Fiscal Multipliers in Recessions

Matthew Canzoneri*
Georgetown University

Fabrice Collard†
University of Bern

Harris Dellas‡
University of Bern

Behzad Diba§
Georgetown University

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Abstract

The Great Recession, and the fiscal response to it, has revived interest in the size of fiscal multipliers. New empirical evidence shows that multipliers tend to be quite large during recessions but small – below one– during expansions. Standard business cycle models have difficulties generating multipliers greater than one. And they also fail to produce any significant asymmetry 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 to show that fiscal multipliers are strongly countercyclical. In particular, they can take values exceeding two during recessions, declining to values below one during expansions.

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*Georgetown University, Department of Economics, Washington, DC 20057, email: canzonem@georgetown.edu, Homepage: http://www9.georgetown.edu/faculty/canzonem/canzoneri.htm

†Department of Economics, University of Bern, CEPR. Address: VWI, Schanzeneckstrasse 1, CH 3012 Bern, Switzerland. email: fabrice.collard@gmail.com, Homepage:http://fabcol.free.fr

‡Department of Economics, University of Bern, CEPR. Address: VWI, Schanzeneckstrasse 1, CH 3012 Bern, Switzerland. email: harris.dellas@vwi.unibe.ch, Homepage: http://staff.vwi.unibe.ch/dellas

§Georgetown University, Department of Economics, Washington, DC 20057, email: dibab@georgetown.edu, Homepage: http://www9.georgetown.edu/faculty/dibab/

Introduction

Keynes advocated a fiscal stimulus during the Great Depression, and since then governments have routinely implemented fiscal expansions during recessions as a means of stimulating economic activity. Standard business cycle models offer scant support for this practice. Much of the criticism levelled at the Obama administration's stimulus plan was based on the implication of these models that government spending is ineffective. In a nutshell, this implication rests on the argument that an increase in government spending raises consumers' expected tax burden, and this negative wealth effect largely curtails the expansion of aggregate demand. The associated multipliers are small, hovering around one. Moreover, as we elaborate below, these models also imply that fiscal policy is ineffective even during very severe downturns. Recent empirical evidence, however, suggests that output multipliers are quite large in recessions (exceeding the value of two) even if they are low during expansions (below one). That is, the data seem to be kinder to Keynes and fiscal policy practices than are the currently popular "Keynesian" models.

The objective of this paper is to propose a model that can account for the large and asymmetric multipliers mentioned above, thus potentially justifying countercyclical fiscal policy. The model represents an extension of the Curdia and Woodford [2009, 2010] model of costly financial intermediation. Our main extension is to allow financial frictions to vary over the business cycle, and in particular, to be countercyclical. This possibility has been long recognized in financial economics[1] and is also confirmed by our empirical analysis. More recently, Cromb and Vayanos [2011] develop a model that has this implication. In particular, they show that when the wealth of financial intermediaries decreases, intermediation becomes less effective (more costly) because of margin constraints and spreads increase.

We find that countercyclical financial frictions can make multipliers large during recessions and small during expansions[2]. Indeed, our calibrated model gives rise to multipliers that, for increases in government spending of the order of 1%, are very close to those estimated by Auerbach and Gorodnichenko [2010] and Bachmann and Sims [2011]. Auerbach and Gorodnichenko [2010] use regime switching SVAR's to show that output multipliers are countercyclical. Most (if not all) of the previous work on multipliers did not allow for this

[1] 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. induces countercyclical variation in moral hazard and adverse selection problems.

[2] Collard and Dellas [2008] calculate fiscal multipliers in the model of Bernanke et al. [1999]. They find that they are small and exhibit limited cyclical variability. They attribute this to the limited cyclical variability in the degree of the financial friction present in this model even when one solves the non linear model. Similarly, in a model with financial frictions, Fernández-Villaverde [2010] finds output multipliers of about 1.

non-linearity; so, the multiplier estimates that were obtained are just averages across the business cycle. To be specific, Auerbach and Gorodnichenko 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. When they ignore the distinction between recessions and expansions they obtain an estimate of 1.00, which is right in the middle and typical of estimates in the more recent empirical literature.[3] Auerbach and Gorodnichenko also estimated cumulative output multipliers (over 20 quarters); their point estimates are -0.33 during expansions and 2.24 during recessions.

These empirical results are problematic for the currently popular New-Keynesian models. Cogan et al. [2010] (CCTW hereafter) used the Smets and Wouter's [2007] model to compute consumption and output multipliers. They consider several alternative experiments (such as permanent vs temporary government spending increases, the particular case of the Obama administration American Recovery and Reinvestment Act, different lengths of time for the zero bound constraint, 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 bound become endogenous hardly affects the output multipliers; if anything, it made them slightly smaller.

The existing literature is not unanimous regarding the role of the zero nominal interest rate bound in making fiscal multipliers larger. While CCTW find no role, Eggertsson [2001] and Christiano et al. [2009] find that it can make a big difference for the multipliers.[4]. Erceg and Lindé [2010] fall in between CCTW and Christiano et al. [2009]. But independently 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 Auerbach and Gorodnichenko data set[5]

An additional implication of our analysis is that the size of the fiscal intervention matters for the magnitude of the multiplier. In particular, while a 1% increase in government purchases during a recession produces a multiplier between 2 and 3, an increase of 5%

[3] It should be noted that the standard errors of all of these estimates are rather large, averaging about 0.24.

[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.

[5] Although the mechanism presented in this paper relies on the existence of financial frictions, it does not require financial shocks induced recessions. Most business cycle shocks will give rise to non-linear, countercyclical multipliers in our model.

or 10% gives rise to multipliers between 1.5 and 2. The reason large fiscal interventions may prove less effective than smaller one 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 finance premium is decreasing in the size of the fiscal expansion.

The rest of the paper proceeds as follows: In Section 2, we outline the model, and describe it's calibration; at the end of the section, we discuss a financial accelerator that is created by our countercyclical intermediation friction. In Section 3, we present our results for consumption and output multipliers, and we show that they can capture roughly the empirical results of Auerbach and Gorodnichenko. In Section 4, we conclude by discussing directions for future research.

1 The Model

Our model adopts the Curdia and Woodford [2009, 2010] framework of financial intermediation. Our main point of departure from that model is that we assume credit market frictions are countercyclical. This is the mainstream view in the profession, but we will present empirical evidence that offers direct support to this hypothesis, as it is crucial to our results. And we will use our empirical findings to calibrate the parameters of the function describing the financial friction.

