.56

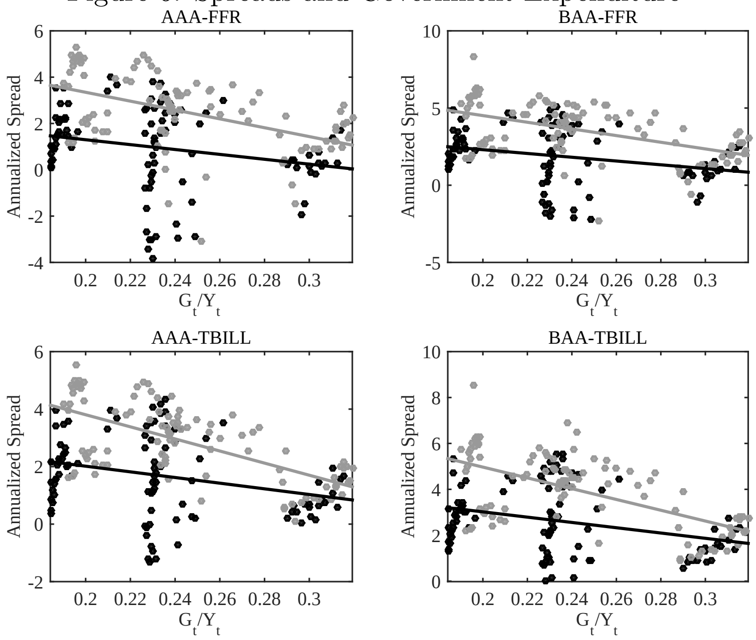
Note: This table reports the cumulative multipliers of output obtained in a 1.9% expansion (E) and in a 1.9% recession (R) generated by each of the shocks considered.

There is some variation in the impact multipliers; our benchmark shock gives the largest impact multiplier. But in all cases, multipliers are larger in recessions (about 2) and smaller (around one or less) in expansions. After the first year, the cause of the business cycle does not seem to matter much. So, our benchmark case is quite representative, and we will continue to use it in what follows.

3.3 Additional Evidence Supporting Our Model's Multiplier Process

Here, we present additional evidence supporting the way in which our model generates fiscal multipliers. This evidence explores the relationship between government spending and the interest rate spread during contractions and expansions. Figure 6 and Table 5 document the relationship between government spending (as a share of GDP) and various measures of the interest rate spread by running a regression of the latter on the former. In order to minimize possible endogeneity problems we have used as instruments for G/Y the same instruments we used in the spread equation. The results with and without instrumental variables are identical and they are also the same across the different sets of instruments, so we only report results with the growth of defense spending and the real price of oil. In Figure 6 each period is classified as either a "contraction" or an "expansion," depending on whether output in that period is above or below the H-P filtered trend. The light dots in the graph correspond to contractions and the dark ones to expansions. The figure exhibits three features. First and consistent with the information reported in the calibration section, spreads are on average higher during recessions than during expansions. Second, spreads are negatively related to government spending. And third and more importantly from the point of view of the properties of the model, there is state dependence; that is, the slope of the light line steeper than that of the dark line. The effect of a change in government spending on spreads is considerably more pronounced in recessions than in booms.

Figure 6: Spreads and Government Expenditure



Note: Dark points mark expansions (and the dark line the corresponding regression line); light points mark contractions (and the light line the corresponding regression line). A "contraction" ("expansion") is identified with periods during which the cyclical component of output (obtained from the HP filter) is negative (positive). Period: 1960Q1-2008Q1. Changes in oil prices and the rate of growth in government defense spending (current value and 4 lags) were used as instruments for the share of government spending in GDP.

Table 5 reports the corresponding p-values for the test that the slopes of the two lines in Figure 6 are the same.

Table 5: Difference in slope in Figure 6: p–value

AAA-FFR	BAA-FFR	AAA-TBILL	BAA-TBILL
0.14	0.12	0.01	0.01

4 Structural Variations and Other Robustness Exercises

In this section, we show how our results fare when we consider a variety of structural changes and different parameter values.[20] The countercyclicality of bank intermediation costs is crucial to our results, and we focus much of our attention on that part of the model. More specifically, we consider: (1) different ways of modeling the "gap" in bank intermediation costs; (2) debt versus tax financing of a change in government spending; (3) changing the magnitude of the fiscal response; (4) changing the amplitude of business cycles; (5) different parameters in the monetary policy rule;

[20]The companion technical appendix reports additional robustness checks and empirical evidence. It also provides a discussion of whether and how the model can generate hump shaped multipliers.

(6) changing the severity of financial frictions in the steady state; (7) changing the elasticity of bank lending costs with respect to the output gap (that is, the parameter α); and finally, (8) changing the degree of price rigidity (as measured by the Calvo parameter, γ). This sensitivity analysis is conducted only under the benchmark bank lending cost shock as we established in the previous section that the source of the cycle did not make much of a difference.

4.1 The Cyclicality of Financial Intermediation Costs

In our benchmark specification, bank intermediation costs are represented by

$$\Psi_t(b_t, y_t) = \xi_{\Psi,t} b_t^{\eta} \exp\left(-\alpha \widetilde{y}_t\right) \tag{24}$$

where $\widetilde{y}_t = \frac{y_t - y^\star}{y^\star}$ denotes the output gap relative to the steady state value of y. The counter-cyclicality of intermediation costs plays a crucial role in our results. But, should the cyclical gap be defined in this particular way? Here, we consider alternative specifications of the gap term. First, we replace the output gap with either an employment gap or a profits gap; in each case, the gap is defined relative to steady state values. Then, we replace the benchmark output gap with alternative notions of how an output gap might be defined; that is, we consider output gaps relative to variables other than the steady state value of y. The punch line from these exercises is that for our mechanism to work it is essential that the economic activity measure used in the spread equation must be positively influenced by a fiscal expansion and that this influence must be disproportionate during recessions relative to expansions.

