Non-linear effects of the financial cycle on fiscal multipliers*

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Abstract

The economy often shows puzzling non-linear reactions to a fiscal shock. Such non-linear features are captured by a smooth transitioning economy fluctuating between two extreme states with a continuum of intermediate phases. These fluctuations are governed in our model by the financial cycle; we propose an instrument that takes into account the role of the financial environment and may lead to better and more aware policy crafting. Using Generalized Impulse Response Function analysis, we examine the effect of unanticipated government expenditure shocks on U.S. GDP. When accounting for the expansions and contractions of the financial cycle, our results challenge the common notion of a stronger multiplier during a contraction. Furthermore, the output reaction to a fiscal shock shows more sensitivity to the financial environment than to the sign of the shock itself. This questions the ability of fiscal policy to achieve its goals altogether.

JEL: C32; E17; E32; E37; E51; E62; H20; H63
Keywords: Markov Chain Monte Carlo; Nonlinear vector autoregression; Generalized Impulse Response Functions; Financial cycle; Fiscal shock; Fiscal multiplier; Smooth transition

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1 Introduction

The debate about fiscal multipliers, their magnitude, their evolution over time, their sensitivity to different monetary policy attitudes or, as more recently explored, to other institutional and macroeconomic environmental variables (unemployment level, labour or goods market openness degree) is endowed with a long history and yet is far from being concluded. In very recent times the centrality of the topic has been fostered both by the use of fiscal policy to counteract the effects of the financial crisis, as well as by the subsequent need to operate fiscal consolidations.
We structure a fluctuating economy along the financial cycle, focusing on the state contingency of the effects of a fiscal stimulus. We show that fiscal multipliers are weakly dependant on the extreme states of the financial cycle, while they are significantly affected by the cycle dynamic.

We do not venture into a detailed literature survey, relying on the efforts already made by other scholars, notably Warmedinger et al. (2015) and Favero and Karamysheva (2015).
This research roots in the promising field of the state contingency of fiscal multipliers, with a focus on whether the economy reacts differently in different phases of the financial cycle, either expanding or contracting. We pitch our model against both the same model fluctuating alongside the business cycle and a linear version of it.

We focus on the financial cycle in an effort to, as brilliantly summarized by Jorda et al. (2016), *take finance seriously*. Several phenomena compel us to consider financial fluctuations: the surge of the private credit in the second half of the last century, the astonishing growth of the financial sector and the very recent evidence from the Great Recession, where a financial turmoil brought a deep output shrinkage. Arcand et al. (2015) consider whether there is a threshold over which the growth of the financial sector is detrimental to output growth. We want to investigate the medium-term combined effect of credit fluctuations and fiscal stimuli imparted to the economy.

We find a number of significant results: government expenditure multipliers are heavily influenced by the cycles, but we are not able to unambiguously confirm the common notion of stronger multipliers in recessions. Moreover, the results are sensitive to the macroeconomic variables included in the analysis. Interestingly, when we expand the traditional Blanchard and Perotti

(2002) three variables approach with public debt, the two cycles yield opposite outcomes.

Putting a special emphasis on public debt is borne out naturally from our aim to take the financial environment seriously: the link between the credit and the business cycle was explicitly investigated by Kiyotaki and Moore (2015), but the missing piece, that is the interaction between sovereign debt and the financial cycle, has found new interest due to the most recent crisis and the subsequent burst of state-owned debt. A recent analysis on such interaction can be found in the work of Poghosyan (2015), whose findings - an asymmetrical relation between financial and debt cycles- complement our own evidence of an asymmetrical and non proportional output reaction to different fiscal stimulus sizes.