It is not easy to formulate a dynamic general equilibrium model with private borrowers and lenders. Keeping track of the wealth of heterogeneous agents can be a daunting task. So, Curdia and Woodford devise a rather ingenious insurance scheme to make the solution tractable. In the Curdia-Woodford framework, households have access to complete financial markets, but only on a random and infrequent basis. During the intervening periods, the household only has access to limited – and costly – financial intermediation: savers can deposit funds at a bank (or hold government bonds) and borrowers can obtain loans from the bank. Banks are competitive, and they maximize profits period by period. But more importantly, banks incur a cost when making a loan. It turns out that households' infrequent access to complete financial markets makes wealth dynamics tractable, while costly financial intermediation adds the financial friction that is at the heart of our results.

1.1 Households

In each period t an individual agent, i, has a type $\mu(i) \in \{b, s\}$. The household's type may vary over time in a manner that is described below. Household i's preferences in period t

are represented by

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

where $u^{\mu}(\cdot,\cdot)$ is the utility of consumption of type μ household. 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 type μ household's disutility for the hours worked at each firm. ξ_t is the vector of preference shocks: specific preference shocks for borrowers and savers, and aggregate shocks to the disutility of hours worked. The difference between type b and type s agents lies in the fact that type b agents have a higher marginal utility of current consumption, that is,

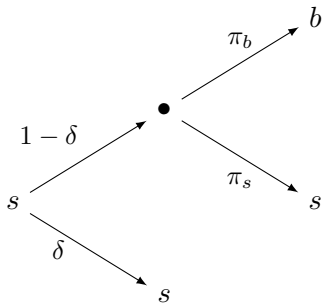
$$u_c^b(c,\xi) > u_c^s(c,\xi) \tag{2}$$

for all c and all ξ. In equilibrium, the type b agents will borrow while the type s will save. We will also refer to type b (resp. s) agents as impatient (resp. patient).

1.1.1 Evolution of Household Types

As explained previously, the type of an agent can change from one period to the next.[6] The type change is governed by a simple stochastic process. In each and every period an agent either keeps his type with probability $\delta \in [0,1)$ or redraws a type with probability $1-\delta$. In the latter event, the agent draws type b –becomes a borrower– with probability π_b or type s with probability $\pi_s = 1 - \pi_b$. The law of large numbers implies that π_b and π_s will be the –unchanging– fractions of borrowers and savers in the economy. The type drawing process for somebody who is at present a saver is described in Figure 1 (a similar process applies to a current borrower). Given that agents can switch type with

Figure 1: Evolution of Types



[6]The setting is identical to Curdia and Woodford, and the reader is referred to their paper for a more detailed presentation.

probability $1-\delta$, the number of household histories goes to infinity, potentially generating a formidable heterogeneity of wealth. Curdia and Woodford [2009] develop an insurance scheme that makes it possible to aggregate across agents in a tractable way. Agents can sign state contingent contracts that allow them to transfer to or receive resources from an insurance agency when and only when they have been selected to draw a new type. These contracts –which are optimal in the context of the Curdia-Woodford model– have the property that they eliminate all history dependence for those drawing a new type. In particular, wealth is redistributed in such a way that all agents who end up drawing the same type after visiting the insurance agency are identical. Curdia and Woodford then show that the consumption and employment decisions within each type is the same, independent of individual history. The distribution of wealth across agents at any point in time becomes irrelevant.

1.1.2 The Household's Budget Constraint

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

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

where $\Pi_t^{\mathrm{F}}(i)$ and $\Pi_t^{\mathrm{B}}(i)$ are the profits received by the household as the owner of firms and banks, $T_t(i)$ is a transfer from the insurance fund (0 unless the household had access to the agency at the beginning of the period), $\tau_t^g(i)$ is a real lump sum tax, and $A_t(i)$ denotes agent i's nominal assets at the beginning of period t; that is,

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

i_{t-1}^b is the nominal interest rate on bank loans and i_{t-1}^d is the interest rate on bank deposits created in period $t-1$. Note that government bonds compete with bank deposits, and the government bond rate, i_{t-1}^g, is equal to the deposit rate in equilibrium.

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

1.2 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. Its costs are given by

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

where $\widetilde{y}_t = \frac{y_t - y^\star}{y^\star}$ denotes the relative deviation of output from its steady state level. $\xi_{\Psi,t}$ is a cost shock. Like Curdia and Woodford, we assume that the cost is convex in the

(real) amount of loans made, b_t.[7] But, in addition, we assume that banking costs vary as a function of the business cycle (the output gap). We use this as a proxy for agency problems (default risk) in credit markets that become more severe during recessions. This assumption implies, that loan rates will have a countercyclical spread over deposits rates. There are compelling theoretical reasons for this countercyclicality[8] which also received strong empirical support[9].

Banks are competitive – they take the deposit and lending rates, i_t^d and i_t^b, as given – and they maximize profits period by period. Real bank profits in period t are

$$\frac{\Pi_t^B}{P_t} = d_t - b_t - \Psi_t(b_t, y_t) \tag{6}$$

and it chooses d_t and b_t to maximize profits subject to[10]

$$(1 + i_t^d)d_t = (1 + i_t^b)b_t \tag{7}$$

Let us define the spread between the lending and the deposit rate, ω_t, by $1 + i_t^b = (1 + \omega_t)(1 + i_t^d)$, then the bank's first order condition is

$$\omega_t = \frac{\partial \Psi_t(b_t, y_t)}{\partial b_t} \tag{8}$$

The cost of making an additional dollar loan (the RHS) is equal to the benefit (the LHS). Using (5), the bank's first order condition can be written as

$$\omega_t = \eta \xi_{\Psi,t} b_t^{\eta-1} \exp\left(-\alpha \widetilde{y}_t\right) \tag{9}$$

Our assumption that spreads are countercyclical ($\alpha > 0$) will play a crucial role in what follows. This represents the conventional view and there are compelling theoretical arguments that justify it. Nonetheless, given the role it plays in our analysis, we also present empirical evidence that supports it. Table 1 reports estimates of the long–run elasticities of the spread with respect to total loans, η, and the output gap, α, obtained from the regression

$$\widehat{\omega}_t = cst + (\theta_b - 1)\widehat{b}_t - \theta_y \widehat{y}_t + \sum_{i=1}^{\ell} \gamma_i \widehat{\omega}_{t-i}$$

[7] Using the loan to GDP ratio in place of b_t does not affect the implications of the model. See the technical appendix.

[8] 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 modelling these agency problems in macroeconomics do not easily apply to models with heterogenous agents. Curdia and Woodford use the shock to the cost of banking to represent exogenous variation in the probability of default. We adopt their approach and use the endogenous output gap in place of their exogenous shock to capture the same variation in default (agency problems).

[9] See, for instance, Gilchrist and Zakrajsek [2011], Figure 1.