Replacing the output gap with an employment gap or a profits gap: We tried replacing the output gap with either an employment gap or a profits gap.[21] In each case, α was re-calibrated using the procedure described in the calibration section. Table 6 reports the results; the top panel shows multipliers generated by the various shocks using our benchmark specification of the gap, while the other panels show the multipliers associated with the use of employment or profits gaps. The patterns of the multipliers remain largely unaffected; our basic results seem robust to changes in the variable appearing in the cyclical gap at least to the extent that candidate variables share the property that they are positively influenced by expansionary fiscal policy.

Other measures of the output gap: Here, we stick to an output gap, but we consider alternative notions of how the gap should be defined. The "efficient" output gap replaces the steady state value, $y^\star$, with the efficient level of output, y_t^E; this is the level of output that is generated by our model when prices are flexible ($\gamma = 0$) and the financial friction is eliminated ($\xi_{\Psi,t} = 0$). The "flexible" output gap replaces $y^\star$ with the flexible price level of output, y_t^F; this is the level of

[21] Note that we cannot consider an investment gap as there is no capital in our model.

output generated by our model when just the price rigidities are eliminated. Table 7 reports the size of the multipliers under the efficient output gap, and Figures 7 and 8 give the IRFs for the benchmark gap, the efficient output gap and the interest rate spread. Table 8, and Figures 9 and 10 present the same information for the flexible price output gap.

Table 6: Multipliers: Other variables in the gap term

Shock	1 Quarter		1 Year		2 Years		5 Years	
	E	R	E	R	E	R	E	R
Output gap (the benchmark case)								
$\xi^b_{c,t}$	1.17	1.85	0.80	0.92	0.65	0.70	0.54	0.56
$\xi^s_{c,t}$	1.11	1.94	0.78	0.94	0.64	0.72	0.53	0.56
$\xi_{h,t}$	1.10	1.92	0.77	0.94	0.64	0.72	0.53	0.56
$\xi_{\Psi,t}$	1.07	2.04	0.77	0.95	0.64	0.72	0.53	0.57
$\xi_{y,t}$	1.10	1.92	0.77	0.94	0.64	0.72	0.53	0.56
$\xi_{i,t}$	1.22	1.82	0.82	0.90	0.66	0.70	0.54	0.56
Employment gap								
$\xi^b_{c,t}$	1.24	2.02	0.84	0.96	0.67	0.73	0.55	0.57
$\xi^s_{c,t}$	1.18	2.11	0.81	0.98	0.66	0.74	0.54	0.58
$\xi_{h,t}$	1.18	2.08	0.80	0.98	0.66	0.74	0.54	0.58
$\xi_{\Psi,t}$	1.13	2.22	0.81	0.99	0.66	0.74	0.54	0.58
$\xi_{y,t}$	1.34	1.79	0.79	0.99	0.65	0.74	0.54	0.58
$\xi_{i,t}$	1.29	1.98	0.86	0.95	0.68	0.72	0.55	0.57
Profits gap								
$\xi^b_{c,t}$	1.25	1.55	0.92	1.02	0.74	0.79	0.59	0.60
$\xi^s_{c,t}$	1.21	1.59	0.89	1.05	0.73	0.80	0.58	0.61
$\xi_{h,t}$	1.20	1.60	0.89	1.05	0.73	0.80	0.58	0.61
$\xi_{\Psi,t}$	1.18	1.62	0.88	1.05	0.73	0.80	0.58	0.61
$\xi_{y,t}$	1.20	1.60	0.89	1.05	0.73	0.80	0.58	0.61
$\xi_{i,t}$	1.38	1.42	0.97	0.98	0.76	0.77	0.59	0.60

Note: This table reports the cumulative multipliers of output obtained in a 1.9% expansion (E) and in a 1.9% recession (R) generated by each of the shocks considered and for three alternative activity variables in the banking costs equations. The parameter α was calibrated in each case so as the average spread is 2% (23, 18, and 25 respectively).

Two observations emerge. First, regardless of which definition of the gap is used, the multiplier is always countercyclical. And second, for multipliers to be large, the shock under consideration has to have a substantial impact on the output gap that appears in the spread equation; the financial

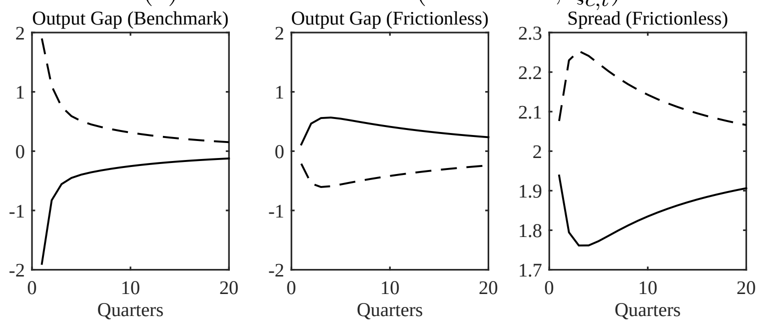
Table 7: Multipliers: Alternative output gaps

Shock	1 Quarter		1 Year		2 Years		5 Years	
	E	R	E	R	E	R	E	R
Efficient Output Gap								
$\xi^b_{c,t}$	1.16	1.46	0.74	0.84	0.61	0.66	0.52	0.54
$\xi^s_{c,t}$	1.02	1.72	0.72	0.86	0.60	0.67	0.52	0.55
$\xi_{h,t}$	1.02	2.10	0.73	0.90	0.61	0.69	0.52	0.55
$\xi_{\Psi,t}$	0.97	1.83	0.72	0.87	0.60	0.67	0.52	0.55
$\xi_{y,t}$	1.02	2.10	0.73	0.90	0.61	0.69	0.52	0.55
$\xi_{i,t}$	1.10	1.64	0.76	0.83	0.62	0.66	0.53	0.54