To reproduce the fluctuating economy we use the approach of Auerbach and Gorodnichenko (2012, henceforth AG), creating a Smooth Transition VAR able to *smoothly* change the coefficients between two extreme regimes (a state of absolute contraction/expansion of the economy). The choice of a non-linear model is deliberate. While we will inevitably face econometric and computational challenges, a growing awareness in the literature supports this path advocating for phenomena representation strategies closer to reality -and the reality itself is indeed non-linear[1]. Building on the AG approach, we extend our analysis to the financial cycle, include the private credit and the public debt among the variables considered and, furthermore, we choose to use the Generalized Impulse Response Functions -GIRF- analysis pioneered by Koop et al. (1996). This powerful instrument allows us to use the entire sample informative history to study the response of a truly fluctuating economy, accounting for the chance that the shock itself is able to change the way in which the economic macrovariables interact. We also perform some scenario analysis, investigating what happens if a fiscal shock is delivered in a typical recessionary/expansionary quarter.

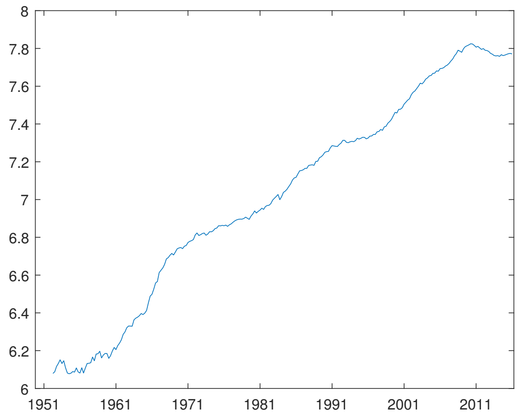
The evidence drawn from GIRFs analysis strongly advocates taking into account the financial context and the timing of any fiscal stimulus. Interestingly, we find that sizeable shocks are not always more effective than smaller ones and that sometimes positive shocks can trigger an output contraction.

[1] For a more structured and compelling case for a change of perspective in the economic modelling, one could refer to Chiu and Hoke (2016)

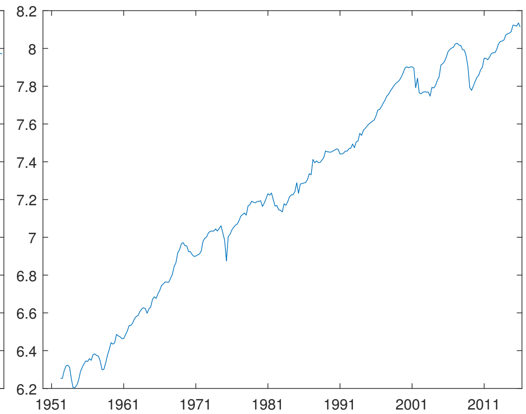
We believe that this line of work possesses an evident normative relevance. Knowing the way in which a specific fiscal manoeuvre affects the economy, given the current macroeconomic scenario, is a key element in allowing policy makers to make informed choices; to further emphasize the importance of an effective fiscal policy, take the European Union situation, where the Member States are delegating the monetary policy to a supranational institution, the ECB, and therefore are only able to rely on fiscal policy to offset any shock hitting the economy.

2 The data

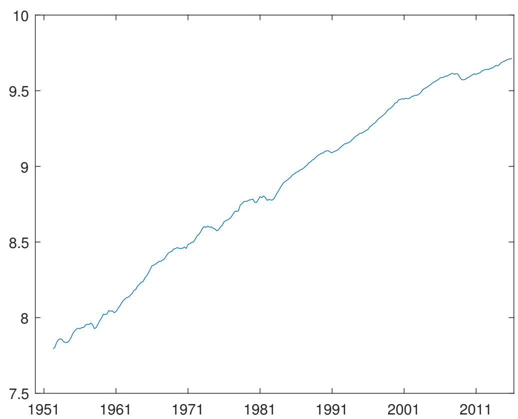
We use U.S. quarterly data from 1966Q1 (1952Q2, for all the specifications not including debt) to 2016Q1. Government expenditure, tax receipts and GDP are all log real series; public debt and private credit to non financial institutions are normalized by GDP.



