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Fiscal Policies and Credit Regimes: A TVAR Approach

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Fiscal Policies and Credit Regimes: A TVAR Approach*

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Abstract

In the present work we investigate how the state of credit markets affects the impact of fiscal policies. We estimate a Threshold Vector Autoregression (TVAR) model on U.S quarterly data for the period 1984-2010. We employ the spread between BAA-rated corporate bond yield and 10-year treasury constant maturity rate as a proxy for credit conditions. We find that the response of output to fiscal policy shocks is stronger and more persistent when the economy is in the "tight" credit regime. Fiscal multipliers are significantly different in the two regimes: they are abundantly and persistently higher than one when firms face increasing financing costs, whereas they are feebler and often lower than one in the "normal" credit regime. The results appear to be robust to different model specifications, fiscal foresight, alternative threshold variables, different measure of variables and sample periods.

JEL Codes: J32, E32, E44, E62

Keywords: fiscal policy, threshold vector autoregression (TVAR), non-linear models, impulse-response functions, fiscal multipliers, credit frictions, financial accelerator

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1 Introduction

The Great Recession has revealed the strong interrelations between financial markets, macroeconomic dynamics and the effects of fiscal policies. The pervasiveness of financial frictions (see Brunnermeier et al., 2012, for a survey) imply that that credit markets propagate shocks in a non-linear way, increasing the magnitude and the persistency of negative supply and demand shocks (Bernanke et al., 1999; Gertler and Kiyotaki, 2010; Brunnermeier and Sannikov, 2014). In fact the role of financial markets in business fluctuations is much greater: Ng and Wright (2013) find that all the recessions hitting the U.S. economy in the last thirty years originate from financial market shocks and they share many salient features (e.g., pronounced leverage cycles and "tight" credit conditions during recoveries), which distinguish them from "standard" textbook downturns (see also Jermann and Quadrini, 2012; Christiano et al., 2014). This poses a new challenge to fiscal policies, especially concerning the size of fiscal multipliers which could change according to the state of financial markets. For example, Blanchard and Leigh (2013) have argued that the recent fiscal consolidation plans released by many advanced economies produced stronger recessionary effects than forecasted, because the estimated fiscal multipliers did not take into account the dismal situation of the financial system (together with the zero lower bound constraining monetary policy and the deep slack in the economy).

In this work, we explore these issues using a Threshold Vector Autoregression model (TVAR; Tsay, 1998) to study how the effects of fiscal policy can be amplified or dampened according the state of credit markets.[1] More precisely, we conjecture that fiscal policies should be more successful in stimulating output in regimes where the financial accelerator leads to "tight" credit conditions, which increase the difficulties of firms to finance their investment and production activities forcing them to curb their employment levels (see the empirical evidence in Balduzzi et al., 2013; Chodorow-Reich, 2014; Gilchrist et al., 2014).

Whenever financial frictions dry up the flow of credit to firms, debt-financed expansionary fiscal policies could stimulate aggregate demand and output without siphoning resources off the private sector. More specifically, whenever households are credit constrained, positive fiscal shocks stimulate private consumption (Galí et al., 2007; Kaplan and Violante, 2011; Anderson et al., 2012; Parker et al., 2013) and their impact should be higher when credit markets are "tighter". In addition, if agents are limited in their borrowing capacity by the value of their collaterals (e.g. Kiyotaki and Moore, 1997), expansionary fiscal policies could relax such constraint, thus further stimulating private

[1] An increasing number of papers employ multiple regime models to study the non-linear effects of fiscal policies according to the state of the economy (see e.g. Auerbach and Gorodnichenko, 2012a,b; Bachmann and Sims, 2012; Afonso et al., 2011; Mittnik and Semmler, 2012; Baum and Koester, 2011). To our knowledge, our work is the first attempt to study the interconnections between the state of firms access to credit markets and fiscal policy in a multiple regime framework. More on that in Section 2.

aggregate demand independently of the degree of economic slack (Turrini et al., 2010). In presence of spread shocks stemming from financial frictions, surges in government expenditures boost aggregate demand, while minimizing the crowding out of investment as they reduce firms' external finance premium (Fernández-Villaverde, 2010).[2] Such results are in line with the empirical finding that credit spreads fall after positive fiscal shocks (Melina and Villa, 2014). In fact, positive fiscal shocks could *crowd-in* investment in presence of financial frictions. According to Woodford (1990), if there are liquidity-constrained agents having investment opportunities, debt-financed expansionary fiscal policies can spur capital accumulation by channelling more financial resources to them in exchange of claims on their future higher income (see also Holmstrom and Tirole, 1998).

As a proxy for the non-linearities resulting from credit conditions, we consider as threshold variable the spread between the BAA-rated corporate bond yield and the 10-year treasury constant maturity rate (BAA spread; Atanasova, 2003; Ernst et al., 2010). We also consider the alternative spread variable developed by Gilchrist and Zakrajsek (2012). Credit spreads represent a good way of measuring the tightness of financial conditions in the economy as suggested by an increasing amount of empirical evidence (Gertler and Lown, 2000; Gilchrist et al., 2009; Faust et al., 2013). Nonetheless, we also employ a variable strictly linked to the loan supply to better catch the effects of credit rationing (Stiglitz and Weiss, 1981).

Following the suggestions of Tsay (1998) and sup-LR tests (Galvão, 2003; Hansen, 1999), we estimate a two credit-market regime TVAR model in first differences on U.S. quarterly data for the period 1984-2010. We add fiscal variables to the specification employed by Balke (2000) and in line with the literature assessing the effects of fiscal policy with (linear) SVAR (e.g. Fatás and Mihov, 2001; Galí et al., 2007), we identify the fundamental shocks through a Choleski decomposition of residuals. More precisely, we order first in the TVAR real government expenditures and gross investment, followed by GDP, a public-debt dynamics variable, the price acceleration rate, the federal fund rate, and the BAA spread variable. We estimate the model by minimizing the sum of squares of the residuals (Tsay, 1998; Galvão, 2003) and we compute the generalized impulse response functions (GIRFs; Koop et al., 1996) as to fiscal policy shocks.

We find that the responses of output to fiscal policies significantly change according to the state of credit markets. Whenever the economy is in the "tight" credit regime, the GIRFs display a strong and persistent reaction of output to fiscal policy shocks. On the contrary, the response of GDP to fiscal policies is much milder when the economy experiences "normal" credit conditions.

The different patterns exhibited by the GIRFs in the two credit regimes are reinforced

[2] Aghion et al. (2011) show that industries facing tighter stronger constraints grow more in countries implementing stronger counter-cyclical fiscal policies. See also Dosi et al. (2013) for an investigation on the interactions between Minskian credit dynamics, fiscal policies and firm investment in an evolutionary, agent-based model.

by the computation of fiscal multipliers. When firms face increasing financing costs, the multipliers are much higher than one at different time horizons. Conversely, the multipliers are much weaker — usually lower than one — when the external finance premium is reducing. A battery of t-tests confirm that the fiscal multipliers are significantly different in the two credit regimes.

We test the robustness of our results to four potential issues concerning i) the specification of the model (first differences vs. levels); ii) the presence of expectations about fiscal policies not already absorbed by the model (i.e. the fiscal foresight); iii) the adoption of a different threshold variables; iv) alternative measures of output, fiscal and monetary variables and different sample periods going back to the sixties and excluding the observations after the Lehman Brothers bankruptcy. In all cases, we find that the results of our empirical analysis are robust to the battery of controls we performed.

Our empirical results suggest that policy makers should also pay attention to the state of credit markets when they plan fiscal interventions. When credit conditions become very “tight”, expansionary fiscal policies could be desirable in order to restore economic growth and stabilize credit markets. On the contrary, if governments aim to stabilize public debt dynamics with negligible sacrifices, they should put in place fiscal consolidation policies in periods of credit bonanza when firms can easily borrow at moderate interest rates.

The rest of the paper is organized as follows: in Section 2 we discuss the literature about the effects of fiscal policies and the possible interactions between credit and real dynamics; in Section 3 and Sections 4 we describe our methodology and the data employed; the mains results of the empirical analysis are presented in Section 5; the battery of robustness checks are performed in Section 6; finally, in Section 7 we provide concluding remarks.

2 Related literature

Our work refers to two main research avenues. The first one aims at assessing the magnitude of government spending multipliers, while the second one studies the macroeconomic consequences of financial market imperfections. In both strands of literature, notwithstanding a blossoming of works in recent years, several research questions remain open. For example, the debate about the size of fiscal multipliers is far from being settled (see the surveys in Ramey, 2011a; Hebous, 2011) and the mechanisms trough which fiscal policies affect macroeconomic dynamics in periods of financial turmoils have not been completely uncovered.

The size of fiscal multipliers has been so far explored using both theoretical models and empirical investigation.[3] Theoretical models, mostly rooted either in the Real Business

[3] Spilimbergo et al. (2009) identify four methodologies to study fiscal multipliers: model simulations; case studies; vector autoregressions (VARs); econometric studies of consumer behavior in response to

Cycle or in the New Keynesian traditions, typically find lower-than-unity multipliers, unless one modifies household utility functions (e.g. Linnemann, 2006; Ravn et al., 2006; Bouakez and Rebei, 2007) or government-spending productivity (e.g. Baxter and King, 1993); or introduces non-Ricardian consumers (e.g. Galí et al., 2007); or it is assumed that the Central Bank operates at the zero lower bound (e.g. Erceg and Lindé, 2010; Christiano et al., 2011; Woodford, 2011).[4]

The evidence coming from empirical studies is even more blurred, as results differ according to many features of the econometric strategy, such as sample period, model specification, the choice of the fiscal variable, the way multipliers are computed, etc. In addition, a central issue concerns the identification of fiscal shocks. Among the different identification strategies used in the literature, empirical studies usually resort either to the Structural VAR (SVAR) methodology or to the narrative approach.[5]

SVAR studies rely either on recursive identification (e.g. Fatás and Mihov, 2001; Galí et al., 2007) or on more complex structures (e.g. Blanchard and Perotti, 2002), where the fiscal variable is ordered first, as implementation lags are supposed to postpone the effects of discretionary fiscal policy on output.[6] Blanchard and Perotti (2002) report a peak spending multiplier between 0.9 and 2 depending on assumptions about the trend and fiscal foresight, whereas Galí et al. (2007) find an impact multiplier of 0.68 and a response of 1.78 after 8 quarters for their main model specification.