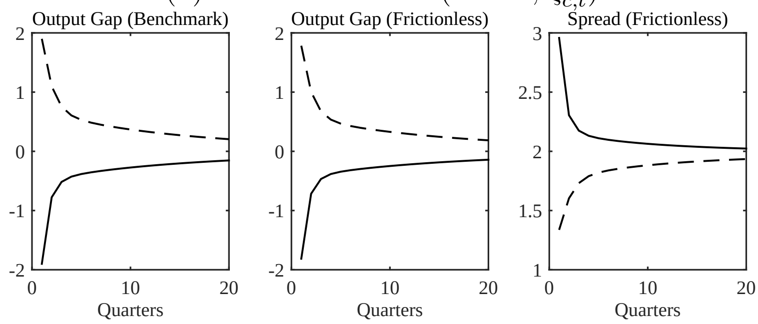
Note: This table reports the cumulative multipliers of output obtained in a 1.9% expansion (E) and in a 1.9% recession (R) with regard to output trend generated by each of the shocks considered.

Figure 7: Impulse responses to shocks, efficient output gap

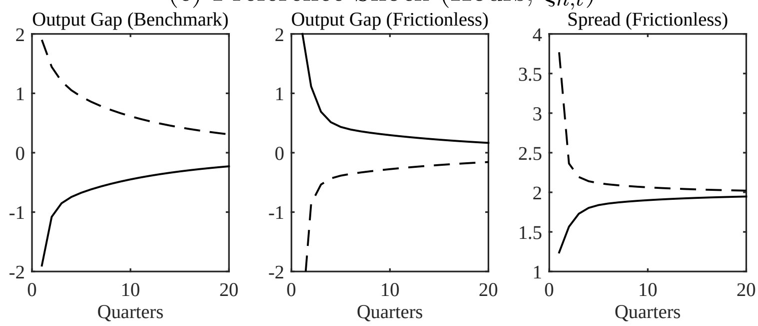
(a) Preference Shock (Borrowers, $\xi^b_{c,t}$)



(b) Preference Shock (Savers, $\xi^s_{c,t}$)



(c) Preference Shock (Hours, $\xi_{h,t}$)



- - - - Boom; —— Recession

Figure 8: Impulse responses to shocks, efficient output gap

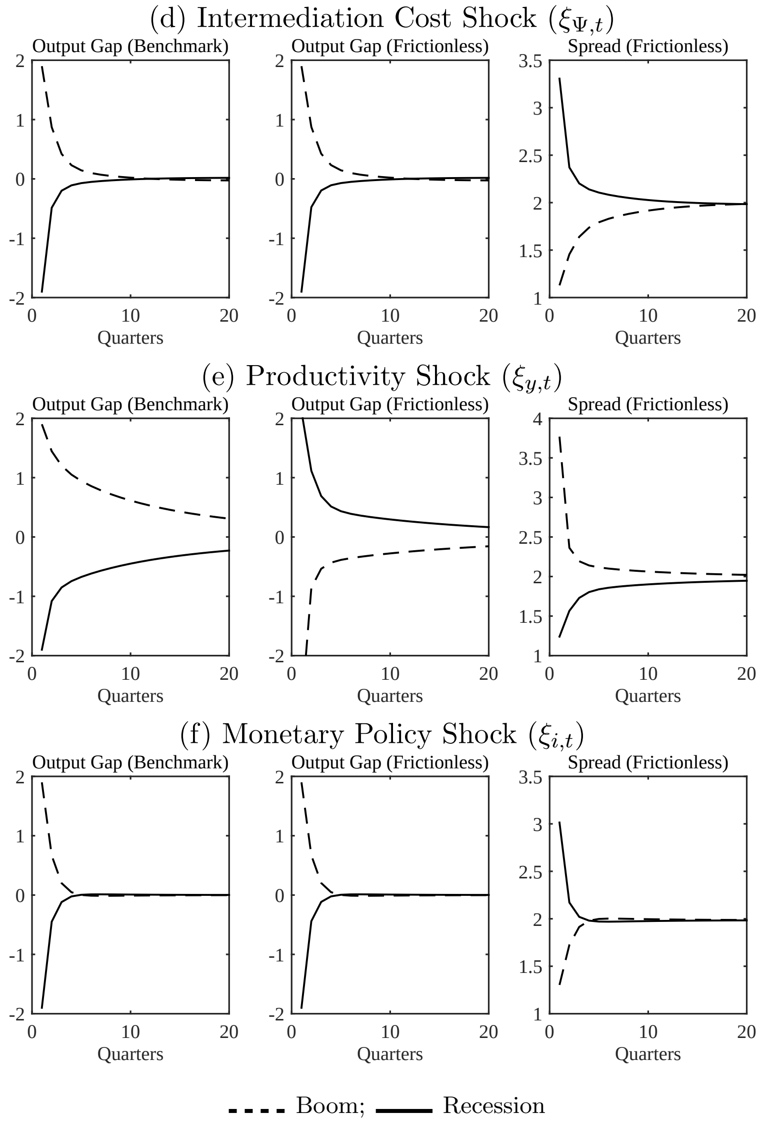


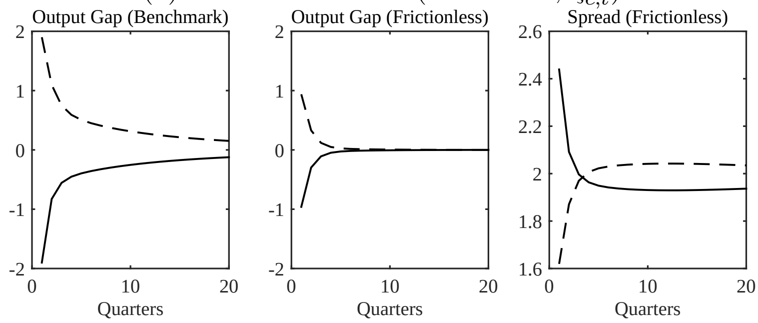
Table 8: Multipliers and the source of the business cycle