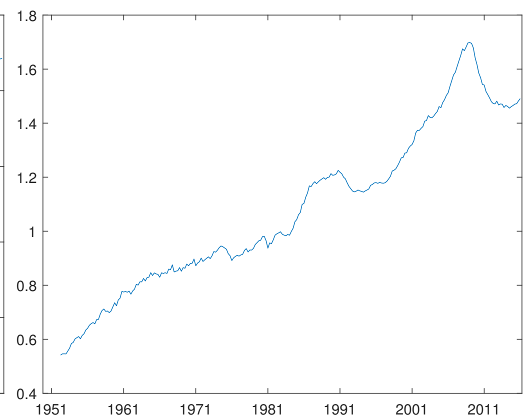
(a) Government expenditure



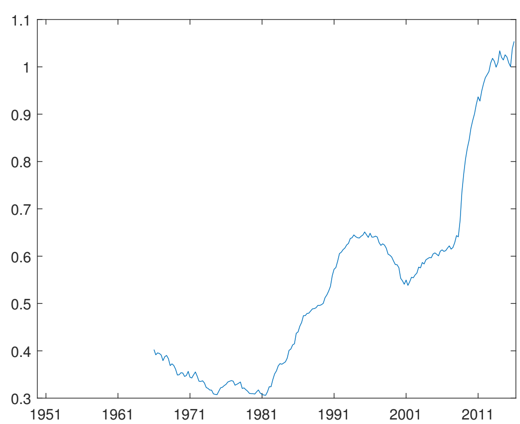
(b) Tax revenues



(c) GDP



(d) Private credit (normalized by GDP)



(e) Public debt (normalized by GDP)

Figure 1: Data series, log real data

We estimate the model in first differences to ensure stationarity.

2.1 Cycles and recessions

The business cycle is computed following AG, as the seven quarters moving average of output growth, an index providing good comparability with the NBER measurements of business cycle periods.

To get an estimate of the financial cycle, we adopt the approach of Drehmann et al. (2012) and Borio (2014) relying on frequency analysis. Specifically, we apply the Christiano and Fitzgerald (2003) passband filter to isolate and extract the so called medium term frequency component of the cycle, that is the components oscillating with a frequency between 32 and 120 quarters (8 and 30 years). The choice of the frequency analysis over the much more consolidated turning point analysis is dictated by the need to have an explicit value of the cycle for each quarter, instead of an estimate of maximum and minimum points of the cycle.

Our result is comparable with previous literature estimates, even if we drastically reduce the number of variables considered from five to just one, the *Credit to private non-financial institutions*, normalized by GDP. This choice allows us to base the estimation of the financial cycle on one of the variables included in the STVAR specification, an essential condition to use the Generalized Impulse Response analysis.