Conversely, in the narrative approach the identification of exogenous fiscal shocks involves the use of external information provided by, e.g., government reports or newspapers (Ramey and Shapiro, 1998; Edelberg et al., 1999; Burnside et al., 2004; Romer and Romer, 2010; Ramey, 2011b).[7] The multipliers produced by models following the narrative approach range from 0.6 to 1.2 depending on the sample employed and the way multipliers are computed (i.e. cumulative vs. peak responses).

Spurred by the Great Recession, a new strand of literature has recently started to study the non-linear effects of fiscal policies conditioning on the state of the economy. For instance, Almunia et al. (2010) show that fiscal multipliers were much greater during the Great Depression, when the economy was in a regime characterized by a dysfunctional banking system and a monetary policy constrained by a zero lower bound (see also DeLong and Summers, 2012). Employing annual data for a panel of 17 OECD countries, Corsetti

fiscal shocks. Gechert and Will (2012) propose a meta regression approach in order to deal with the enormous amount of results coming out from both model-based strategies and empirical methods.

[4]See Coen et al. (2012) for a comparison of the predictions resulting from seven structural DSGE models provided by different economic organizations and two medium-scale DSGE models (Christiano et al., 2005; Smets and Wouters, 2007).

[5]A third approach focuses on sign restrictions, (see e.g. Canova and Pappa, 2007; Mountford and Uhlig, 2009; Dungey and Fry, 2009; Candelon and Lieb, 2013). Alternative approaches are proposed, among others, by Fisher and Peters (2010), Acconcia et al. (2011), and Mertens and Ravn (2012).

[6]For a justification for ordering first the government spending variable see Fragetta and Melina (2011).

[7]For a description of the relationship between the SVAR and the narrative approach, see Perotti (2008), Favero and Giavazzi (2012) and Caldara and Kamps (2012).

et al. (2012) find that fiscal multipliers are higher than two when the economy experiences financial-crisis episodes (as captured by dummy variables).

The main modeling tools employed to study the effects of fiscal policies under different regimes are smooth transition vector autoregressions (STVAR) and threshold vector autoregressions (TVAR). The sources of multiple regimes studied so far are GDP growth/output gap (e.g. Auerbach and Gorodnichenko, 2012b,a; Baum et al., 2012b; Batini et al., 2012; Baum and Koester, 2011; Mittnik and Semmler, 2012; Bachmann and Sims, 2012; Candelon and Lieb, 2013); financial stress indexes (e.g. Afonso et al., 2011); banking crises (e.g. Turrini et al., 2010); public debt (e.g. Baum et al., 2012a). A common outcome of these studies is the result that fiscal policies have a stronger impact during periods of crisis. For instance, Auerbach and Gorodnichenko (2012b) and Bachmann and Sims (2012) find fiscal multipliers higher than 2 during recessions but around 1 in periods of expansion.

The closest antecedent to our study is the work of Afonso et al. (2011), who employ a TVAR to assess the effects of fiscal policies vis-à-vis a financial-stress index encompassing bank, stock-market and exchange-rate dynamics. In the case of the U.S., they find insignificant differences between the cumulative multipliers in the two regimes.

Our work is focused instead on the possible interrelations between fiscal policies and the state of corporate-bond markets, which are intimately related to firm investment decisions. Furthermore, we consider an alternative threshold variable (see Section 4) strictly connected to the supply of credit (the MIX, cf. Section 6.3), or the spread variable proposed by Gilchrist and Zakrajsek (2012), which allow to disentangle the effects related to firm balance-sheet conditions vis-à-vis the ones connected to financial shocks hitting the lenders. With respect to Afonso et al. (2011), we stick to a more general model allowing the impact multipliers to differ in the two regimes. This seems more in line with the literature suggesting that shocks are both amplified and more persistent in periods characterized by financial turmoil (see e.g. Brunnermeier et al., 2012). We also provide generalized impulse response functions (GIRFs) with bootstrap confidence bands and we formally test whether multipliers are significantly different in the two credit regimes. Finally, we control for many potential problems which could bias our analysis, such as fiscal foresight and the impact of the Great Recession (see Section 6).[8]

The present work is also related to the wide micro and macroeconomic literature studying how imperfect information in financial markets affects the dynamics of the real economy.[9] At the microeconomic level, financial market imperfections increase firm cost

[8]See also Balke (2000) and Atanasova (2003) for TVAR studies on the the effects of monetary policy in different credit-market regimes.

[9]The empirical research on the relation between financial frictions and investment decisions has grown rapidly over the last decades (see e.g. Stein, 2003). Such literature has provided convincing evidence about the significative role of financial frictions in affecting firms' production, employment and investment (e.g. Chodorow-Reich, 2014; Balduzzi et al., 2013; Gilchrist et al., 2014).

of borrowing (Townsend, 1979), reduce the supply of credit (Stiglitz and Weiss, 1981) and justify the adoption of incomplete contracts (Hart and Moore, 1994), thus forcing firms to provide their net worth as collaterals. In this framework, the credit sector can increase macroeconomic instability amplifying and propagating negative shocks through the financial accelerator and possibly leading to flight-to-quality episodes, which in turn inhibits firms' investment and production (Bernanke and Gertler, 1989; Bernanke et al., 1996, 1999; Brunnermeier et al., 2012). The key mechanisms at the root of the financial-accelerator dynamics are the external finance premium paid by firms and the evolution of their net worth (the so called "balance-sheet channel"). Moreover, as confirmed by the findings of Ng and Wright (2013), financial markets are also an autonomous source of shocks for the real sector, as financial intermediaries are fragile institutions which may be subject to runs (e.g. Diamond and Dybvig, 1983) and their balance-sheets can considerably constraint the flow of funds to firms (the so called "lending channel", see e.g. Holmstrom and Tirole, 1997; Adrian et al., 2010).

Recently, a new vintage of macro models has started to investigate how financial frictions impact on macroeconomic performance explicitly accounting for the non-linear propagation mechanisms arising from the agency problems between agents and financial intermediaries and the net worth dynamics of the latter (e.g. Gertler and Karadi, 2010; Gertler and Kiyotaki, 2010; Cúrdia and Woodford, 2011; Brunnermeier and Sannikov, 2014), as well as from financial shocks (e.g. Hall, 2011; Jermann and Quadrini, 2012; Christiano et al., 2014).

When financial frictions are pervasive, how can fiscal policies stabilize the economy in periods of financial turmoil? Both empirical and theoretical work suggest that, whenever households are credit constrained, positive fiscal shocks stimulate private consumption (Kaplan and Violante, 2011; Anderson et al., 2012; Parker et al., 2013) and push fiscal multipliers upward (Galí et al., 2007; Parker, 2011). Moreover, expansionary fiscal policies can relax agents' borrowing capacity constraints by increasing the value of their collaterals (Turrini et al., 2010). When firms face spread shocks, fiscal stimulus can stimulate aggregate demand, while cutting firms' external finance premium (Fernández-Villaverde, 2010; Melina and Villa, 2014). In line with such results, Aghion et al. (2011) and Aghion and Kharroubi (2013) find that counter-cyclical fiscal policies are more effective in stimulating growth in industries facing tighter credit constrains. Finally, debt-financed expansionary fiscal policies can crowd-in investment by routing more financial resources to liquidity-contrained agents in exchange of claims on their future higher incomes (Woodford, 1990; Holmstrom and Tirole, 1998).

3 Methodology

In this paper, we investigate the effects of government spending shocks using Threshold VAR (TVAR) models (Tong, 1983; Tsay, 1998; Galvão, 2003). This allows us to account for the possible presence of different credit market regimes. TVAR models have a number of interesting features that make them a useful and flexible tool to capture some of the possible non-linearities stemming from regime switching, multiple equilibria, and asymmetric reaction to shocks (Atanasova, 2003; Afonso et al., 2011). First, the threshold variable is considered as endogenous. This allows one to study regime switches, which result from shocks hitting another variable within the system. Second, TVARs are very simple to estimate: within each regime, the parameters can be recovered by ordinary least squares (OLS). However, once estimated, the state dependent dynamics of TVARs allows for non-linear and asymmetric impulse-response functions.

Let us consider a TVAR model with two regimes. Given the vector of endogenous variables (y) and the threshold variable (w, belonging to y), the model can be represented as follows:

$$y_t = c_j + \sum_{i=0}^{p} A_{j,i} y_{t-i} + \epsilon_{t,j} \tag{1}$$

where $j = 1$ if $w_{t-d} < r$ and $j = 2$ otherwise; r is the value of the threshold; d is the lag of the threshold variable relevant for regime changes; c_j is a constant vector; p is the autoregressive order; $A_{j,i}$ is the matrix of coefficients of regime j and lag i. Each regime can be characterized by a variance-covariance matrix Σ_j.[10] Note that the TVAR model is linear within each regime, but the changes in the parameters across regimes account for non-linearities.

TVARs can be estimated through OLS conditional on the threshold variable, w_{t-d}, the number of regimes and the order p. Identification can be performed employing standard procedures used in the linear framework. In particular, we rely on a Cholesky decomposition of the variance-covariance matrix of residuals in each regime, ordering first the fiscal-policy variable. Such procedure is standard and allows to disentangle discretionary fiscal policies from automatic stabilizers in both linear (e.g. Fatás and Mihov, 2001; Galí et al., 2007) and non-linear models (Auerbach and Gorodnichenko, 2012b; Baum et al., 2012b; Batini et al., 2012; Bachmann and Sims, 2012).[11]

There are many tests in order to assess linearity in VAR models. Here we use the method proposed by Tsay (1998), which requires the stationarity of the threshold variable and the continuity of its distribution, restricted to a bounded set $S = [\underline{z}, \overline{z}]$, which is an

[10]As economic theory suggests that financial frictions can increase the effects and the persistency of shocks, we estimate regime-dependent variance-covariance matrices.

[11]As the Cholesky identification strategy could be too restrictive in a 6 dimensional TVAR, we also estimate a TVAR with only 3 variables, ordering government spending first, then GDP and finally the BAA spread variable. The results of the smaller TVAR model are in line with those of the benchmark one.

interval on the full sample.