Shock	1 Quarter		1 Year		2 Years		5 Years	
	E	R	E	R	E	R	E	R
Flexible Output Gap								
$\xi^b_{c,t}$	0.82	0.90	0.57	0.58	0.50	0.51	0.48	0.48
$\xi^s_{c,t}$	0.77	0.97	0.56	0.59	0.50	0.51	0.47	0.48
$\xi_{h,t}$	0.97	0.78	0.59	0.57	0.51	0.50	0.48	0.48
$\xi_{\Psi,t}$	0.74	1.05	0.55	0.60	0.50	0.52	0.47	0.48
$\xi_{y,t}$	0.97	0.78	0.59	0.57	0.51	0.50	0.48	0.48
$\xi_{i,t}$	0.77	0.99	0.57	0.59	0.50	0.51	0.48	0.48

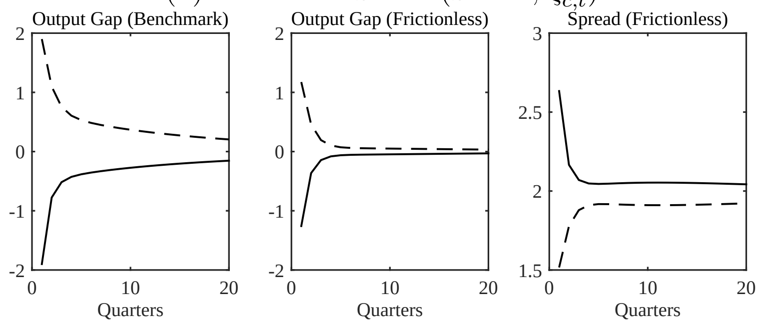
Note: This table reports the cumulative multipliers of output obtained in a 1.9% expansion (E) and in a 1.9% recession (R) with regard to output trend generated by each of the shocks considered.

Figure 9: Impulse Responses to Shocks, Flexible Price Output Gap

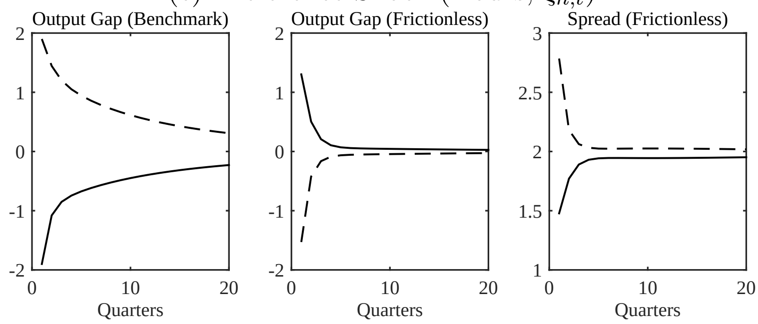
(a) Preference Shock (Borrowers, $\xi_{c,t}^{b}$)



(b) Preference Shock (Savers, $\xi_{c,t}^{s}$)



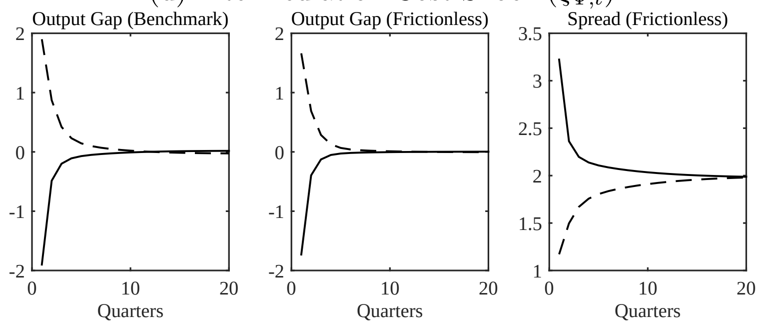
(c) Preference Shock (Hours, $\xi_{h,t}$)



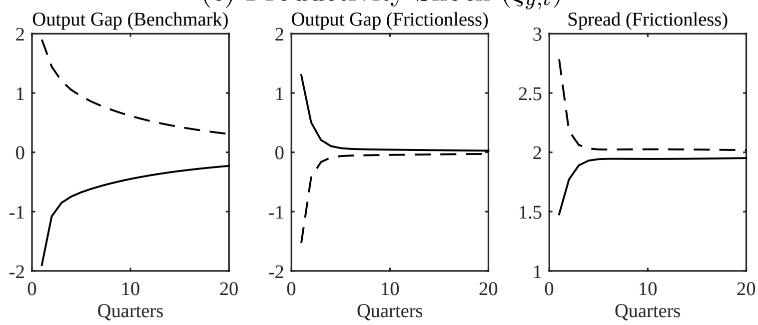
- - - - Boom; ——— Recession.

Figure 10: Impulse Responses to Shocks, Flexible Price Output Gap

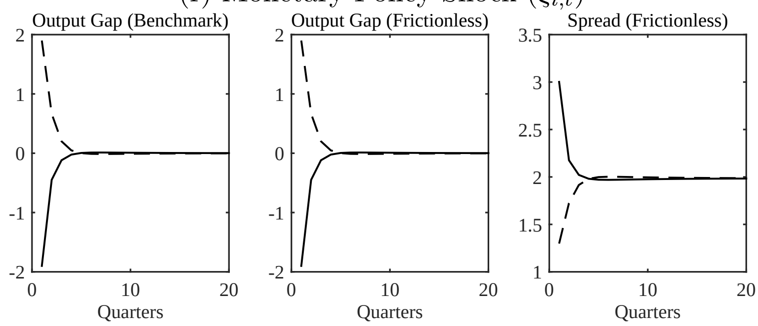
(d) Intermediation Cost Shock ($\xi_{\Psi,t}$)



(e) Productivity Shock ($\xi_{y,t}$)



(f) Monetary Policy Shock ($\xi_{i,t}$)



- - - - Boom; —— Recession.