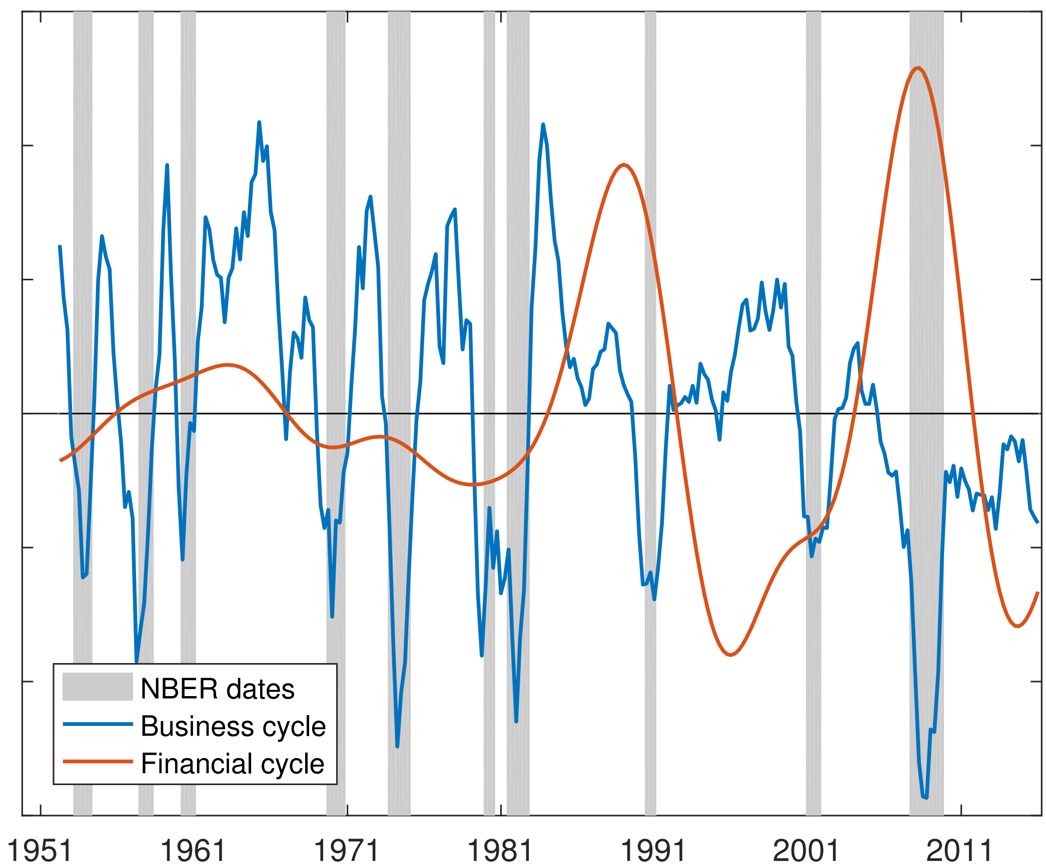


Figure 2: *Business and financial cycles (normalized), NBER recessionary periods* The business cycle is the $MA(7)$ of the ouput growth; the financial cycle is obtained via a band pass filter extracting the components fluctuating with frequency 32-120 quarters.

3 The model

Our model is a Smooth Transition VAR (henceforth STVAR) as in AG. The econometric specification is as follows:

$$\mathbf{X}_t = [(1 - F(z_{t-1}))\mathbf{\Pi}_E + F(z_{t-1})\mathbf{\Pi}_C](L)\mathbf{X}_{t-1} + \mathbf{u}_t \tag{1}$$

$$\mathbf{u}_t \sim N(\mathbf{0}, \mathbf{\Omega}_t) \tag{2}$$

$$\mathbf{\Omega}_t = \mathbf{\Omega}_E(1 - F(z_{t-1})) + \mathbf{\Omega}_C F(z_{t-1}) \tag{3}$$

$$F(z_t) = \frac{e^{-\gamma z_t}}{1 - e^{-\gamma z_t}} \qquad \gamma > 0$$

$$\text{Var}(z) = 1 \qquad \text{E}[z] = 0,$$

where $\mathbf{X}$ is the data matrix; z is the switching variable, ruling the transition on the cycle; $0 \leq F \leq 1$ is the smoothing function; the subscripts E and C refer respectively to expansion and contraction phases of the cycle; the lag polynomial is four lags long.

The model shows a twofold way of shock propagation: dynamic, through the lag polynomials $\mathbf{\Pi}_E$ and $\mathbf{\Pi}_C$ in equation (1), and contemporaneous, via the state contingent shock covariance matrix $\mathbf{\Omega}_t$ in equations (2)-(3). The latter feature makes the model highly non-linear.

3.1 Specifications and scenario analysis

The different specifications used amount to different choices of macroeconomic variables included in the vector $\mathbf{X}$ and of switching variable z. Table 1 summarizes the different combinations adopted to produce both the main and the benchmark results.

Table 1: Model specifications

	$\mathbf{X_t}$	z
Linear VAR	$[g_t,\ \tau_t,\ y_t,\ Pc_t]$	None
	$[g_t,\ \tau_t,\ d,\ y_t,\ Pc_t]$	
Specification 1	$[g_t,\ \tau_t,\ y_t,\ Pc_t]$	Financial cycle
Benchmark 1		Business cycle
Specification 2	$[g_t,\ \tau_t,\ d,\ y_t,\ Pc_t]$	Financial cycle
Benchmark 2		Business cycle

where all variables are first differences of the log real series. g is government expenditure; τ is tax revenues; y is GDP; Pc is private credit (normalized by GDP); d is public debt (normalized by GDP).