[10] Following Curdia and Woodford we let banks select deposits and loans subject to this equation. As i_t^d is smaller than i_t^s, $d_t > b_t$. The difference between the volume of deposits and loans is used to pay for the intermediation costs and is the source also of bank profits.

where $\widehat{x}_t = (x_t - x^\star)/x^\star$. Output is measured by real GDP and loans correspond to total loans at commercial banks.[11] For both variables we use deviations of the log levels from a linear trend. The long–run elasticities are obtained as

$$\eta_x = \frac{\theta_x}{1 - \sum_{i=1}^{\ell} \gamma_i}$$

Table 1: Spread Regressions

	1960Q1–2008Q4			
	AAA-FFR	BAA-FFR	AAA-TBILL	BAA-TBILL
η	5.60	7.23	6.46	7.88
	(4.94)	(3.79)	(3.99)	(3.56)
α	37.45	30.90	24.39	23.11
	(15.29)	(11.33)	(11.81)	(9.82)
Lags	2	2	4	4
$\overline{R}^2$	0.82	0.83	0.85	0.86
D.W.	1.95	1.90	1.96	1.89
	1982Q3–2008Q4			
	AAA-FFR	BAA-FFR	AAA-TBILL	BAA-TBILL
η	3.86	6.77	4.34	6.25
	(3.20)	(4.30)	(3.16)	(3.31)
α	24.90	27.99	18.15	21.21
	(12.08)	(13.19)	(9.40)	(9.67)
Lags	2	2	2	2
$\overline{R}^2$	0.89	0.89	0.89	0.89
D.W.	2.08	1.96	2.17	1.90

Note: Standard deviations between parenthesis. The number of lags was determined relying on a likelihood ratio test.

The spread is measured as the difference between corporate bond rates, either AAA or BAA, and either the federal funds rate, FFR, or the Treasury bill rate, TBILL.[12] We present two sets of regressions, since monetary policy is generally thought to have changed fundamentally around 1980. The estimates of the marginal cost parameters, α and η , are very stable over time. All of the regressions produce a positive and significant estimate of α. We utilize these regression results to calibrate the parameters in the cost function (5).

[11] 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.

[12] Data sources are reported in Appendix A.

1.3 Firms

A continuum of monopolistically competitive firms, indexed by f, produce intermediate goods using the technology

$$y_t(f) = \xi_{y,t} h_t(f)^{\frac{1}{\varphi}} \tag{10}$$

where $h_t(f)$ is a CES aggregate of the households' labor and $\xi_{y,t}$ is an auto-regressive aggregate productivity shock. Competitive retailers buy the intermediate goods at price $P_t(f)$ and bundle them into the 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 popular Calvo price setting scheme. In each period, an intermediate good firm gets the opportunity to re-set price optimally 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

$$y_t = \frac{\xi_{y,t}}{\Delta_t} \int_0^1 h_t(f)^{\frac{1}{\varphi}} \mathrm{d}f \tag{11}$$

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

$$y_t = \pi_b c_t^b + \pi_s c_t^s + g_t + \Psi_t(b_t, y_t) \tag{12}$$

1.4 Government

The consolidated government flow budget constraint is

$$\tau_t^g + b_t^g = \frac{1 + i_{t-1}^g}{\pi_t} b_{t-1}^g + g_t \tag{13}$$

where i_t^g is the interest rate on government bonds; it will be recalled that $i_t^g = i_t^d$ (since savers are indifferent between holding bank deposits and public debt). Government spending follows an auto-regressive process

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1 - \rho_g) \log(g^\star) + \xi_{g,t} \tag{14}$$

where $\xi_{g,t}$ is an innovation. Increases in government spending are initially bond financed, but lump sum taxes increase over time to stabilize the debt

$$\tau_t = \tau^\star + \varrho \frac{b_{t-1} - b^\star}{y^\star} \tag{15}$$

Note that Ricardian equivalence does not hold in our model. In particular, borrowers discount future liabilities at a rate that exceeds the interest rate on public debt.[13] A tax cut financed by an increase in government debt generates a positive wealth effect for them.

Monetary policy follows a standard interest rate rule

$$i_t^g = \rho_i i_{t-1}^g + (1-\rho_i)\left[i^{g^\star} + \kappa_\pi(\pi_t - \pi^\star) + \kappa_y\left(\frac{y_t - y^\star}{y^\star}\right)\right] + \xi_{i,t} \tag{16}$$

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

1.5 Model Calibration

The baseline calibration of our model's parameters closely follows Curdia and Woodford [2009, 2010][14] and is reported in Table 2. In what follows, we will let

$$u^\mu(c^\mu, \xi) = \frac{\xi_c^{\mu\,\frac{1}{\sigma_\mu}} c^{\mu\,1-\frac{1}{\sigma_\mu}}}{1-\frac{1}{\sigma_\mu}} \text{ and } v^\mu(h^\mu, \xi) = \psi_\mu \frac{\xi_h^{-\nu} h^{\mu\,1+\nu}}{1+\nu} \tag{17}$$

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 $\sigma_b/\sigma_s = 5$. The levels of ξ_c^b and ξ_c^s are set in a way that guarantees that borrowers always have a higher marginal utility than the savers (see equation 2). The value of the labor elasticity parameter is as in Curdia and Woodford. The discount factor, β, is set so that the nominal deposit rate is 1% per quarter. Households' access to the insurance agency is infrequent: $\delta = 0.975$. But once there, the household has a 50–50 chance of changing type: $\pi_b = \pi_s = \frac{1}{2}$.

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.

The financial costs parameters are of great importance for our analysis. The values used for η and α are representative of the estimates reported in Table 1. η is set to 6.5, which actually coincides with the value used in Curdia and Woodford. α is set to 23, which is

[13] Savers also discount the future at a rate exceeding that on public debt because of the possibility of switching type.

[14] More precisely, the parameters are set using the same methodology as in Curdia and Woodford. However, since our model departs slightly from theirs in several minor ways (for example, we do not have sales taxes) some of our parameters differ from theirs.