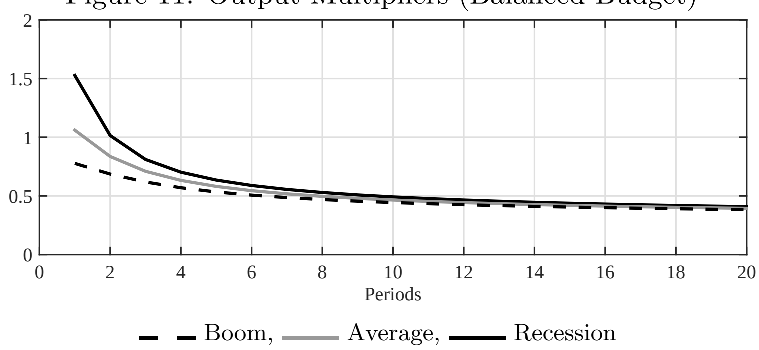
accelerator cannot get going when it receives a weak impulse.[22] The importance of the amplitude of the business cycle will be demonstrated further in Section 4.4. While the impulse is typically strong in the case of the efficient output gap, it is typically weak under the flexible price gap. Figures 9 and 10 demonstrate this. Consider, for instance, the effect of a preference shock to savers. The graph in the second row, first column of Figure 9 shows the response of the benchmark output gap while the graph in the second column of the same row gives the response of the flexible price gap; the third graph in this row shows the response of the spread. The initial change in the flexible price output gap is small, about half of that for the benchmark gap (or for the efficient gap, see the graphs in the second row, second column of Figure 7). So while the shock gives rise to a severe recession according to the benchmark gap (1.9%), it gives rise to a smaller flexible price gap (1%) due to the fact that it moves actual and flexible price output in the same direction. A smaller recession has a smaller effect on the corresponding spread and consequently fails to set a strong financial accelerator in motion.

To summarize: In order for our model to produce state dependent fiscal multipliers it is necessary that particular measures of activity be used in the spread equation. These measures must be sufficiently responsive to business cycle shocks and also respond the "right" way to fiscal policy. Of the gaps considered above, only the flexible price output gap does not have these properties and thus fails to generate sufficient variation in the fiscal multipliers across the different states of the business cycle.

4.2 Debt vs Tax Finance of Government Spending

In our benchmark simulations, the tax rule (16) stabilizes debt dynamics. With this rule, the increase in government spending is partially bond financed. Figure 11 shows how Figure 3 would change if this rule were replaced by a balanced budget rule.

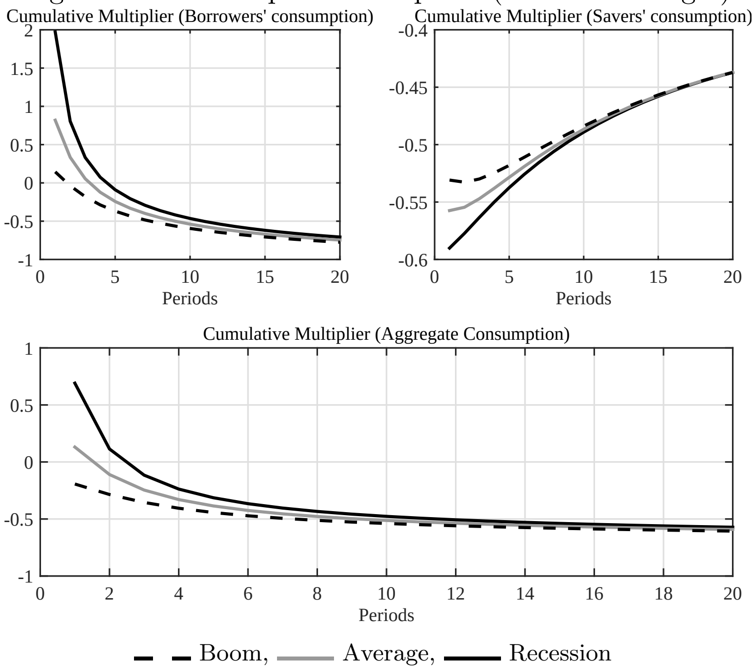
Figure 11: Output Multipliers (Balanced Budget)



[22] A further requirement that has been already stressed is that the output gap must be appropriately responsive to fiscal policy, in the sense that a fiscal expansion during a recession closes the output gap.

The cumulative multipliers in Figure 11 are now smaller than those in Figure 3. The reason is that the increase in the consumption of the borrowers is now lower, as can be seen by comparing Figures 12 and 4. As in the the benchmark case, government spending expands output and closes the output gap, which decreases the interest rate spread and generates a positive wealth effect for the borrowers. But with the balanced budget rule, the borrower is taxed in the current period and so has fewer funds to spend on consumption. This implies a weaker consumption response and a smaller multiplier.

Figure 12: Consumption Multipliers (Balanced Budget)



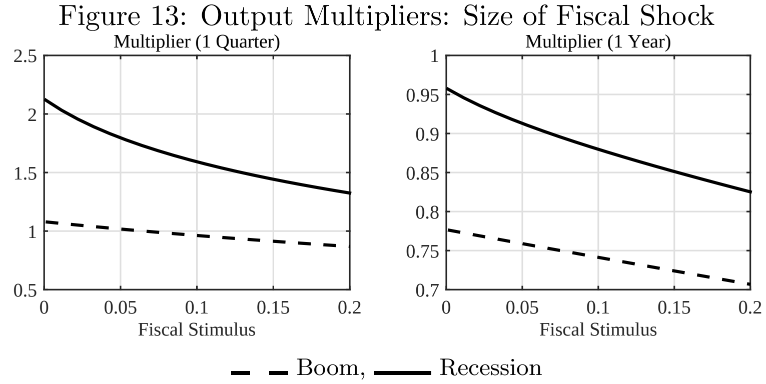
By contrast, savers' consumption drops by less under a balanced government budget. This is due to the difference in interest rates across the two schemes of financing government spending. When no debt is issued the deposit rate is lower than when debt is issued. With a lower interest rate there is less of an incentive to reduce current consumption. Nonetheless, this effect on savers' consumption is much smaller than the effect on borrowers' consumption; total consumption increases, but by less than before, leading to the lower multipliers.