We also perform a scenario analysis considering two different environments in which the fiscal shock is triggered: a typical expansion and a typical recession. Our methodology consists in building a *typical regime-specific* quarter and appending it to our data, effectively including it in the history of realizations. This allows us to use our GIRF approach to investigate the effects of a fiscal shock imparted during a representative recession/expansion without sacrificing the smooth transitioning nature of our model. To build such a typical quarter, we use as a discriminating criterion the NBER business cycle dates (as in Figure 2) and then we take the median value of the variables, thus obtaining the median recessionary/expansionary quarter.

3.2 Model estimation and impulse response analysis

Since the model is heavily non-linear and possesses many parameters, we proceed as in AG and perform estimation using a Markov Chain Monte Carlo method detailed in Chernozhukov and Hong (2003). Given that the model becomes linear for any given guess of covariance matrices $\mathbf{\Omega}_E$ and $\mathbf{\Omega}_C$, the approach roots in building up a sequence of guesses leading to the highest likelihood. As we already mentioned, the model is estimated in first differences to ensure stationarity.

We use the Generalized Impulse Response Functions approach developed by Koop et al. (1996) to study the economy reaction to a shock keeping the smooth transitioning from one state to another intact. The technique uses expectation operators conditioned either on the history ($\mathcal{H}$) or on the history *and* the shock (s), averaging out future shocks. The General Impulse is defined as the expectation of the realization of $\mathbf{X}_t$ conditional on the history and the shock over a baseline consisting in the conditional expectation on just the history:

$$\begin{aligned} GI_{\mathbf{X}}(h, s_t, \mathcal{H}_{t-1}) = \mathrm{E}\left[\mathbf{X}_{t+h} \mid \mathcal{H}_{t-1}, s_t\right] - \mathrm{E}\left[\mathbf{X}_{t+h} \mid \mathcal{H}_{t-1}\right], \\ \text{for the horizon } h = 0, 1, \ldots . \end{aligned} \tag{4}$$

$GI_{\mathbf{X}}(h, s_t, \mathcal{H}_{t-1})$ represents a realization of the random variable GI, defined in equation (4) as the difference of two conditional expectations being themselves random variables. Since our model is known, we are able to use a Monte

Carlo approach to estimate the distribution of the conditional expectations and, therefore, to retrieve the empirical distribution of the realizations of GI allowing for a measure of centrality and for the estimation of the confidence bands.

We use two different shock absolute values, both positive and negative in sign: $\pm 1\%$ and $\pm 5\%$ of the U.S. government expenditure, roughly corresponding to $\pm 0.15\%$ and $\pm 0.8\%$ of GDP. We are aware that the larger shock can look *too* large, however, the American Recovery and Reinvestment Act of 2009 (2009) stimulus package delivered an estimated combined impact of roughly 2.5% of GDP in the first year of enactment, as detailed in CBO (2012).

The GIRF analysis is optimal to account for the non linearity of our model and it would make little sense to resort to a different analysis method. However, for the sake of comparability of results with the general literature about fiscal multipliers, we also include orthogonalized impulse response functions. The most striking limitation of this approach is that the results are no longer state-contingent, as we pick one specific value of the smoothing function (and therefore a specific phase of the cycles). We follow the example of AG and present results for the extremes of the cycle, choosing $F = \{1; 0\}$, thus assuming that the economy will always be stuck in either a peak or a trough of the cycle.