Table 2: Parameters

Parameter		Value
Household		
Discount Factor	β	0.9874
Intertemp. Elasticity (Borrowers)	σ_b	12.2209
Intertemp. Elasticity (savers)	σ_s	2.4442
Inverse Frischian Labor Elasticity	ν	0.1048
Disutility of Labor param. (Borrowers)	ψ_b	1.1492
Disutility of Labor param. (Savers)	ψ_s	0.9439
Probability of Drawing Borrowers type	π_b	0.5000
Probability of Keeping Type	δ	0.9750
Share of Borrowings	b/y	4×0.8
Preference Shock (Average, Borrowers)	$\log(\overline{\xi}_c^b)$	8.0133
Preference Shock (Average, Savers)	$\log(\overline{\xi}_c^s)$	0.8123
Production		
Elasticity of Subst. btw. goods	θ	7.6667
Inverse labor Elasticity	$1/\varphi$	0.7500
Financial Costs		
Borrowing Elasticity	η	6.5000
Output Gap Elasticity	α	23.0000
Constant	$\overline{\xi}_\Psi$	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 (Taylor Rule)	κ_y	0.0500
Shocks		
Government Shock (Persistence)	ρ_g	0.9700
Government Share	g/y	0.2000
Persistence (Other shocks: x)	ρ_x	0.9500
Debt feedback	ϱ	0.0200

representative of the values obtained in the regressions.[15] With this value, spreads are about 4% during a recession with a GDP gap of -2.5% and about 1% in a boom of the same magnitude. The average value of the financial shock, $\overline{\xi}_\Psi$ is set so that, as in Curdia and Woodford, the steady state annual premium is 2% (which is in line with the values reported in the literature; see, e.g., Gilchrist and Zakrajsek, 2011). This also implies that steady state financial costs represent 0.24% of output. Note that we later conduct a thorough sensitivity analysis on these parameters.

The model is solved under perfect foresight using the non–linear method proposed by Laffargue [1990] and Boucekkine [1995] as implemented in DYNARE.

2 Cyclical Fiscal Multipliers

We can compute multipliers over the business cycle for cycles generated by any of the shocks in the model. Let ξ_x denote a shock to the exogenous variable x. Let us denote by ξ_x^R, respectively ξ_x^E, the value of the shock to the exogenous variable x that triggers a recession, respectively expansion. In our benchmark experiment, we choose a ξ_x^R that is large enough to make output fall by 2.5%; then, we choose a ξ_x^E that will make output rise by 2.5%.[16]

In order to evaluate the effectiveness of fiscal policy over the business cycle we generate an expansion or recession and then immediately induce a fiscal response to it by having the government spending shock, $\xi_{g,t}$, respond by one percent. Let $z \in \{c, y\}$, where c refers to consumption and y to aggregate output, be the multiplier, 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

$$M_h^z(\xi_x) = \frac{\sum_{i=0}^{h}(z_{t+i}(\xi_x, g) - z_{t+i}(\xi_x))}{\sum_{i=0}^{h}(g_{t+i} - g^\star)} \tag{18}$$

2.1 Financial Market Shocks and Multipliers

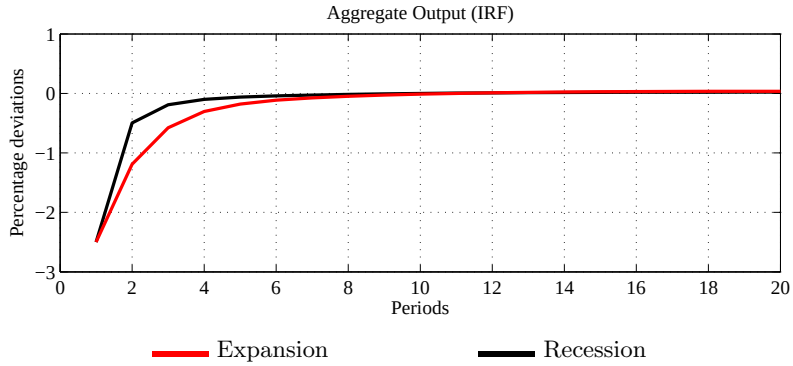
In our benchmark simulations, we study business cycles caused by the shock to the spread, ξ_Ψ. Figure 2 shows impulse response functions (IRF) for output in the *absence* of a fiscal

[15] Note that the value chosen is rather conservative. As noted previously, when consumer loans or business loans are used in place of total loans, higher values of α are obtained. Using those values would result in even higher multipliers during recessions (in the range of 3 to 4).

[16] Note that the two shocks need not be of the same size (in absolute value) since the model is not linear.

response. The dark (or black) IRF is generated by a positive shock that is large enough to cause a output to fall by 2.5%. The light (or red) IRF is generated by a negative shock that would cause a 2.5% expansion; the graph for an expansion has been inverted for easier comparison with the recession case.

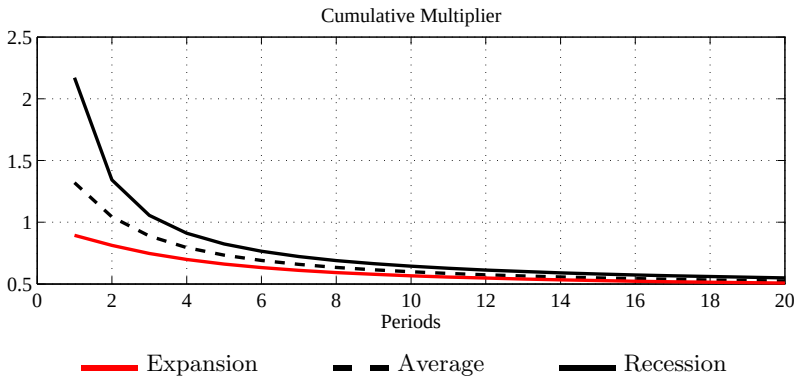
Figure 2: IRF of Output to a Financial Market Shock (Benchmark Experiment)



The IRF's are not symmetric. In particular, output reverts to its steady state value more quickly in the case of a recession; a fact which is consistent with the empirical evidence (see Hamilton [1989], Beaudry and Koop [1993], Acemoglu and Scott [1997]). This is due to the fact that any given change in output has a more powerful effect on the premium during recessions, which serves to accelerate the process of recovery during recessions.

Figure 3 reports the cumulative output multipliers generated when fiscal policy reacts contemporaneously to the financial shock. The dark line shows multipliers during a recession; the light line shows multipliers during an expansion. For the recession, the first quarter

Figure 3: Cumulative Multipliers (Benchmark Experiment)



(and maximal) multiplier is about 2.25; for the expansion, it is less than unity (0.89). These multipliers roughly capture the empirical results of Auerbach and Gorodnichenko

[2010].[17]

Figure 4: Consumption Multipliers (Benchmark Experiment)