While the mechanisms are different, this result is reminiscent of a similar result in the traditional IS-LM, Keynesian model. The size of the multiplier varies with the method used to finance government spending; greater reliance on debt finance leads to bigger fiscal multipliers.

4.3 The Size of the Fiscal Shock and Multipliers

Does the size of the multiplier vary with the magnitude of the fiscal response? Figure 13 shows that the multiplier is decreasing in the size of the fiscal intervention. The reason that large amounts of government spending may prove less effective than smaller amounts is that the –negative– marginal wealth effect due to the higher tax liabilities is increasing in the size of the fiscal intervention while the –positive– marginal effect on the borrower from the reduction in the premium is decreasing in the size of the fiscal expansion. However, our analysis is silent on normative issues such as the optimal size of the fiscal intervention.

Figure 13: Output Multipliers: Size of Fiscal Shock



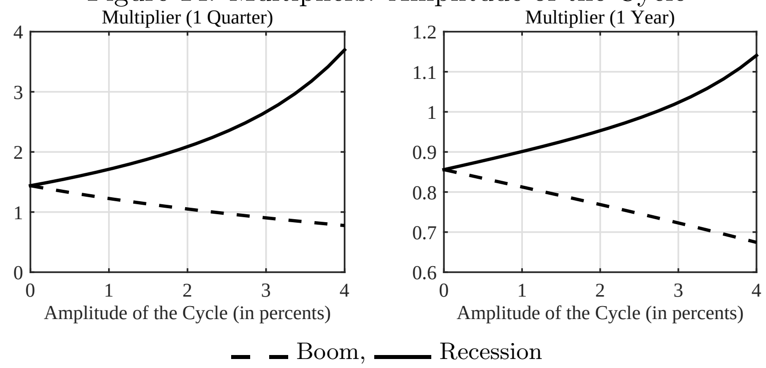
4.4 Amplitude of the Business Cycle

Since the model is non-linear, the size of the multiplier ought to depend on the amplitude of the business cycle. Figure 14 shows that this is indeed the case: the size of multipliers in a recession grows with the amplitude of the cycle, while the size of multipliers in an expansion falls with an increase in the amplitude. In our benchmark case, we chose shocks that made output rise or fall by 1.9%, which may be deemed a normal amplitude for business cycles. The impact multiplier during a recession was about two. But for a deeper recession of say 3.5%, the impact multiplier would be about 3. The multipliers rise quickly with the magnitude of the recession.

The reason for this can be found in, yet again, the cyclical variation of the spreads. The deeper the recession the larger the interest rate spread, $i_t^b - i_t^g$, and more importantly the larger the elasticity of the spread to a variation in $\widetilde{y}$.[23] Hence after an increase in fiscal expenditures, the amelioration of the financial friction will be larger in deeper recessions. The output gains from a fiscal stimulus are therefore magnified. In contrast, the greater the expansion, the smaller the elasticity and hence the smaller the gains from the mitigation of the friction.

[23]This elasticity is given by $-\alpha\widetilde{y}_t$.

Figure 14: Multipliers: Amplitude of the Cycle

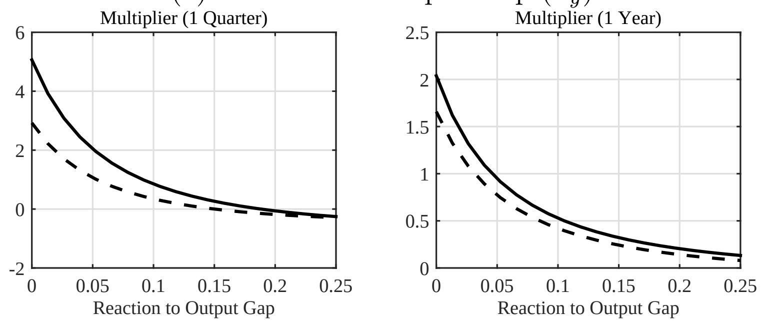


4.5 The Conduct of Monetary Policy

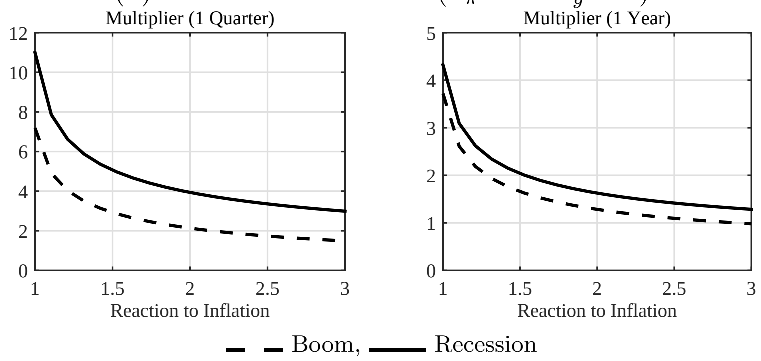
As the literature on the zero lower bound has shown, multipliers are not independent of the conduct of monetary policy. Figure 15 shows how monetary policy can affect the cumulative output multipliers through its reaction to inflation and output fluctuations.