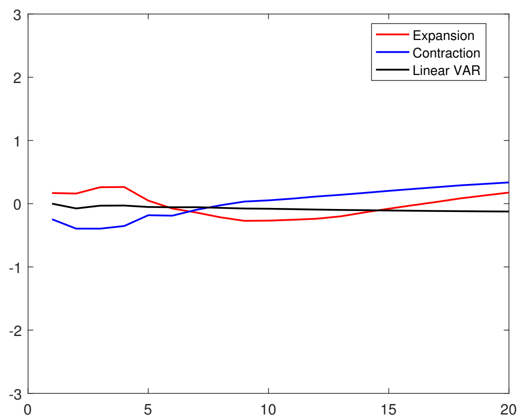
4 Empirical findings

Our empirical findings focus on a double layered comparison: the first is between a linear VAR benchmark and our fluctuating STVAR, the second is between competing STVAR specifications. To this aim, we will compare the output responses to a shock in an economy fluctuating alongside the financial cycle to those of an economy governed by the business cycle.

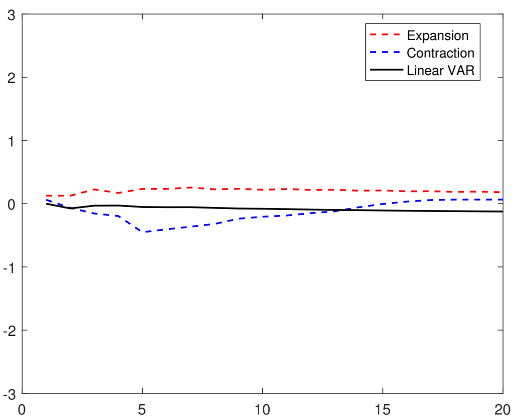
When considering the STVAR model, we present both the Cholesky and the Generalized IRFs. The former are computed using the extreme case of an economy stuck in one of the two limit regimes (an infinite and strong expansion/contraction of the cycle) and are commonly found in the fiscal multipliers literature. The latter are useful to understand the evolution of the output responses to differently sized shocks.

4.1 Specification 1

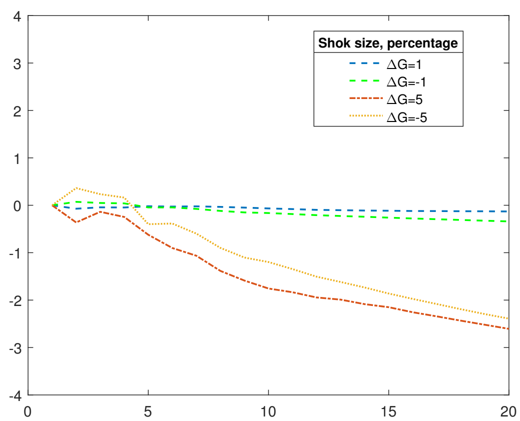
In accordance with Table 1, in this specification we augment the traditional Blanchard and Perotti (2002) vector of variables with the private credit, which we will use to extract the financial cycle.



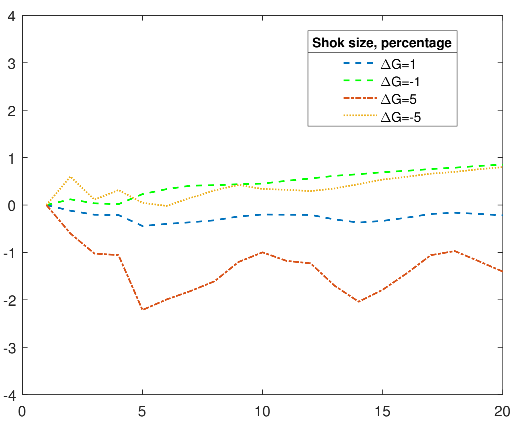
(a) Cholesky IRF - Financial cycle



(b) Cholesky IRF - Business cycle



(c) GIRF - Financial cycle



(d) GIRF - Business cycle

Figure 3: *Specification 1 - Financial and business cycle* Cumulative orthogonalized (a and b) and generalized (c and d) impulse responses. Percentage GDP response to a unit standard deviation (a and b) or to a percentage of public government expenditure shock (c and d). STVAR includes public expenditure, tax revenues, GDP and private credit.