Once the hypothesis of linearity is rejected by the data, we can estimate the Threshold VAR.[12] Given the linearity of the model within each regime, we apply conditional least squares (for all the possible threshold values) and — under the assumption of a given number of regimes — we select the model minimizing the sum of squares of the residuals (Tsay, 1998).[13] Since the number of parameters to estimate is proportional to the number of regimes and our main dataset contains only 108 usable observations (see Section 4), once the linearity hypothesis is rejected, we assume the existence of *two* regimes. In order to check the robustness of the results provided by the Tsay tests as to possible small-sample biases, we also perform a sup-LR test (Hansen, 1999; Lo and Zivot, 2001; Galvão, 2003; Clements and Galvão, 2004).[14]

We estimate a TVAR model in first differences.[15] Given the limited amount of observations, we estimate the model selected by the *Bayesian Information Criterion* (BIC from now on).

Note that if cointegration relationships are present in the data, our analysis is not exploiting all the possible information provided by our sample. In order to control for the robustness of our results as to cointegration, in Section 6.1 we estimate also TVAR models in levels without explicitly specifying the cointegrating relationships linking the endogenous variables.

Once the estimation of the TVAR is accomplished, the next step consists in analyzing the impulse response functions. In a non-linear setup, the reaction of an endogenous variable to a shock depends on the past history, the state of the economy and the size of the shock under study at time 0, and the size and the sign of all the shocks hitting the economy within the period of interest (a shock at time t may trigger a switching of regime till time $t+d$, where d is the estimated lag of the threshold). In order to average out the influences of history and of all other shocks, simulation methods are necessary to recover the generalized impulse response functions (GIRF; Koop et al., 1996). In particular, if we define ε_t as the shock to the variable we are interested in, a horizon m, and a history Ω_{t-1}, we can define the GIRF as:

$$\begin{aligned} GIRF = {} & E\left[X_{t+m}|\varepsilon_t, \varepsilon_{t+1}=0, \ldots, \varepsilon_{t+m}=0, \Omega_{t-1}\right] - \\ & E\left[X_{t+m}|\varepsilon_t=0, \varepsilon_{t+1}=0, \ldots, \varepsilon_{t+m}=0, \Omega_{t-1}\right] \end{aligned} \tag{2}$$

The algorithm employed to derive the generalized impulse response function is described

[12] On the plausibility of approximating a non-linear model with a threshold model see e.g. Tong (1983).

[13] See Galvão (2003) for an alternative method consisting in minimizing the determinant of the variance-covariance matrix of the residuals.

[14] For alternative linearity tests, see e.g. Hansen (1996) and Hansen and Seo (2002).

[15] An exception is the output gap. For the threshold variable, we employ a MA(2) filter, cf. Section 4.

in Appendix B. In a nutshell, the idea is to simulate the model for any possible starting point over the time horizon of interest by feeding the system with bootstrapped shocks and to repeat the exercise by adding a new shock of a specific size (1 or 2 times the standard deviation of the fundamental shock in the linear model). The procedure is done hundreds times with newly generated series of bootstrapped residuals. The responses to shocks specific to a particular regime is recovered by averaging out the simulation results. As suggested in Zheng (2013) and Schmidt (2013), we compute confidence bands by bootstrapping the TVAR residuals (see Appendix B for the algorithm). We now turn to a description of the data.

4 Data

We employ U.S. quarterly data drawn from the FRED database released by the Federal Reserve of St. Louis. Our main sample ranges from the first quarter of 1984 to the last quarter of 2010. The choice of the data sample is motivated by the willingness to study a relatively coherent time period as far as both fiscal and monetary policies are concerned. That is why we exclude, for instance, the period of the Great Inflation and the ensuing Volcker's disinflation. Furthermore, as Ng and Wright (2013) pointed out, the recessions hitting the U.S. economy since 1984 have all financial origins (see also Jermann and Quadrini, 2012; Christiano et al., 2014) and they share many common features (e.g., pronounced leverage cycles and "tight" credit conditions during recoveries) which distinguished them from the previous ones driven by supply and demand shocks. However, to refine the robustness of our analysis, we also extend the sample back to 1961 and we shrink it up to 2007, thus excluding the period following the Lehman Brothers collapse that was characterized by strong policy shocks (e.g., the Economic Stimulus and the American Recovery and Reinvestment acts) and by the interest rate close to the zero lower bound (see Section 6.4 below). A detailed description of the data is provided in Appendix A.

The threshold variable. We specify a TVAR model that studies the effects of government consumption and gross investment on output dynamics under different credit regimes. More precisely, we consider as endogenous variable the spread between the BAA-rated corporate-bond interest rates and the 10-year treasury constant-maturity rate (BAA spread henceforth) as a proxy for credit conditions. In presence of financial market imperfections, the BAA spread is supposed to capture the premium for external finance possibly linked to restrictions in the supply of credit to firms (Ernst et al., 2010). According to the "credit-spread puzzle", less than half of variations in corporate bond spreads can be attributed to the financial health of the issuer (e.g., Elton et al., 2001), while the remaining part captures time-varying liquidity premium, tax tratment, and the compensation demanded by investors for bearing the credit risk (Gilchrist and Zakrajsek, 2012). In this framework, as fluctuations in spreads should reflect changes in the supply of credit, their dynamics becomes relevant when there are financial frictions (Gilchrist and Zakrajsek, 2012), which could give rise to e.g. flight-to-quality phenomena (Bernanke et al., 1996). According to Atanasova (2003), the presence of financial frictions should imply rising spreads after a monetary tightening. At the empirical level, Gertler and Lown (2000) find that spreads increase during downturns.

We prefer the BAA corporate-bond spread to commercial-paper spread because the former is more intertwined with long-term investment projects, and therefore it should allow one to better capture long-term changes in lenders' perceived risk (see Atanasova, 2003; Ernst et al., 2010). Moreover, as the low default rates on commercial paper makes it a close substitute for treasury bills, we believe that the BAA spread is better suited to catch flight-to-quality episodes.[16]

However, in order to further improve the robustness of our results, we use alternative threshold variables to single out periods of "tight" credit conditions, namely the MIX and the GZ, ED and EBP spreads (see Section 6.3). The MIX variable should capture the quantity of loans supplied within the economy. More precisely, the MIX is computed as the ratio between the total amount of loans in the liabilities of non-financial firms (corporate and non-corporate) and the sum of that amount plus the amount of commercial paper issued by non-financial corporate firms (Kashyap et al., 1993; Bernanke et al., 1996; Balke, 2000). The MIX should allow to better catch the impact of credit rationing (Stiglitz and Weiss, 1981) on firm financing choices.

Exploiting microeconomic information about firms' secondary market prices of their outstanding securities, Gilchrist and Zakrajsek (2012) build a spread variable (henceforth, GZ spread) characterized by an extremely high predictive content (see also Gilchrist et al., 2009). Moreover, they decompose it in a part capturing the counter-cyclical movements in expected firm defaults (henceforth ED spread) and in another one, the excess bond premium (henceforth EBP spread), which catches the risk-bearing capacity of financial intermediaries, thus reflecting credit supply conditions. The adoption of the GZ, ED and EBP as threshold variables should allow us not only to assess the robustness of our results, but also to exploit the proposed decomposition to single out which of the two components is more responsible for the different effects of fiscal policies in the two credit regimes.

As to linearity testing, notice that Tsay (1998) test for linearity requires the stationarity of the threshold variable. Therefore, we consider the first difference of the BAA spread.

Furthermore, following Balke (2000), we apply a MA(2) (i.e., we simply take the

[16]Another appealing feature of the BAA spread is its public availability in almost real time. Indeed, the BAA spread can be recovered from the FRED database with no lags and it is not subject to frequent and strong data revision process as it happens for other macroeconomic variables such as GDP and its components.

average growth rate of two subsequent quarters) to the series in first-differences to avoid the presence of an implausible number of regime switches over time.[17] The obtained series is showed in Figure 1 for the whole sample period (1961:1-2010:4). The same strategy is used for the GZ spread (and its ED component), as it is significantly correlated (0.93) with the BAA spread (Figure 1). Given that the EBP component is stationary and quite persistent, we do not apply any first-differencing or MA filters. We also apply to the MIX variable a flexible moving average (for details, see Section 6.3) to avoid too many changes of regime (cf. Figure 1).

A possible problem could arise if the variations of the BAA spread variable closely track business cycles. In this case, our threshold variable would not be able to capture different credit-market regimes as it would turn out to be only a proxy for output fluctuations. A straightforward way to test this hypothesis is to compute the correlation between our spread variable and GDP growth rates. We find that the correlation between the first difference of GDP and the BAA spread is only -0.34. Moreover, we compare the sample of observations in the "tight" credit regime with the ones classified as "contractions" according to the NBER business cycle chronology. We find that only 9 observations out of 31 in the "tight" credit regime correspond to NBER recessions. Finally, we estimate a TVAR model using the GDP rate of growth as threshold variable (in line with Auerbach and Gorodnichenko, 2012a) and we compare the ensuing regimes with the ones resulting from our original model finding that only 8 observations overlap.

Other variables. All the variables are made stationary when necessary before entering in the TVAR. All the series, both in first differences and in levels, are shown in Figures 2 and 3.

As a measure of output, we employ the rate of growth of GDP. We also perform the analysis using the output gap estimated through an HP-filter. This is the first of a series of robustness checks (cf. Section 6.4) where we replace one variable of the TVAR model with its closest substitutes.

The variable identifying fiscal policy is the real government consumption and gross investment. In order to study public debt dynamics, we consider the difference between government gross investment and savings divided by the GDP (as in Galí et al., 2007). We also control for a primary deficit measure and the results do not substantially change.

As far as monetary policy is concerned we use the federal fund rate. For robustness, following Atanasova (2003), we repeat the analysis with both nominal and real M2. For inflation, we employ the first difference of the logarithm of GDP implicit deflator.

[17] In the multiple-regime model literature, it is standard practice to filter the threshold variable when it is non-stationary or not sufficiently persistent. For instance Auerbach and Gorodnichenko (2012b) and Bachmann and Sims (2012) use a seven quaters moving average of GDP growth rates; Baum and Koester (2011) use the HP-filtered output gap; Atanasova (2003) uses a moving average of the spread; Balke (2000) an MA(2) of the rate of growth of the spread. Our results appear to be robust to different filters applied to the BAA spread variable either in growth rates or in levels.