Figure 15: Multipliers and Monetary Policy (κ_y, κ_π)

(a) Reaction to Output Gap (κ_y)



(b) Reaction to Inflation (κ_π with $\kappa_y = 0$)



Panel (a) suggests that an increase in the reaction of monetary authorities to the output gap lowers the size of the multiplier. This is because monetary policy now closes more of the output gap and hence lowers the spread by more. As we have shown before, fiscal policy is less effective when applied to a smaller spread, so the multipliers are decreasing in the level of κ_y.

Panel (b) depicts the multiplier as a function of the reaction to inflation, κ_π. In order to facilitate the exposition we employed a policy rule with $\kappa_y = 0$.[24] An increase in the weight placed on price stability means a smaller multiplier. The reason is as follows. Consider a negative financial shock.[25] Both output and inflation decrease. The central bank cuts interest rates as inflation is below target, and the cut is larger the larger κ_π. A more expansionary monetary policy means a smaller (negative) output gap and thus a smaller spread. But with a smaller spread, the effects of fiscal policy on output are smaller. That is, a more aggressive countercyclical monetary policy limits the contribution of countercyclical fiscal policy.

Does the measure of the output gap in the monetary policy equation matter for the effectiveness of fiscal policy and, thus, for the size of the multiplier? The answer is affirmative. Consider, for instance, using the flexible price output gap (rather than our standard measure that relies on deviations from the steady state). Because the "potential" output part of this gap responds to the shocks too, the flexible price output gap tends to move less than the steady state based gap. As a result, with a smaller gap, monetary policy needs to react less strongly, which allows fiscal policy to thrive (a situation reminiscent of the extant results in the zero interest rate bound). The effects on the size of the multipliers can be quantitatively significant, see Table 9 which is analogous to Table 4 but with the flexible price output gap in the Taylor rule.

One may ask a similar question regarding the role of the measure of the output gap but for the dynamics of the multipliers rather than their values on impact. As is evident from Figure 3, the multiplier dissipates quite fast. Is this quick tapering off affected by the output gap used in the policy equation? It turns out that using the flexible output gap in the monetary policy equation shifts the multiplier schedule upwards (this can be seen, for instance, in Table 4) but this happens in a rather uniform manner with no noticeable effect on the degree of tapering-off. What makes a difference for the path of the multipliers is not only the inertial features mentioned in footnote 16 but also the degree of persistence of the fiscal stimulus. Making the fiscal intervention less persistent matters little for the magnitude of the initial impact but makes the multipliers decline less precipitously.

4.6 The Banking Parameters

As argued before, the existence of a sizable multiplier lies in the presence of the "financial accelerator mechanism" described at the end of section 4.4. One measure of the severity of the financial friction is $\omega^\star$, the steady state level of the spread between borrowing and deposit rates. Figure 16 shows

[24] As expected in light of the previous discussion, this leads to much larger multipliers.

[25] Note that the influence of κ_π on the multiplier differs somewhat across shocks but the difference is rather small and becomes negligible as κ_π increases.

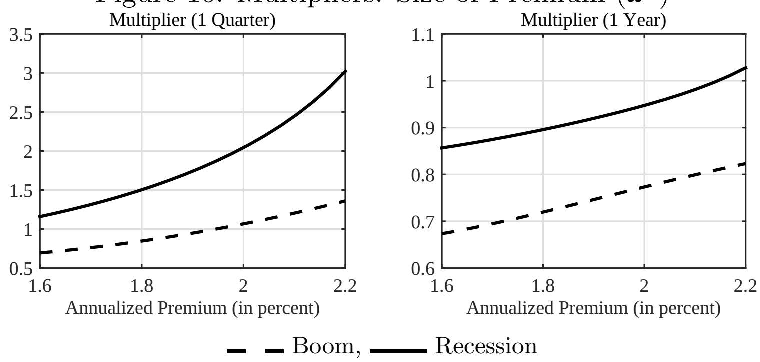
Table 9: Multipliers: Flexible price output gap in the Taylor rule

Shock	1 Quarter		1 Year		2 Years		5 Years	
	E	R	E	R	E	R	E	R
$\xi^b_{c,t}$	2.04	3.11	1.22	1.38	0.91	0.98	0.68	0.72
$\xi^s_{c,t}$	1.99	3.19	1.20	1.40	0.90	0.99	0.68	0.72
$\xi_{h,t}$	2.01	3.14	1.21	1.39	0.90	0.98	0.68	0.72
$\xi_{\Psi,t}$	1.90	3.37	1.19	1.42	0.89	1.00	0.68	0.72
$\xi_{y,t}$	2.01	3.14	1.21	1.39	0.90	0.98	0.68	0.72
$\xi_{i,t}$	2.10	3.07	1.25	1.36	0.92	0.97	0.69	0.71

Note: This table reports the cumulative multipliers of output obtained in a 1.9% expansion (E) and in a 1.9% recession (R) generated by each of the shocks considered.

that the cumulative output multipliers in a recession vary significantly with perturbations to the steady state spread. For instance, in our benchmark calibration – with an annual spread of 2% – the recession multiplier is about 2, but raising the spread by just 20 basis points increases the recession multiplier by about 50%.

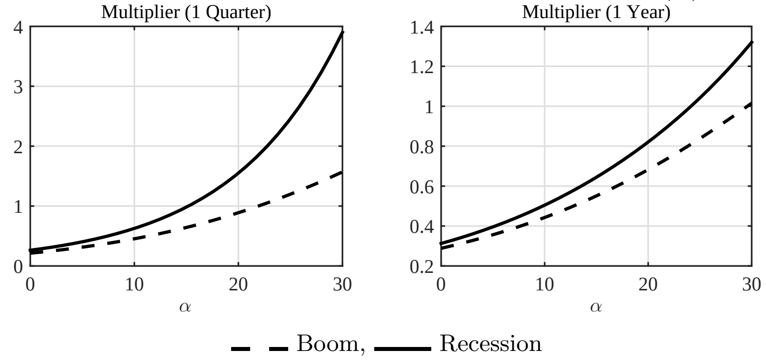
Figure 16: Multipliers: Size of Premium ($\omega^\star$)



The reason is that a larger steady state spread corresponds to a larger gap between the rates used to discount future consumption streams and tax liabilities. Hence the positive wealth effects for borrowers – and hence the multipliers – are larger the greater is the spread.