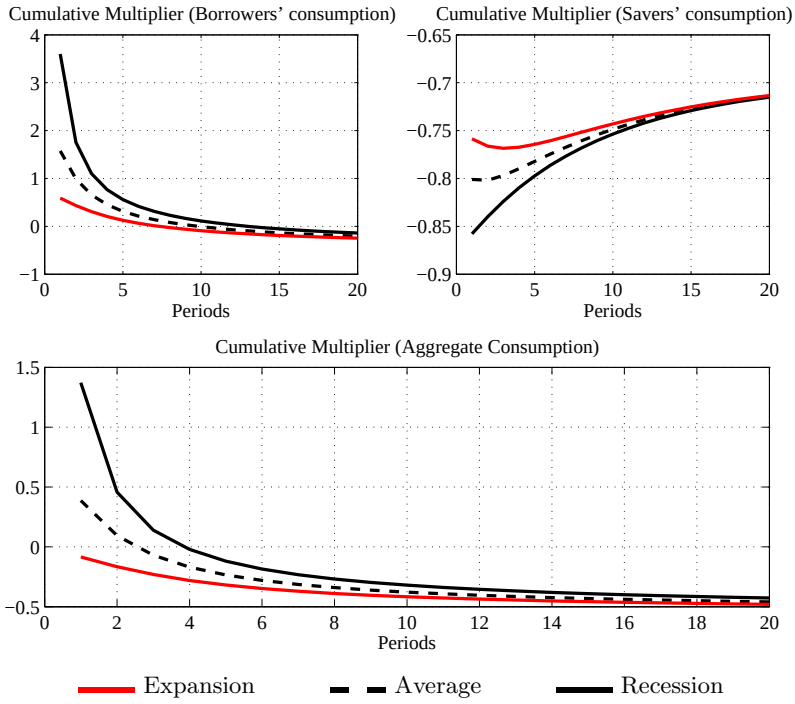
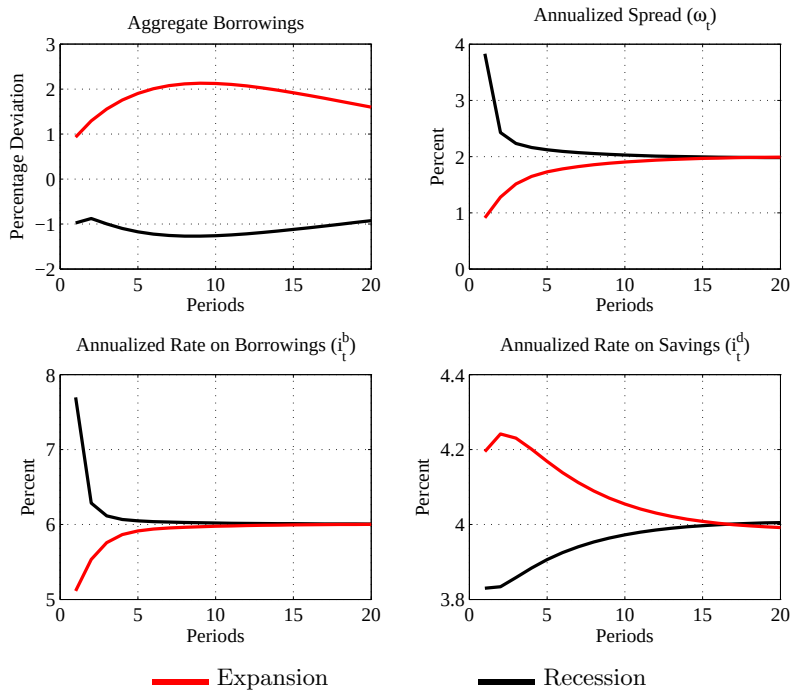


Figure 4 reports cumulative multipliers for aggregate consumption, and for borrowers and savers individually; it shows what the determinants of the output multipliers are. An increase in government spending that is partly financed by higher taxes raises the present and future tax burden on all agents. This by itself has a negative wealth effect on households. In the standard model, this is the only effect, and the Ricardian households are induced to work harder and/or consume less in order to to meet their higher tax obligations. In our model, however, there is an additional effect that operates through the credit constraint. The reduction of the spread caused by higher government spending has a positive effect on the consumption of the credit constrained agent. If this effect is large enough relative to the negative wealth effect associated with the higher expected taxes, then the borrowers end up increasing their consumption (while the savers' consumption drops).

An expansion in government spending during a severe recession (a period of high spreads) has thus the potential to lead to an increase in the consumption of borrowers that exceeds

[17]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 cannot match the shape of theirs.

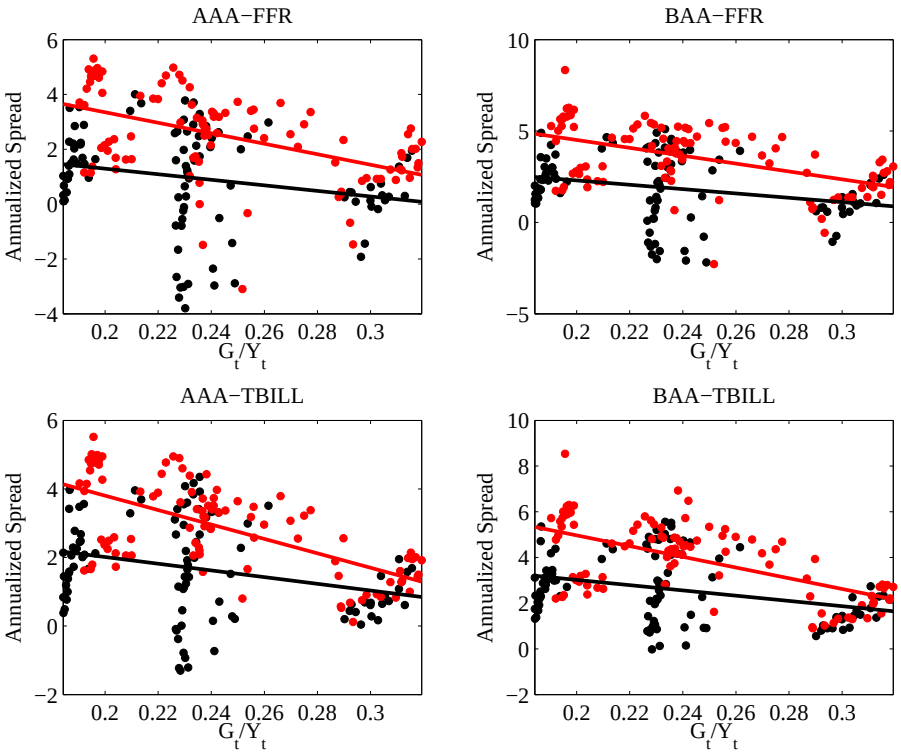
Figure 5: Financial Markets (Benchmark Experiment)



the reduction in the consumption of the savers. Aggregate consumption rises. This is sufficient to produce output multipliers that are greater than one. But in expansions, the increase in the consumption of the borrowers is smaller, and in our calibration, aggregate consumption falls; output multipliers are less than one. The reason for this result lies in the asymmetric 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 than in good times.