Finally, although we mainly rely on aggregate data, we also employ a model specification with normalized GDP, government spending and money supply. More precisely, following Galí et al. (2007), we normalize real GDP, government consumption expenditure and gross investment and M2 by the size of the civilian population over 16 years old.

5 Main results

In this Section we provide the results on the effects of fiscal policy shocks under different credit regimes for the main sample period (1984:1-2010:4). In Section 6, we discuss the results of a large battery of additional exercises that we have performed to test the robustness of our main findings.

The specification of the TVAR model follows the one proposed by Balke (2000) to study the role of financial-market regimes as non-linear propagators of shocks to which we add a fiscal policy variable and a variable capturing the dynamics of public debt. The Choleski order of the variables of our model is in line with the one followed by Fatás and Mihov (2001) and Galí et al. (2007). More specifically, the first difference of the logarithm of real government expenditures and gross investment is ordered first, followed by the first difference of GDP, the first difference of the public debt dynamics variable, the price acceleration rate, the federal fund rate, and the BAA spread variable. Our choice of ordering the fiscal policy variable first and just before GDP is supported by the evidence provided by Fragetta and Melina (2011). We let the cyclical component of the public budget to be captured by our measure of public deficit which is ordered third. Moreover, as it is standard in the literature, we order the interest rates and the spread as last (e.g. Gilchrist and Zakrajsek, 2012).

We start performing augmented Dickey-Fuller tests to check the stationarity of the filtered spread between the BAA-rated corporate bond interest rates and the 10-year treasury constant-maturity rate. The results, together with the details about the specification of the tests (e.g. inclusion of the constant, number of lags, etc.) are reported in Table 1. All the performed tests reject the null hypothesis concerning the presence of a unit root in the threshold series.

Given the stationarity of the threshold variables, we can perform linearity tests. Both the results of the Tsay and sup-LR tests reject the hypothesis of linearity, suggesting the presence of multiple regimes in corporate-bond markets (see Table 2).[18]

The estimated lag of the threshold variable is two.[19] In particular, the value according to which the sum of the squares of the residuals is minimized is 0.12. This implies that

[18]We perform the tests and we estimate the model leaving at least 15% of the observations in each regime. Notice that, given the limited amount of usable observations we assume here the existence of two regimes.

[19]The results of our study do not substantially change when we consider only one lag of the threshold variable.

the model spends almost one third of the time (31 observations out of 108) in the regime characterized by the presence of tensions in corporate-bond markets. According to the cut-off value of the threshold variable, whenever in the last two quarters the variation of the BAA spread accelerates on average by more than 12 basis points, the economy is going to enter in the "tight" credit regime in the next period.

In Figure 1, we plot the series of our threshold variable together with the bands identifying "tight" credit regimes. The average length of the "tight" credit regimes is 1.82 periods, while the maximum length is 7 quarters (for the "normal" credit regimes, the average and maximum length are 4.41 and 12 quarters respectively). The shortest "tight" credit episodes are mainly localized at the beginning of the sample dominated by the 1987 stock market crash and the S&L crisis in the late 80s.

As the BIC selects a model with one lag, we estimate a TVAR(1) and we assess the effect of fiscal policy shocks by way of generalized impulse response functions (GIRF, see Section 3 and Appendix B) together with 68% bootstrap confidence bands.[20] More specifically, we study the average response of GDP growth rates as to a 1% standard deviation shock to the rate of growth of government consumption expenditure and gross investment in both regimes for the period 1984:1-2010:4 normalized in order to obtain a 1% actual increase in the policy variable in both regimes. The GIRFs well capture the non-linear response of output to fiscal policy shocks (see Figure 4). When corporate-bond markets are under stress, government spending shocks appear to spur GDP growth strongly and persistently. On the contrary, fiscal policy does not seem to succeed in stimulating output during "ordinary" credit periods. The outcomes do not change if a negative shock is considered: fiscal consolidation policies appear to be extremely harmful in periods when the economy is in the "tight" credit regime.

To provide a more precise quantitative assessment of the patterns just showed by the GIRFs, we report in Table 3 the multipliers associated to a (positive) fiscal shock under different corporate-bond market regimes. The multipliers (k) are computed dividing the cumulative responses at each horizon by the average ratio (over the whole sample) between government spending and GDP. More specifically, denoting output with Y and government consumption expenditures and gross investment with G, the multiplier at time $t+n$ (k_n) as well as the peak multiplier (k_n^*) are computed as follows:

$$k_n = \frac{\Delta Y_{t+n}}{\Delta G_t}, \qquad k_n^* = \frac{max_n \Delta Y_{t+n}}{\Delta G_t}. \tag{3}$$

We also test for significance of differences in fiscal multipliers obtained in the two credit regimes employing the bootstrap distribution obtained from the simulated impulse-response functions. More precisely, we test the null hypothesis that the multipliers in the

[20]Since the number of observations in the tight credit regime is relatively small, we shall rely upon 68% confidence bands, which are quite common in the VAR literature. See Sims (1987) and Sims and Zha (1999) for a discussion.

"ordinary" credit regime are higher or equal than those computed within the "tight" regime resorting to standard t-tests.

The multipliers associated to the TVAR model for the period 1984-2010 reveal strong differences in the effects of fiscal policies under the two credit regimes. In periods when the BAA spread is accelerating, the multipliers are at least more than two times bigger than the ones associated to the "peaceful" corporate-bond market regime. More precisely, in the "tight" credit regime, fiscal policies appear to have strong effects on output dynamics: the impact multiplier is 2.26, rising to 4.16 after 5 quarters. On the contrary, in the "normal" credit regime, only the impact multipliers are not lower than one. Note that according to the performed t-tests, the multipliers resulting from the two credit regimes are always significantly different between them.

What are the possible transmission channels of fiscal policies under different credit regimes? We try to shed some light on this issue estimating the GIRFs of the BAA spread variable as to fiscal shocks (cf. Figure 5). We find that the reaction of the BAA spread to a positive fiscal shock is significantly negative in the "tight" credit regime, but positive under "normal" credit conditions (the results are robust to the specification of the BAA spread in levels or growth rates). When credit markets are under stress and financial frictions are stronger, expansionary fiscal policies contribute to boost real activity by directly pushing aggregate demand (positive response of GDP on impact), as well as by easing the credit conditions faced by firms, thus further stimulating their production and investment activities.

According to our analysis, as the effects of fiscal policies are amplified when corporate-bond markets are under pressure, policy-makers should pay attention to the dynamics of financial markets when planning fiscal interventions. More specifically, when spreads are accelerating and firms are paying increasing financing costs, expansionary fiscal policies could be implemented to boost aggregate demand and foster output growth, postponing fiscal consolidation measures to periods in which confidence in corporate-bond markets is restored. In the next Section, we control whether the results supporting such policies implications are robust to a series of issues that could potentially undermine our analysis.

6 Robustness analysis

We control the sensitivity of our results vis-á-vis four potential problems. These are: i) the presence of cointegrating relationships between variables of our data sample; ii) fiscal foresight; iii) alternative threshold variables and their specifications; iv) different measures of variables and sample periods. Before entering in the details of the robustness tests we performed, we can anticipate here, as a kind of sneak preview, that the main findings of our empirical study are robust to all the potential issues we single out and test below.

6.1 Cointegration relationships

In presence of cointegrating relationships between the variables of the sample, specifying a TVAR in growth rates, as we did above, does not allow to exploit all the possible information present in the data. Since macroeconomic theory does not provide any clear insight about possible cointegrating relationships within our model, we pragmatically estimate the TVAR in levels without trying to identify any possible cointegrating relationships.[21]

In line with the results of the previous section, the GIRFs generated by a positive fiscal policy shock show a different patterns in the two corporate-bond regimes (see Figure 6). When firms face increasing financing costs, expansionary fiscal policies have stronger and more persistent impact on GDP dynamics than in the other regime.[22]

The computed fiscal multipliers[23] confirm the above results (cf. Table 3). In the "normal" credit regime, the fiscal multipliers are feeble and become negative after eight quarters, whereas when the BAA spread is accelerating they are persistently higher than one. Note that the multipliers resulting from the TVAR in first difference are higher than the ones stemming from the TVAR in levels. Nonetheless, we can conclude that both the GIRFs and the multipliers confirm the patterns and the results obtained with our baseline TVAR model (the results do not substantially change when the BAA spread is specified in levels).

6.2 Fiscal foresight

The estimates of the effects of fiscal policies performed in Section 5 could not be reliable if the information set exploited by the econometric model does not coincide with the one used by policy makers and consumers (e.g. Leeper et al., 2008; Mertens and Ravn, 2010; Ramey, 2011b). In order to take into account the potential issue of fiscal foresight, following Auerbach and Gorodnichenko (2012b) we add to the baseline specification of our TVAR the forecasted changes in federal, state and local government consumption and gross investment drawn from *Survey of Professional Forecasters*. We order first in the system the variable controlling for expectations and we consider fiscal shocks orthogonal to the forecasted values. We estimate TVAR models of order one both in growth rates and levels employing the thresholds estimated above.

In line with our previous results, the GIRFs[24] resulting from the TVAR controlling for

[21]The presence of non-stationary time series may violate some of the regularity conditions required by both Tsay (1998) and Hansen (1996) procedures thus uncovering spurious non-linearities. For this reason, we do not perform linearity tests and we directly estimate the model in levels. See Pagan and Pesaran (2008), Candelon and Lieb (2013), and Fisher and Huh (2014) for identifying long-run relationships and structural shocks in VAR models.

[22]In both regimes, the GIRFs turn negative at the end of the horizon. The same dynamics is found when a linear SVAR is estimated.

[23]In this case, fiscal multipliers are computed dividing the value of the impulse response at each horizon by the ratio (average value over the sample period) between government spending and GDP.

[24]For reason of space, from now on we only report the GIRFs for the first-differenced TVAR. The

fiscal foresight show that the effects of fiscal policies are much higher in the “tight” credit regime vis-à-vis the one characterized by normal conditions in corporate-bond markets (cf. Figure 7).