The elasticity of bank lending costs with respect to the output gap, α, is a parameter that is fundamental to our quantitative results. A larger α means that the spread is more sensitive to the state of the business cycle, and thus that fiscal policy is more effective: An increase in aggregate demand during a recession has a large impact on the spread, generating large positive wealth effects on borrowers and driving the size of the multiplier up. Figure 17 shows that even small perturbations in α can have a big effect on the cumulative output multipliers. We chose $\alpha = 23$ on the basis of the calibration exercise described in Section 1.5. This value produced multipliers consistent with the multipliers found by Auerbach and Gorodnichenko [2012] in the data. Higher values of α give even larger multipliers.

Figure 17: Multipliers: Degree of Asymmetry (α)

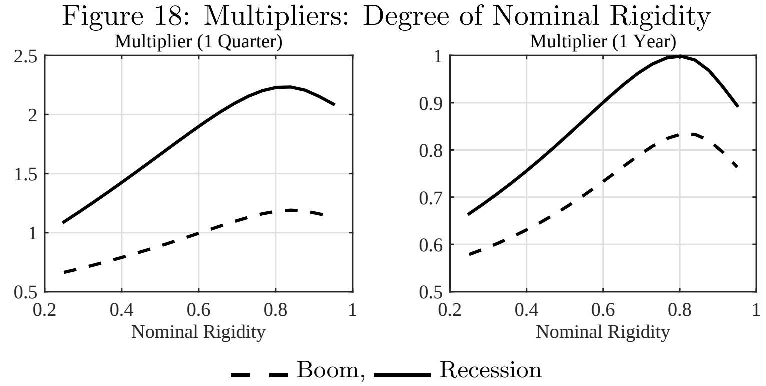


Finally, one can calculate the effect of alternative values for η on the multiplier. In general, a higher η means a larger spread for any given level of debt. Hence its implications for the multiplier are quite similar to those discussed above for the steady state spread.

4.7 The Degree of Price Rigidity

Figure 18 shows that cumulative output multipliers rise as the degree of price rigidity – γ, the Calvo parameter – is increased; they reach their maximum at about $\gamma = 0.8$. Our benchmark setting is $\gamma = 0.67$, that is, prices are reset on average every 3 quarters. In the New Keynesian literature, common values for γ are 0.67 and 0.75. In this range the multipliers are large in recessions and small in expansions, and of a magnitude consistent with the findings of Auerbach and Gorodnichenko [2012].

Figure 18: Multipliers: Degree of Nominal Rigidity



The reason that the multiplier is increasing in the degree of price rigidity is that, the more rigid the prices, the bigger the effect of government spending on closing the output gap and hence the larger the decline in the spread. Under our calibration, this effect peaks at about $\gamma = 0.8$ and then it declines somewhat. The reason for this non-monotonicity seems to be that under extreme degrees of price rigidity, monetary policy is more potent and it closes more of the output gap by itself, leaving less room for the fiscal stimulus to manifest its potency.

It is worth reporting that there is little difference in the size of the multiplier across recessions and expansions under perfect price flexibility. The multipliers are much lower in this case (about 0.55 during recessions). So price stickiness is important both for the size and the difference.

5 Conclusion

Countercyclical fiscal policy represents a puzzle. Policymakers often fight economic downturns by using budget deficits, presumably because they think that fiscal multipliers are large. While this is in line with Keynes's original recommendation and is consistent with IS-LM type of thinking, there exists preciously little in terms of recent economic modeling that supports multiplier values exceeding unity during recessions.

Some recent work has suggested that the zero lower nominal interest bound may make multipliers large during recessions (exceeding one) even when they are quite small during expansion. But, this constraint has not been a factor in most recessions. So, the zero lower bound cannot be the full story.

In this paper we have proposed an alternative, more general explanation for large and cyclically variable multipliers that is not dependent on the conduct of monetary policy. Our proposal is based on the following premises: Financial frictions matter for the business cycle, they vary countercyclically and they can be influenced by policy. And the degree to which they can be influenced by policy depends on the state of the business cycle. We show that the behavior of spreads in the data is consistent with these premises. Spreads vary countercyclically and are more sensitive to changes in fiscal policy during bad times. Under these circumstances, the model has a property present in the old-Keynesian model. Namely, that providing financially strapped agents with funds creates a positive wealth effect for them even when they take into account any increase in their future tax liabilities. The more severe and widespread the financial constraints, the larger this wealth effect and thus the higher the likelihood of a positive *aggregate* consumption response to a fiscal stimulus. Our analysis relies on spread movements rather than on the relaxation of quantitative borrowing constraints but we believe the logic is the same.

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Appendix: Data Sources

- Real Gross Domestic Product (GDPC1): `http://research.stlouisfed.org/fred2/series/GDPC1?cid=106`
- Effective Federal Funds Rate (FEDFUNDS) `http://research.stlouisfed.org/fred2/series/FEDFUNDS?cid=118`
- 3-Month Treasury Bill: Secondary Market Rate (TB3MS): `http://research.stlouisfed.org/fred2/series/TB3MS?cid=116`
- Moody's Seasoned Aaa Corporate Bond Yield (AAA): `http://research.stlouisfed.org/fred2/series/AAA?cid=47`

- Moody's Seasoned Baa Corporate Bond Yield (BAA): `http://research.stlouisfed.org/fred2/series/BAA?cid=47`