Figure 6 provides some direct suggestive evidence concerning the relationship between spreads and government spending (the government spending to GDP share). It exhibits two features. First and consistent with the empirical findings reported in section 1.2, spreads are on average higher during recessions than during expansions. And second and more important from the point of view of the properties of the model discussed above, it shows a cyclical asymmetry. In particular, the effect of any change in government spending (as a share of GDP) on spreads is considerably more pronounced during recessions relative to booms. Related information on correlations between g/y and spreads is reported in Table 3.

Figure 6: Spread–Government Expenditures Correlation



Note: Dark plain line (marks): Booms, Red plain line (marks): Recession. A "recession" is identified with periods during which the cyclical component of output (obtained from the HP filter) is negative. Period: 1960Q1-2008Q1.

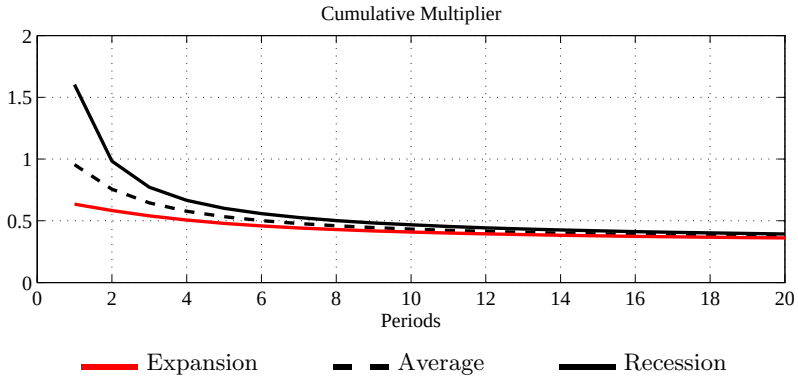
Table 3: Correlation Spread–Share of Goverment Spending

	AAA-FFR	BAA-FFR	AAA-TBILL	BAA-TBILL
Boom	-0.2244	-0.2631	-0.2795	-0.3136
Recession	-0.4888	-0.5041	-0.6493	-0.6017

2.2 Debt vs Tax Finance of Government Spending and Multipliers

In our benchmark simulations, the lump sum tax rule (15) stabilizes debt dynamics. This means that the increase in government spending is partially bond financed. Figure 7 shows how Figure 3 would change if the debt-tax rule were replaced by a balanced budget rule.

Figure 7: Output Multipliers (Balanced Budget)

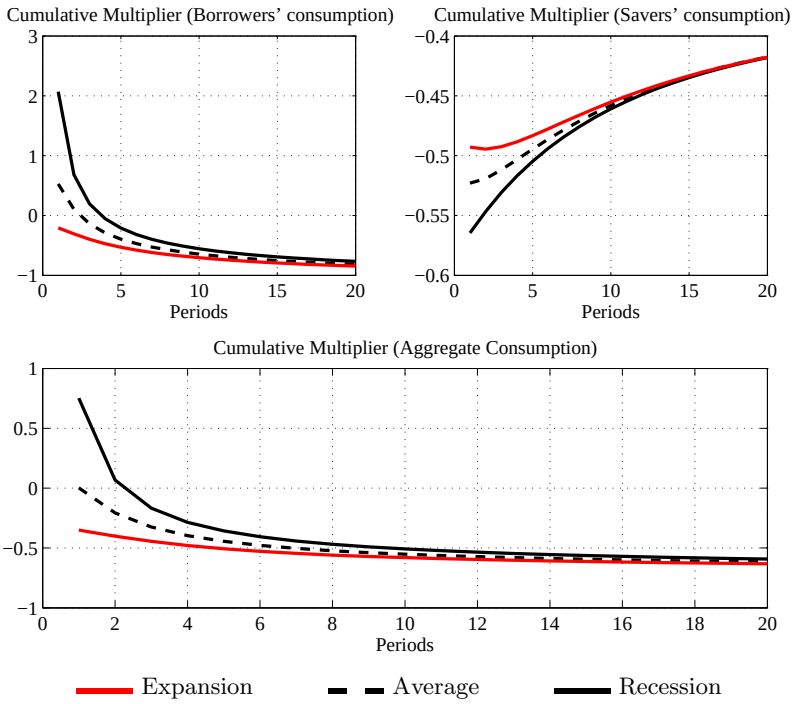


The cumulative multipliers in Figure 7 are now smaller than those shown in Figure 3. The reason is that the increase in the consumption of the borrowers is lower (See Figure 8). As in the case with partly debt financed spending, government spending expands output and closes the output gap, which makes the credit spread decrease and generates a positive wealth effect for the borrowers. But unlike the case of debt financed spending, 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.

In contrast, the 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 (due to the violation of Ricardian equivalence). With a lower interest rate there is less of an incentive to reduce current consumption. Nonetheless, the differential effect on the consumption of the savers is much smaller than that on the borrowers, so total consumption increases by less, leading to lower multipliers.

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

Figure 8: Consumption Multipliers (Balanced Budget)



2.3 The Size of the Fiscal Shock and Multipliers

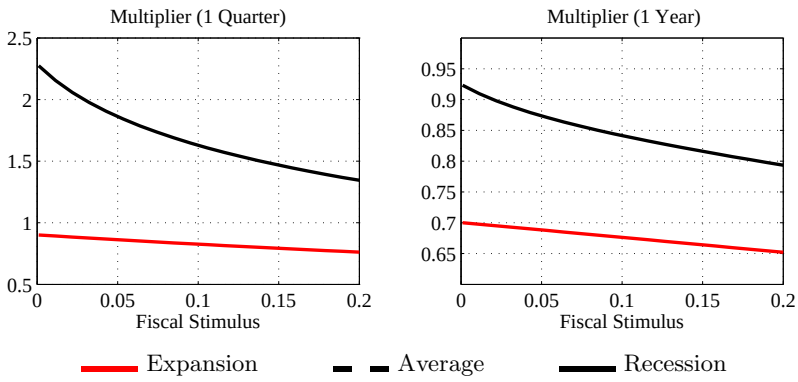
Does the size of the multiplier vary with the size of the fiscal expansion? Graph 9 shows that the multiplier is decreasing in the size of the fiscal intervention. For instance, the impact multiplier for a 5% or 10% intervention is lower that for 1% (1.85, 1.65 and 2.25 respectively). The reason that 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.[18]

2.4 Multipliers and the Source of the Business Cycle

Expansions and recessions can have a variety of origins and the size of multipliers may well depend upon the source of the business cycle. Table 4 reports cumulative output multipliers for various types of shocks: the first three are preference shocks (to the marginal utility of the impatient and patient households and the disutility of labor), the fourth is the financial shock used in the benchmark scenario above, the fifth is a productivity shock ($\xi_{y,t}$), and the sixth is a monetary policy shock ($\xi_{i,t}$). In all cases the size of the shock is

[18]Note that our model is silent on normative issues such as the optimal size of the fiscal intervention.