The related fiscal multipliers (cf. Table 3) show that, in both the growth-rate and level specifications, the impact of fiscal policies on GDP dynamics is significantly stronger when firms face accelerating borrowing costs, with peak multipliers abundantly higher that one. The multipliers associated to the first-differenced TVAR are generally bigger than those computed from the model in levels. The comparison between the fiscal-foresight multipliers and the ones obtained from the benchmark TVAR shows that the effects of fiscal policies are reinforced in the “tight” credit regime when expectations are taken into account. The latter result is reversed when the TVAR model is estimated in levels. The general conclusion of this analysis is that, even after controlling for fiscal foresight, the effects of fiscal policies are significantly strong, with multipliers higher than one when corporate-bond markets are under stress.

6.3 Alternative threshold variables

The threshold variable employed so far —the spread between BAA-rated corporate bond yield and 10-year treasury constant maturity rate— is supposed to capture how financial frictions make the borrowing decisions of firms more difficult, e.g. by rising their financing costs as to safe assets (Balke, 2000; Atanasova, 2003). We now assess the robustness of our results with respect to alternative threshold variables, the MIX and the GZ spread.[25]

Let us start with the *MIX* (Balke, 2000), which is computed as the ratio between the total amount of loans to non-financial firms (corporate and non-corporate) and the sum of this amount plus the commercial paper issued by non-financial corporate firms (Kashyap et al., 1993; Bernanke et al., 1996). As non-corporate firms cannot typically rely upon commercial paper, the MIX should better capture restrictions in the supply of credit.

Contrary to the BAA spread, we apply a moving average to the MIX growth rate series only when we consider it as a threshold variable. Furthermore, we take the threshold not in absolute terms but as a flexible value changing over time. More precisely, the model experiences a change in regime whenever the lagged rate of growth of the MIX is

GIRFs associated to the models in levels are available from the authors upon request.

[25]We control also for different specifications of the BAA spread. We first consider the threshold variable in levels (see Figure 1). This choice is not completely appropriate as the augmented Dickey-Fuller tests rejects the non-stationarity null hypothesis at the 10% level. Nonetheless, linearity tests suggest the presence of multiple regimes (the average length of “tight” credit periods is 3.36 quarters) and the estimated multipliers confirms that government spending is more effective during “tight” credit periods. Second, we estimate a TVAR with the median value of the BAA spread instead of the average one in order to have the same number of observations in each regime. Finally, as in Balke (2000) and Atanasova (2003), we estimate a model in which the threshold variable enters in first differences in the VAR and as a moving average only when the threshold is considered. In both cases we find that the results do not substantially change.

higher/lower with respect to the moving average (whose order has to be estimated) of its past rates of growth. We believe that this approach is better suited to catch regime shifts for a variable like the MIX dealing with firm liabilities, which are characterized by higher degree of inertia over time.[26] The dynamics of the MIX is reported in Figure 1.

The GIRFs show (cf. Figure 8) that expansionary fiscal policies appear to be more successful in spurring output growth when financial frictions restrict the supply of credit to firms, also when we employ a threshold variable related to the supply of loans.

We now turn to the fiscal multipliers (cf. Table 3). Let us begin with the model in first differences. Even when the MIX is employed as threshold variable, there is a significant difference between the fiscal multipliers in the two regimes: when the proportion of loans to firms is squeezing, the multipliers are higher than one, whereas they are lower than one when credit is more abundant. Even if the multipliers associated to the MIX are lower than the ones computed when the BAA spread is employed, they still support the case for implementing expansionary fiscal policies in the "tight" credit regime, as it is also confirmed by the results from the t-tests.

Moving to the *GZ spread* variable computed by Gilchrist and Zakrajsek (2012) exploiting firm level data, we first show that our results do not change if we replace the BAA spread variable with the GZ one. Moreover, we study how fiscal multipliers are affected by the ED and EBP components of the GZ spread.

Let us begin with the GZ spread (see Figure 1). The Tsay test rejects the linearity hypothesis suggesting the presence of multiple credit regimes (cf. Table 2). In line with the results obtained with the BAA spread, the impulse response functions unveil a stronger effect of government spending during periods of "tight credit" when the GZ spread is employed as threshold variable (see Figure 9).[27] The fiscal multipliers confirm that fiscal policies are significantly more effective in stimulative output in the "tight" credit regime (see Table 3).

We then employ as threshold variables the series resulting from the decomposition of the GZ spread into compensation for firms' expected default (ED spread) and financial intermediaries' risk bearing capacity part (EBP spread). For both series, the Tsay test rejects linearity. We find that the response of output to a government spending shock is stronger in "tight" credit periods vis-à-vis normal ones for both the ED and EBP series,[28] hinting to the fact that both the borrowers' default component of the spread (e.g., Canzoneri et al., 2012) and lenders' financial conditions (see e.g. Adrian et al., 2010; He and Krishnamurthy, 2013) are responsible for such dynamics. However, a look at the

[26] To further test the sensitivity of our results as to the filter employed to smooth the threshold variable series, we apply the same strategy used for the MIX to the BAA spread. We find that the results are robust to different smoothing techniques.

[27] Again, the adoption of different filters does not substantially alter the results. Moreover, the results are also robust to the use of the GZ spread in levels.

[28] Due to space constraint we did not provide the GIRFs for the ED and EBP spread cases. They are available from the authors upon request.

evolution of the multipliers over time (cf. Table 3) suggests that, in the EBP case, the effects of expansionary fiscal policies build up over time, whereas, in the ED one, the major effects are on impact.

6.4 Different sample periods and alternative variable definitions

This Section discusses what happens when we play with different sample periods, and when one employs alternative definitions for our main variables concerning output variations, monetary and fiscal policies.

Let us begin with different sample periods. So far we have estimated our TVARs on a sample period ranging from 1984 to 2010 which is supposed to be relatively coherent in terms of fiscal and monetary policies. However, the results of our empirical exercises could be intimately linked to the specific sample period employed. To check whether this is the case, we begin enlarging the covered time period up to the first quarter of 1961. The Tsay test rejects the null hypothesis of linearity also in the enlarged sample (cf. Table 2). We then estimate the TVARs replacing the federal funds rate with M2, both in nominal and real terms, because the latter variable shows a smoother path making the number of observations in both regimes more balanced.[29] The GIRFs confirm the results obtained for the smaller sample: there is a much higher effect of government spending in the regime characterized by increasing spreads (see Figure 10). Moreover, when firms face increasing financing costs, the multipliers are still abundantly higher than one and significantly different from those of the "normal" credit regime (cf. Table 3).[30]

We also consider the sub-sample 1984-2007 in order to exclude the financial crisis originated with the bankruptcy of Lehman Brothers and, more generally, the period in which monetary policy was constrained by the zero lower bound. Once the Great Recession is removed from the sample period, the GIRFs in the "tight" and "normal" credit regimes become closer (cf. Figure 11). Nonetheless, the effects of fiscal shocks keep on being stronger and more persistent in the "tight" credit regimes. In both regimes, the resulting multipliers associated are smaller than the ones related to the full sample period (see Table 3). However, the fiscal multipliers are still largely higher than ones in periods when credit spreads are accelerating and according to the performed t-tests, the differences between the two regimes do persist. These results are even stronger when we control for fiscal foresight.

Next, we move to a series of estimates performed employing alternative measures of

[29] As the enlarged sample period contains some turbulent economic phases (e.g. the oil shocks, the Volcker's disinflation) and it allows us to almost double the number of observations, we estimate a TVAR of order four. This choice is supported by AIC and Ljung-Box tests. Moreover, in order to increase the precision of our estimates we leave at least 20% of observations in each regime.

[30] In this case we cannot control for fiscal foresight as the government spending series of the *Survey of Professional Forecasters* starts only in 1981.

output variations, monetary and fiscal policies.[31] First, we replace output growth rates with the output gap estimated through an HP-filter. We then substitute the federal funds rate with M2 as a proxy variable for monetary policy and we employ also a primary deficit variable to purge public debt dynamics from the expenditures on interest rates. Finally, we normalize the variables entering in the TVAR by the size of the civilian population over 16 years old (see Galí et al., 2007). In all these cases, our main results are confirmed: fiscal shocks are extremely successful in stimulating output when corporate-bond markets are under pressure, whereas their effects are softened in the "normal" credit regime.

7 Conclusions

In this work, we contribute to the literature about non-linear effects of fiscal policies (e.g. Auerbach and Gorodnichenko, 2012b) by studying how the effects of fiscal shocks on output dynamics depend on the state of credit markets. Given the pervasive presence of financial frictions in credit markets (Brunnermeier et al., 2012), we conjecture that the effects of fiscal policies should be much stronger in periods when the financial accelerator (Bernanke et al., 1999; Gertler and Kiyotaki, 2010) worsens the credit conditions faced by firms, as well as the economy is hit by financial shocks (Ng and Wright, 2013; Jermann and Quadrini, 2012; Christiano et al., 2014).

We perform our analysis employing a Threshold Vector Autoregression Model (TVAR; Tsay, 1998), whose threshold variable is deemed to single out two regimes according to how financial frictions affect the dynamics of credit markets. More specifically, we used as threshold variable the spread between the BAA-rated corporate bond yields and the long-term treasury interest rate (BAA spread, see Atanasova, 2003; Ernst et al., 2010), which should capture the dynamics of the external finance premium as well as flight-to-quality episodes (Bernanke et al., 1996).

As the linearity tests support the presence of two different regimes in corporate-bond markets, we estimate a TVAR on U.S. quarterly data for the period 1984-2010 and we compute generalized impulse-response functions (GIRF; Koop et al., 1996) for government spending shocks. We find that the response of output to fiscal shocks is much stronger whenever firms are subject to increasing financing costs in bond markets. The different patterns showed by the GIRFs in the two regimes are confirmed by the fiscal multipliers. In the "tight" credit regime, the multipliers are abundantly and persistently higher than one, whereas they are feebler and often lower than one when the BAA spread is slowing down. A battery of t-tests suggests that the fiscal multipliers are significantly different in the two credit regimes. Our results appear to be robust to a series of checks, namely different model specifications (first differences vs. levels); fiscal foresight; alternative

[31] Tables and Figures related to this set of exercises are omitted for space reasons, but are available from the authors upon request.

threshold variablest; different measures of output, fiscal and monetary policy variables; different sample periods.

On the normative side, our empirical results suggest that credit market conditions should also be taken into account in designing fiscal policy interventions. In periods when firms face increasing difficulties in borrowing funds to finance their production and investment activities, policy makers could consider to carry out expansionary fiscal policies, which would be highly effective in boosting aggregate demand, output and thus relaxing firms' financial constraints. Conversely, fiscal consolidation measures designed to control public debt dynamics should be implemented in periods when financial funds flow copiously from credit markets to firms at low interest rates.