Figure 9: Cumulative Multipliers



such that it generates a recession (resp. expansion) of 2.5%.

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
$\xi^b_{c,t}$	1.02	1.86	0.73	0.87	0.61	0.67	0.51	0.54
$\xi^s_{c,t}$	0.95	2.00	0.70	0.90	0.59	0.68	0.51	0.55
$\xi_{h,t}$	0.94	1.94	0.69	0.90	0.59	0.68	0.51	0.55
$\xi_{\Psi,t}$	0.89	2.17	0.70	0.91	0.59	0.69	0.51	0.55
$\xi_{y,t}$	0.94	1.94	0.69	0.90	0.59	0.68	0.51	0.55
$\xi_{i,t}$	1.06	1.85	0.76	0.86	0.62	0.67	0.51	0.54

Note: This table reports the cumulative multipliers of output obtained in a 2.5% expansion (E) and in a 2.5% 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. Importantly, no matter the source of the business cycle, 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 any more.

3 Sensitivity to Parameters

In this section we examine whether the size of the multipliers implied by our model is sensitive to the calibration used. We consider variation in: *i)* the degree of price rigidity, *ii)* the amplitude of the business cycle, *iii)*, the parameters of the monetary policy rule and, *iv)* the parameters in the bank lending cost function.[19]. In no case do minor perturbations make a big difference for the size of the multipliers. The sensitivity

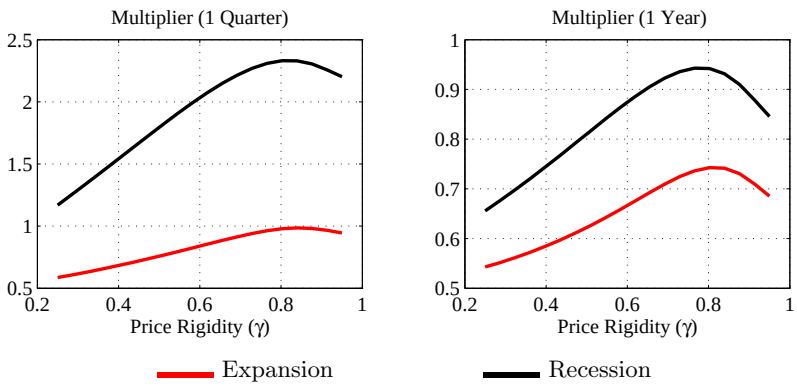
[19] An appendix that is available upon request reports additional robustness checks are empirical evidence as well as a discussion of whether and how the model can generate hump shaped multipliers.

analysis will be conducted only under the benchmark bank lending cost shock as the last section showed that the source of the cycle did not make much of a difference.

3.1 The Degree of Price Rigidity

Figure 10 shows that cumulative output multipliers rise as the degree of price rigidity, γ (the Calvo parameter), increases and that 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 multiplier are large in recessions and small in expansions, and of a magnitude consistent with the findings of Auerbach and Gorodnichenko [2010]. The reason that the multiplier

Figure 10: Multipliers: Degree of Nominal Rigidity

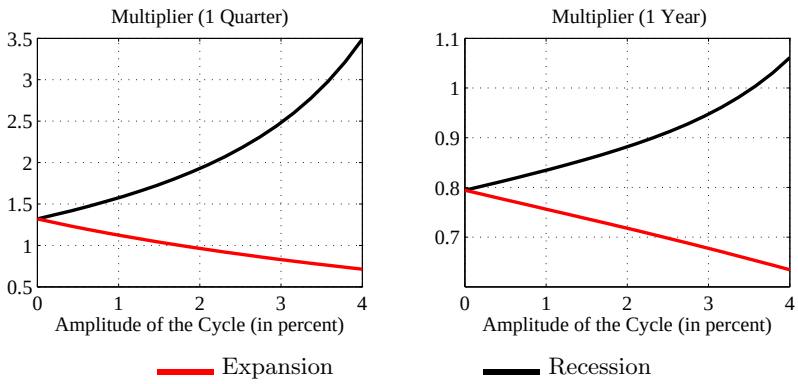


is increasing in the degree of price rigidity is that, the more rigid the prices, the bigger the effect of government spending on closing the output gap and hence the larger the decline in the spread. Under our calibration, this effect peaks at about $\gamma = 0.8$ and then it declines somewhat (but remains large). 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.

3.2 Amplitude of the Business Cycle

The model being non-linear, the size of the multiplier ought to depend on the amplitude of the business cycle. Figure 11 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 2.5%, which may be deemed a normal amplitude

Figure 11: Multipliers: Amplitude of the Cycle



for business cycles. The impact multiplier during a recession was 2.17. 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 also and more importantly the larger the elasticity of the spread to a variation in $\widetilde{y}$.[20] Hence after an increase in fiscal expenditures, the amelioration of the financial friction will be larger in deeper recessions. The potential output gains from a fiscal stimulus are therefore magnified. On the contrary, the greater the expansion, the smaller the elasticity and hence the smaller the gains from the mitigation of the friction.

3.3 Multipliers and the Conduct of Monetary Policy

As the literature on the zero bound has shown, multipliers are not independent of the conduct of monetary policy. Figure 12 shows how monetary policy, through its concern for inflation and output fluctuations, can affect cumulative multipliers.

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 a stronger reaction means that monetary policy 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.

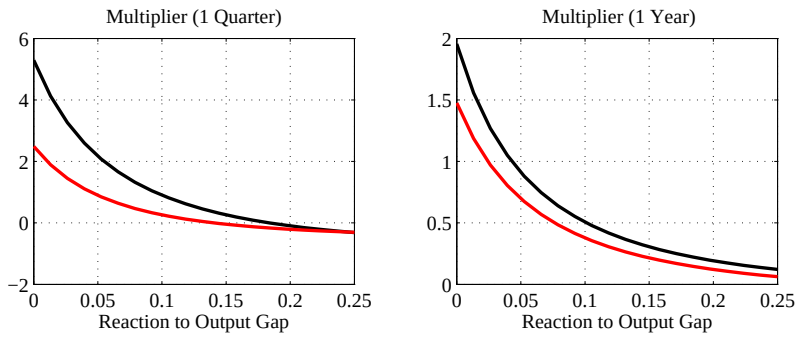
Panel (b) depicts the multiplier as a function of the reaction to inflation, κ_π. In order to facilitate the exposition we employed a policy rule with $\kappa_y = 0$.[21] An increase in the weight placed on price stability means a smaller multiplier. The reason is as follows.