Our work could be extended in several directions. First, state-dependent impulse-response functions could be derived for diverse spending aggregates in order to control for the possible effects due to the different composition of the fiscal shocks in the two credit regimes. A second line of research involves searching for the long-run equilibrium relations between the variables of the model by directly specifying the cointegration relationships. Finally, different identification schemes could be adopted to sort out fundamental shocks, paying special attention to those imposing over-identifying restrictions on the variance-covariance matrices of residuals (see e.g. Moneta, 2008; Moneta et al., 2012).

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Appendices

A Data

The data have been recovered from the FRED database[32] provided by the Federal Reserve Bank of St. Louis and transformed in order to get real values through the GDP implicit deflator. The series employed in the empirical analysis are listed below

- Gross Domestic Product (GDP);
- GDP Implicit Deflator (GDPDEF);
- Government Consumption Expenditures and Gross Investment (GCE);
- Government Gross Investment: Federal National Defense Gross Investment (DGI) + Federal Nondefense Gross Investment (NDGI) + State and Local Government Gross Investment (SLINV);
- Gross Government Saving (GGSAVE);
- Moody's Seasoned BAA Corporate Bond Yield (BAA);
- 10-Year Treasury Constant Maturity Rate (GS10);
- Effective Federal Fund Rate (FEDFUNDS);
- Commercial Paper - Assets - Balance Sheet of Non-farm Nonfinancial Corporate Business (CPLBSNNCB);
- Bank Loans N.E.C. - Liabilities - Balance Sheet of Non-farm Nonfinancial Corporate Business (BLNECLBSNNCB);
- Bank Loans N.E.C. - Liabilities - Balance Sheet of Non-farm Nonfinancial non-corporate Business (BLNECLBSNNB);
- Civilian Noninstitutional Population (CNP16OV).

[32] `http://research.stlouisfed.org/fred2/`

B Generalized Impulse Response Functions

The algorithm to get the generalized impulse response function (GIRF) specific to each regime with R observations works as follows (see Baum and Koester, 2011):

1. pick a history Ω^r_{t-1};
2. pick a sequence of shocks by bootstrapping the residuals of the TVAR taking into account the different variance-covariance matrix characterizing each regime;
3. given the history Ω^r_{t-1}, the estimated TVAR coefficients and bootstrapped residuals, simulate the evolution of the model over the period of interest;
4. repeat the previous exercise by adding a new shock at time 0;
5. repeat B times the steps from 2 to 4;
6. compute the average difference between the shocked path on the non-shocked one;
7. repeat steps from 1 to 6 over all the possible starting points;
8. compute the average GIRF associated with a particular regime with R observations as:

$$y_{t+m}(\varepsilon_0) = \frac{1}{R}\sum_{r=1}^{R} \frac{y_{t+m}(\Omega^r_{t-1}|\varepsilon_0, \varepsilon^*_{t+m}) - y_{t+m}(\Omega^r_{t-1}|\varepsilon^*_{t+m})}{B}$$

Once GIRFs are obtained, we apply the algorithm in Schmidt (2013) to compute the related confidence bands:

1. artificial data are generated recursively using the estimated coefficients and errors from the TVAR structure;
2. using the recursive dataset, the TVAR regression coefficients and the error terms are calculated assuming that the threshold corresponds to the estimated value;
3. employing the original dataset and the newly computed coefficients and errors, GIRFs are computed following the steps described above;
4. steps 1-3 are repeated $S = 500$ times to generate a sample distribution of the GIRFs from which confidence bands are drawn at the respective significance level.

Table 1: Augmented Dickey-Fuller tests applied to the threshold variables ($p - values$ in parentheses). Lag structure chosen according to t-tests down from 8 lags.

Threshold variable	**Treatment**	**Period**	**Specification**	**Results**
BAA spread	MA(2) of growth rates	1984-2010	7 lags; constant	-4.85 (0.000)
BAA spread	MA(2) of growth rates	1961-2010	7 lags; constant	-6.36 (0.000)
BAA spread	MA(2) of growth rates	1984-2007	7 lags; constant	-4.05 (0.001)
BAA spread	levels	1984-2010	7 lags; constant	-2.66 (0.081)
MIX	MA(3) of growth rates	1984-2010	7 lags; constant	-3,47 (0.009)
GZ spread	MA(2) of growth rates	1984-2010	5 lags; constant	-5.58 (0.000)
ED component	MA(2) of growth rates	1984-2010	7 lags; constant	-5.82 (0.000)
EBP component	levels	1984-2010	6 lags; constant	-3.52 (0,008)

Table 2: Tsay and Sup-LR linearity tests ($p - values$ in parentheses).

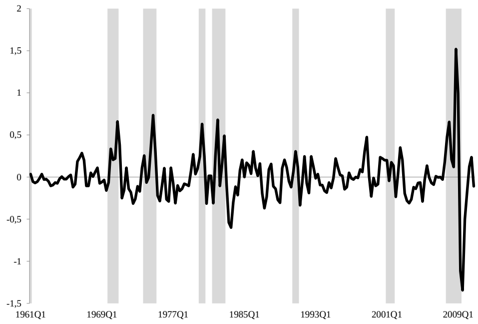
Threshold variable	**Model**	**Lags**	**Period**	**Tsay test**	**Sup-LR test**
BAA spread	growth rates	1	1984-2010	66.68 (0.009)	116.28 (0.014)
BAA spread	growth rates	4	1961-2010	210.22 (0.001)	342.79 (0.028)
BAA spread	growth rates	1	1984-2007	67.67 (0.007)	92.73 (0.052)
BAA spread	output gap	1	1984-2010	61.19 (0.028)	154.03 (0.013)
BAA spread	output gap	1	1984-2007	62.82 (0.020)	115.98 (0.004)
MIX	growth rates	1	1984-2010	n. p.	80.39 (0.013)
GZ spread	growth rates	1	1984-2010	68.95 (0.005)	107.16 (0.027)
ED spread	growth rates	1	1984-2010	62.64 (0.021)	104.33 (0.006)
EBP spread	growth rates	1	1984-2010	68.39 (0.006)	70.02 (0.751)

Table 3: Computed multipliers as to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending - Tight/normal credit regimes. (‡): controlling for fiscal foresight. (* and **): rejecting at the 5% and 10% significance level the H_0: "the multipliers in the ordinary credit regime are higher or equal to those in the *tight* one". t-test performed on the bootstrap distribution of impulse response functions.

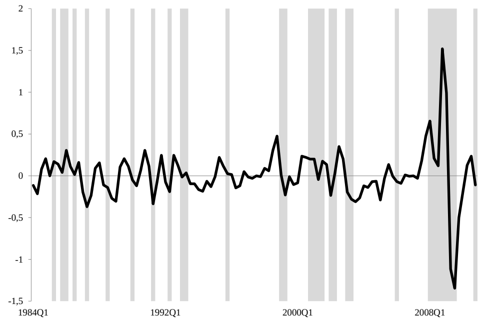
Threshold variable	**TVAR Model**	**Lags**	**Period**	**Fiscal multipliers**			
				impact	4 quarter	8 quarter	peak(quarter)
BAA spread	growth rates	1	1984-2010	2.26/1.00*	4.11/0.42*	4.16/0.37*	4.16(5)/1.00(0)
BAA spread	growth rates ‡	1	1984-2010	2.42/0.95*	4.47/0.37*	4.53/0.32*	4.53(5)/0.95(0)
BAA spread	levels	1	1984-2010	1.63/0.95*	1.95/0.32*	1.05/-0.16*	2.21(2)/0.95(0)
BAA spread	levels ‡	1	1984-2010	2.32/0.84*	1.58/0.42*	0.79/0.16*	2.32(0)/0.84(0)
MIX	growth rates	1	1984-2010	1.21/0.84*	1.32/0.58*	1.32/0.58*	1.32(1)/0.84(0)
MIX	growth rates ‡	1	1984-2010	1.11/0.89*	1.00/0.63*	1.00/0.63*	1.11(0)/0.89(0)
MIX	levels	1	1984-2010	1.21/0.32*	0.53/-0.53*	0.16/-0.89*	1.21(0)/0.32(0)
MIX	levels ‡	1	1984-2010	1.16/-0.32*	0.32/-1.26*	0.05/-1.63*	1.16(0)/-0.32(0)
GZ spread	growth rates	1	1984-2010	1.63/0.84*	3.00/0.26*	3.16/0.05*	3.16(6)/0.84(0)
EBP spread	growth rates	1	1984-2010	1.74/0.95*	3.42/1.16*	4.05/0.95*	4.47(15)/1.16(2)
ED spread	growth rates	1	1984-2010	2.21/0.68*	2.00/0.16*	2.00/0.16**	2.21(0)/0.16(0)
BAA spread	growth rates	4	1961-2010	2.00/1.20*	3.45/0.80*	2.90/0.45*	3.60(2)/1.35(1)
BAA spread	growth rates	1	1984-2007	1.21/1.05*	1.53/0.79*	1.53/0.74*	1.63(1)/1.05(0)
BAA spread	growth rates ‡	1	1984-2007	1.32/0.95*	1.95/0.84*	1.84/0.79*	2.00(2)/1.05(1)

Figure 1: Threshold Variable. Shaded areas in figure a, c, d, e: recession periods according to NBER business-cycle chronology. Shaded areas in figure b: estimated “tight” credit periods.

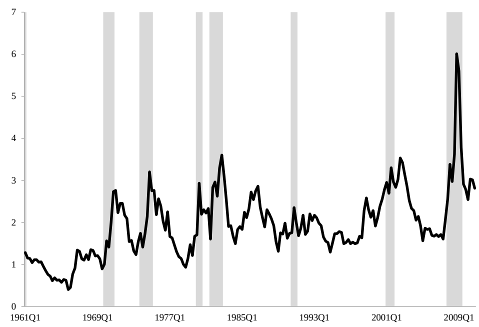
(a) MA(2) of the first difference of the spread between BAA-rated corporate bond yields and 10-year treasury constant maturity rate.



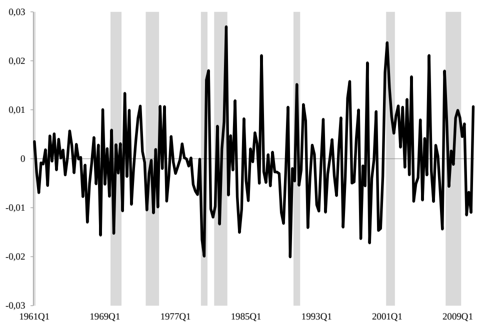
(b) MA(2) of the first difference of the spread between BAA-rated corporate bond yields and 10-year treasury constant maturity rate.



(c) The spread between BAA-rated corporate bond yields and 10-year treasury constant maturity rate (levels).



(d) First difference of MIX.



(e) MA(2) of the first difference of the GZ spread.

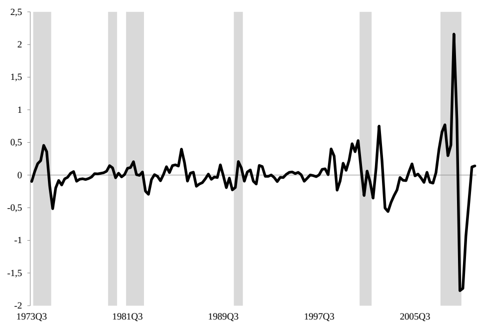
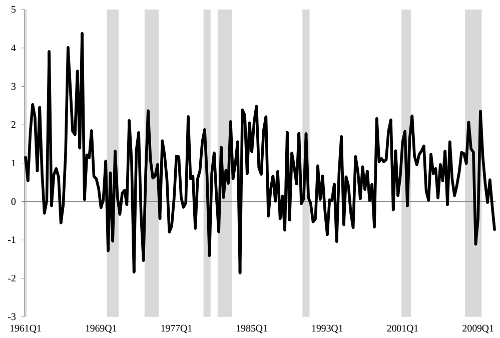
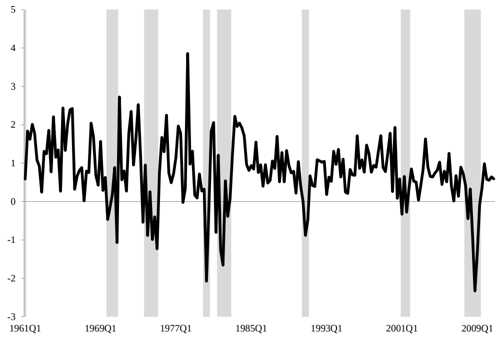


Figure 2: Series (rates of growth)

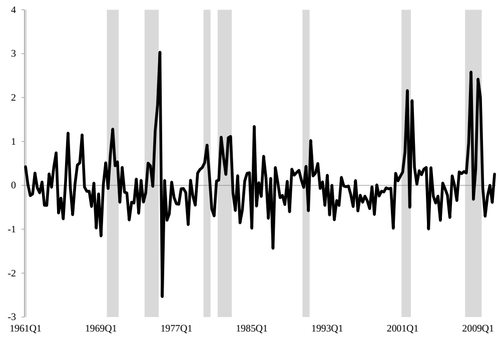
(a) Government consumption expenditures and gross investment



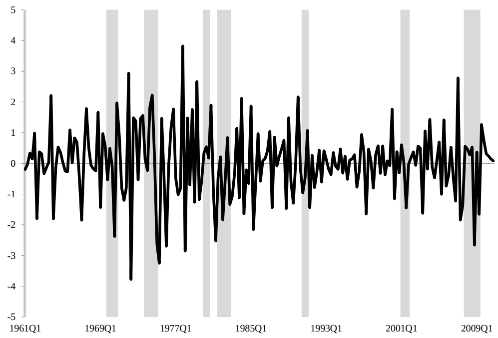
(b) GDP



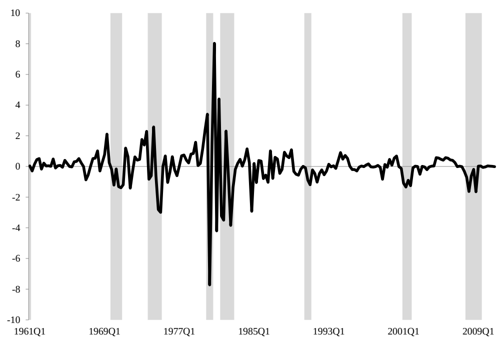
(c) Ratio between gross government investment minus gross government saving and GDP



(d) Inflation



(e) Federal fund rate



(f) M2 (nominal)

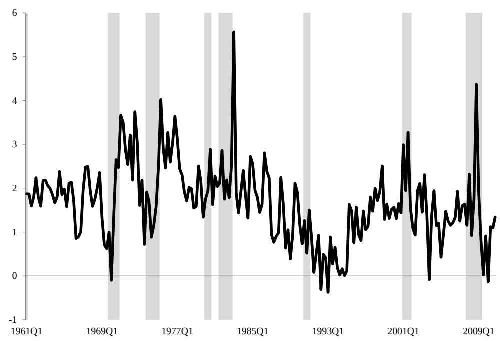
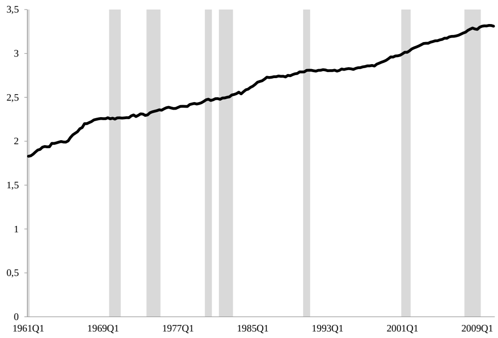
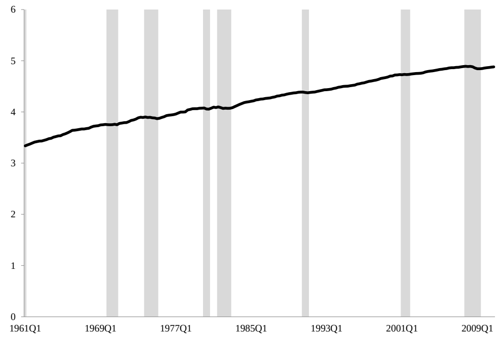


Figure 3: Series (levels)

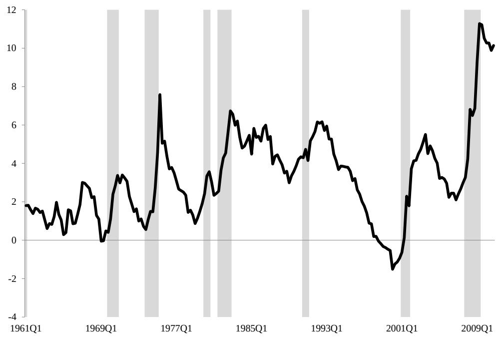
(a) Government consumption expenditures and gross investment



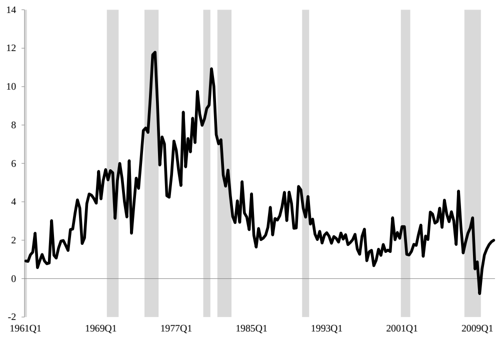
(b) GDP



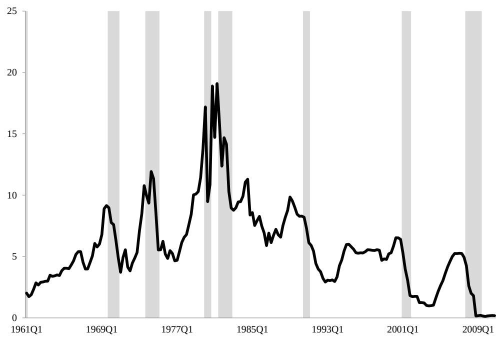
(c) Ratio between gross government investment minus gross government saving and GDP



(d) Inflation



(e) Federal fund rate



(f) M2 (nominal)

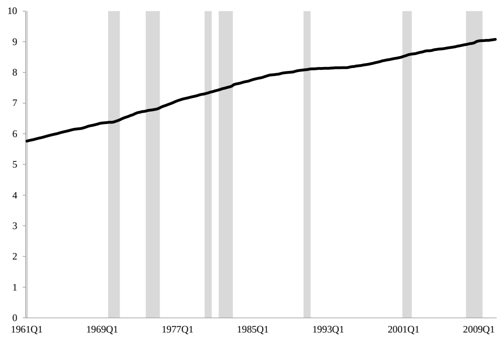
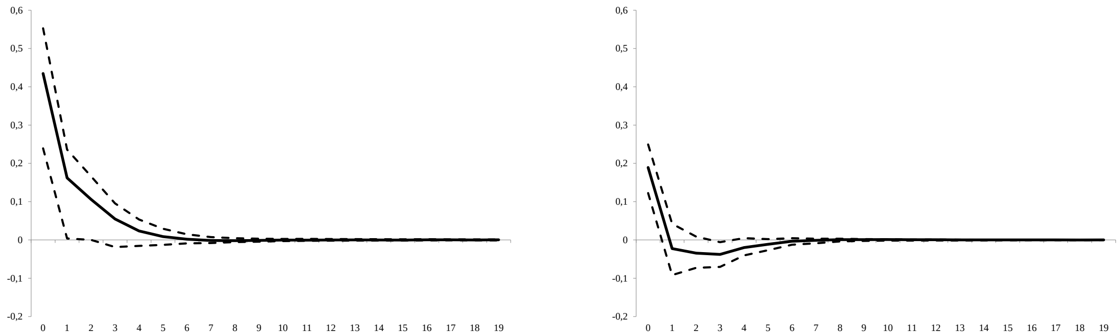


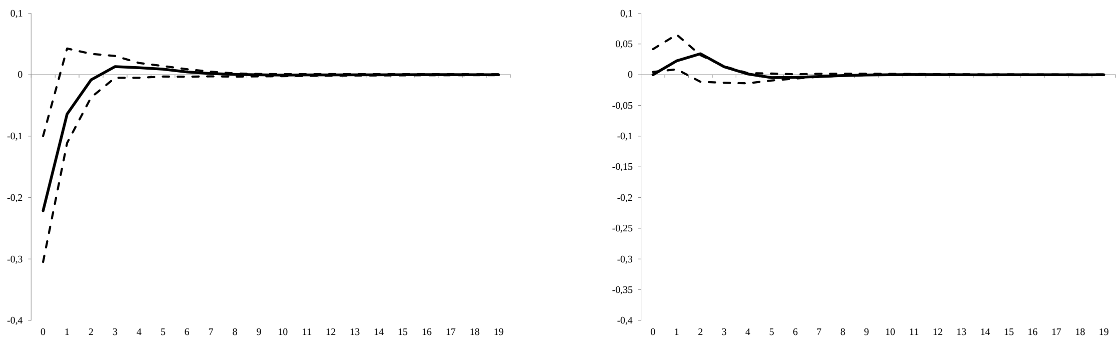
Figure 4: Generalized impulse response functions. Response of GDP growth rate to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending (1984:1-2010:4). BAA spread threshold variable. 68% confidence bands obtained via bootstrap.