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

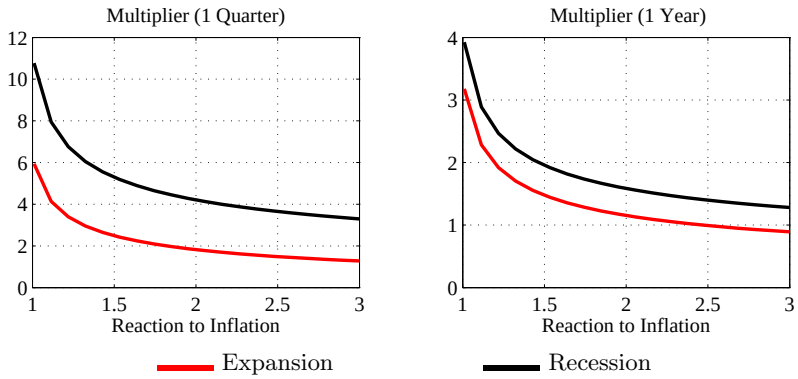
[21] As expected in light of the previous discussion, this leads to much larger multipliers.

Figure 12: Multipliers and Monetary Policy (κ_y, κ_π)

(a) Reaction to Output Gap (κ_y)



(b) Reaction to Inflation (κ_π)

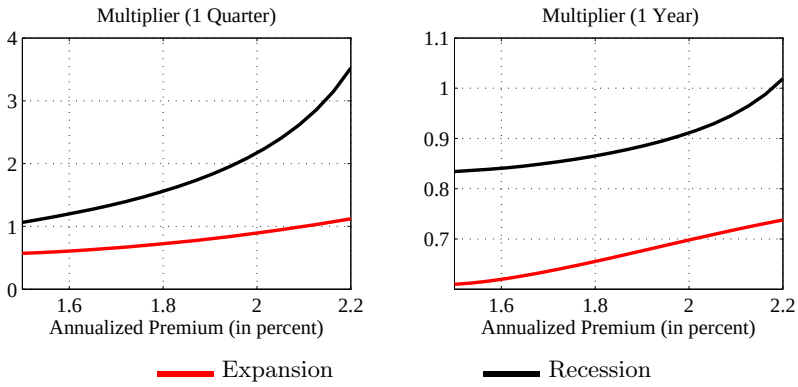


Consider a negative financial shock. Both output and inflation decrease. The central bank cuts interest rates as inflation is below target, and the cut is larger the larger κ_π. A more expansionary monetary policy means a smaller –negative– output gap and thus a smaller spread. But with a smaller spread, the effects of fiscal policy on output are smaller. That is, a more aggressive countercyclical monetary policy limits the contribution of countercyclical fiscal policy.

3.4 The Role of 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 3.2. One measure of the degree of financial friction is $\omega = i^b - i^d$, the steady state level of the spread between borrowing and deposit rates. Figure 13 shows that the cumulative output multipliers in a recession vary significantly with perturbations to the steady state spread. For instance, while in our benchmark calibration —an annual spread of 2%— the recession multiplier is about 2.2, raising the spread by just 20 basis points increases the recession multiplier by about 50% (around 3.25).

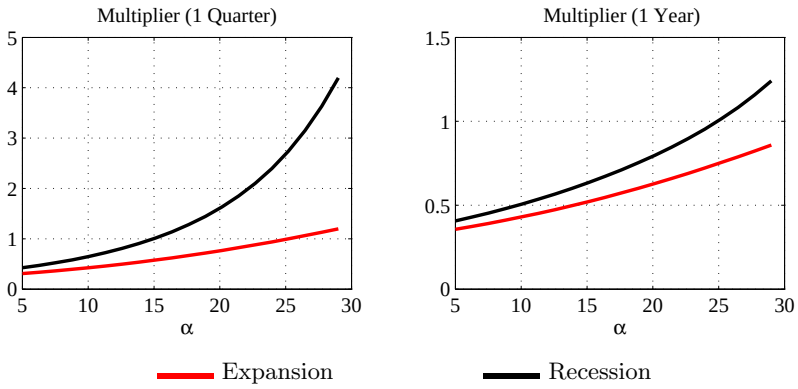
Figure 13: Multipliers: Size of Premium ($\omega^\star$)



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 potential positive wealth effects for borrowers –and hence the multipliers– are larger the greater is the spread.

The elasticity of bank lending costs 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 14 shows that even small perturbations in α can have a big effect on the cumulative output multipliers. We chose $\alpha = 23$ in our benchmark setting as suggested by our empirical estimates (reported in Table 1). This value produced multipliers consistent with the multipliers found by Auerbach and Gorodnichenko [2010] in the data. However, our regressions can not rule out even larger values of α that would give rise to even larger multipliers. For instance, a value of α of 29 gives a multiplier in a recession of about 4.

Figure 14: Multipliers: Degree of asymmetry (α)



One can similarly analyze the role of η for 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 Conclusion

Countercyclical fiscal policy represents a puzzle. Policymakers routinely 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 traditional IS-LM type of thinking, there exists preciously little in terms of modern economic thinking that supports multiplier values exceeding unity. Moreover, at least until recently, the empirical evidence seemed to be consistent with the theoretical predictions of small multipliers, making the common policy practice puzzling.

Recent work by Auerbach and Gorodnichenko [2010] seems to have resolved one part of the puzzle, namely, the inconsistency between the empirical evidence on the size of the fiscal multipliers and policy practices. Auerbach and Gorodnichenko [2010] find that while multipliers are small (below one during expansions) they can be big during recessions. What remains now is the reconciliation of theory with policy practice and the empirical evidence. Some progress has been made on this front by work relying on the role of the nominal zero bound. But as this constraint on monetary policy has been absent for most of the post war period, the zero bound cannot be the full story.

In this paper we have proposed an alternative, more general theory of large and cyclically variable multipliers that is not dependent on the conduct of monetary policy. Our theory is based on the postulate that financial frictions matter for the business cycle. And how much they matter varies over the business cycle. There exists a presumption in the literature that the variation in the financial frictions is countercyclical, and we have provided empirical evidence supporting this presumption. We show that countercylical financial frictions can make government spending quite effective during recessions, in particular when financed by debt. The main mechanism is similar to the old-Keynesian idea that providing financially strapped agents (households and firms) 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. While our analysis relies on spread movements rather than on the relaxation of quantitative borrowing constraints the logic is the same.

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A Data Sources

- Total Loans and Leases at Commercial Banks (LOANS): `http://research.stlouisfed.org/fred2/series/LOANS?cid=49`
- 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`