(a) Tight credit regime

(b) Ordinary regime

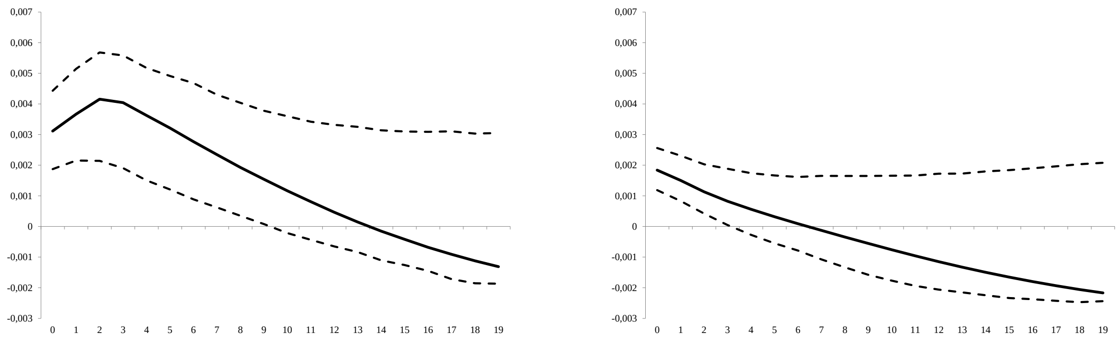
Figure 5: Generalized impulse response functions. Response of BAA spread to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending (1984:1-2010:4). BAA spread threshold variable. 68% confidence bands obtained via bootstrap.



(a) Tight credit regime

(b) Ordinary regime

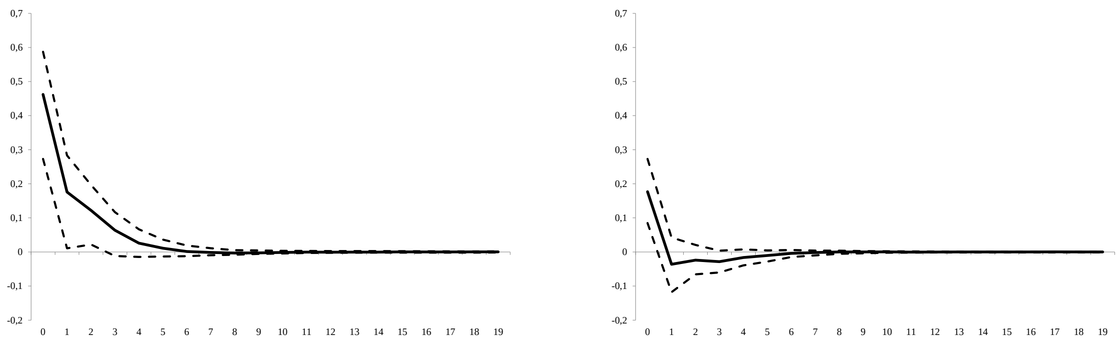
Figure 6: Generalized impulse response functions. Response of GDP to a 1% standard deviation shock to government consumption expenditures and gross investment normalized in order to obtain a 1% increase in actual spending (1984:1-2010:4). BAA spread threshold variable. 68% confidence bands obtained via bootstrap.



(a) Tight credit regime

(b) Ordinary regime

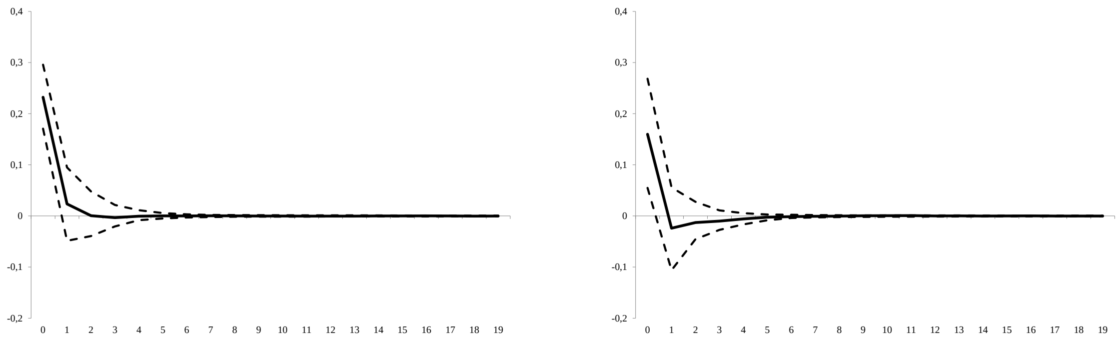
Figure 7: Generalized impulse response functions. Response of GDP growth rate to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates controlling for fiscal foresight normalized in order to obtain a 1% increase in actual spending (1984:1-2010:4). BAA spread threshold variable. 68% confidence bands obtained via bootstrap.



(a) Tight credit regime

(b) Ordinary regime

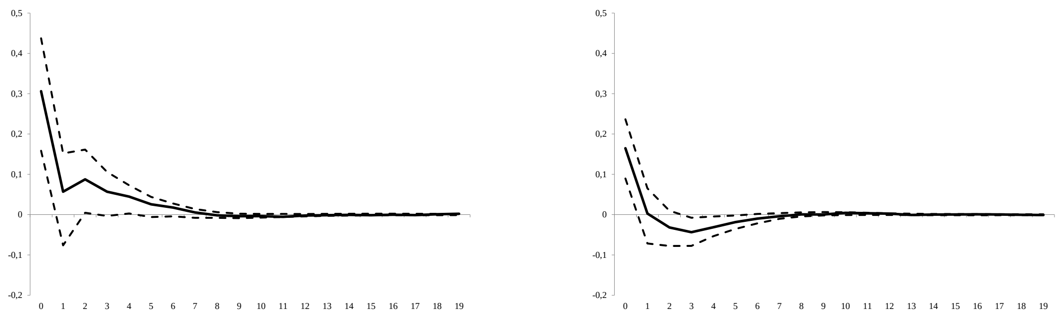
Figure 8: Generalized impulse response functions. Response of GDP growth rate to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending (1984:1-2010:4). MIX threshold variable. 68% confidence bands obtained via bootstrap.



(a) Tight credit regime

(b) Ordinary regime

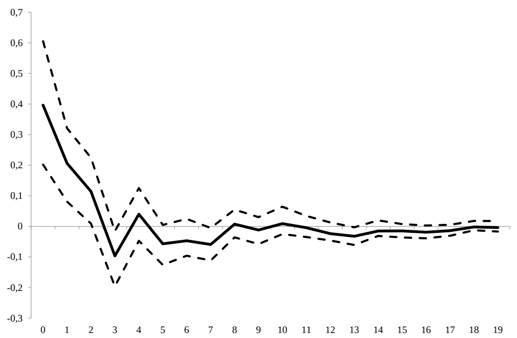
Figure 9: Generalized impulse response functions. Response of GDP growth rate to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending (1984:1-2010:3). GZ spread threshold variable. 68% confidence bands obtained via bootstrap.



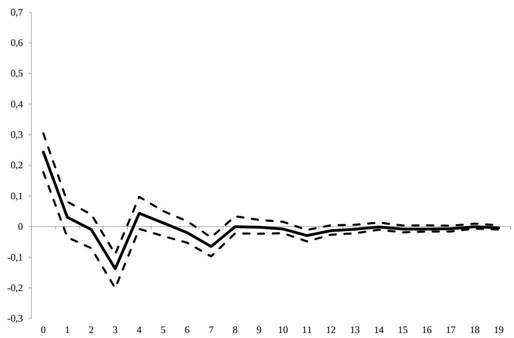
(a) Tight credit regime

(b) Ordinary regime

Figure 10: Generalized impulse response functions. Response of GDP growth rate to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending (1961:1-2010:4). BAA spread threshold variable. 68% confidence bands obtained via bootstrap.

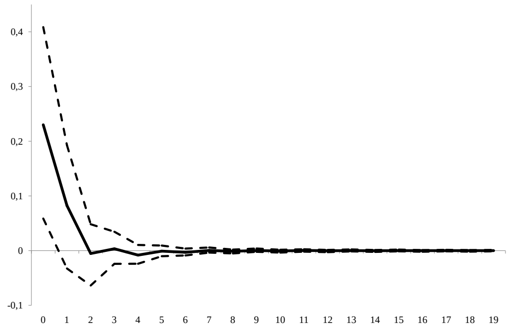


(a) Tight credit regime

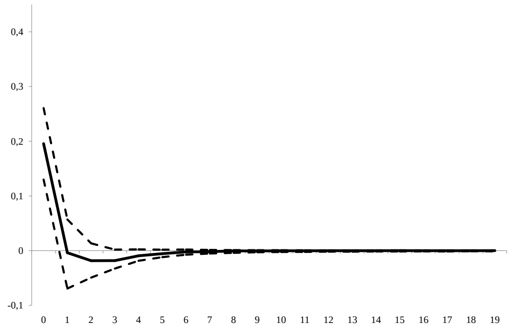


(b) Ordinary regime

Figure 11: Generalized impulse response functions. Response of GDP growth rate to a 1% standard deviation shock to government consumption expenditures and gross investment growth rates normalized in order to obtain a 1% increase in actual spending (1984:1-2007:4). BAA spread threshold variable. 68% confidence bands obtained via bootstrap.



(a) Tight credit regime



(b) Ordinary regime