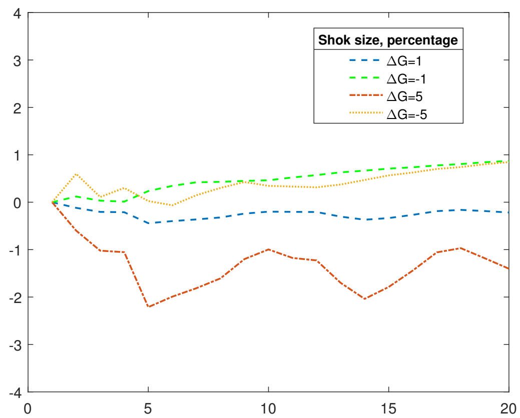
The first main result we can observe from the orthogonal IRFs is that the traditional notion of larger multipliers in a contraction, compared to during expansions, is heavily challenged. The opposite phenomenon is actually evident in the BC benchmark, while the financial cycle leads to more mixed results even featuring an inversion in the relative size of the effects after about two years from the shock.

The linear VAR shows a reaction which is roughly an average of the state-contingent ones, thus providing a much more traditional and flat evolution of the shock.

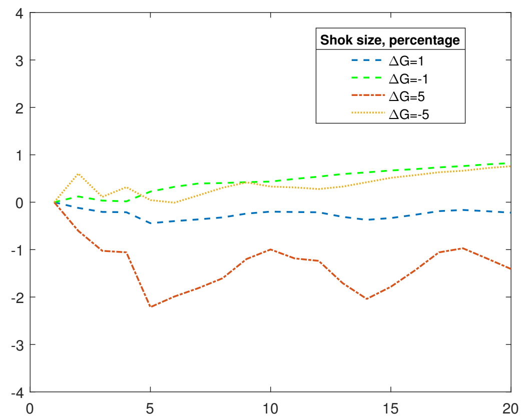
The Generalized Impulse Responses, on the other hand, add complexity to the result. An economy fluctuating on the financial cycle is going to react to any kind of government intervention exhibiting a strong negative response to any size (and, most notably, sign) of fiscal shock.

Fluctuations along the business cycle could instead be used to support the *Austerity* argument: positive measures produce zero to detrimental output responses, while public expenditure cuts are expansionary, thus mirroring the expansionary budget cuts of Alesina and Ardagna (2012).
However, the beneficial effect of public expenditure cuts appears to have strong limitations in terms of efficiency, if a smaller shrinkage is as effective as a more robust reduction.

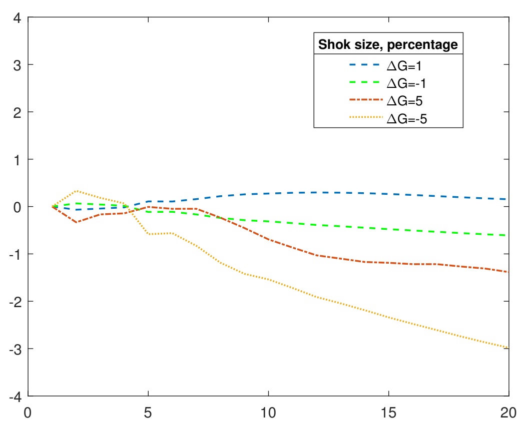
4.1.1 Scenario analysis



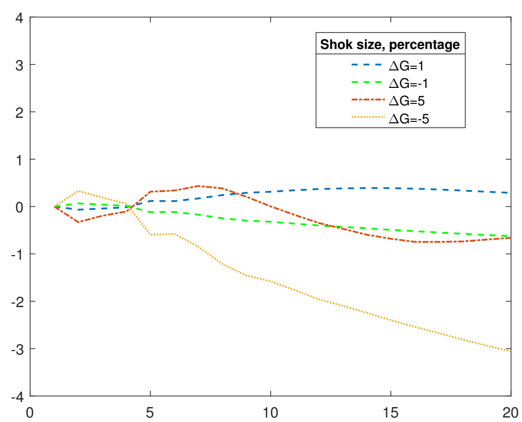
(a) Typical expansion - Business cycle



(b) Typical recession - Business cycle



(c) Typical expansion - Financial cycle



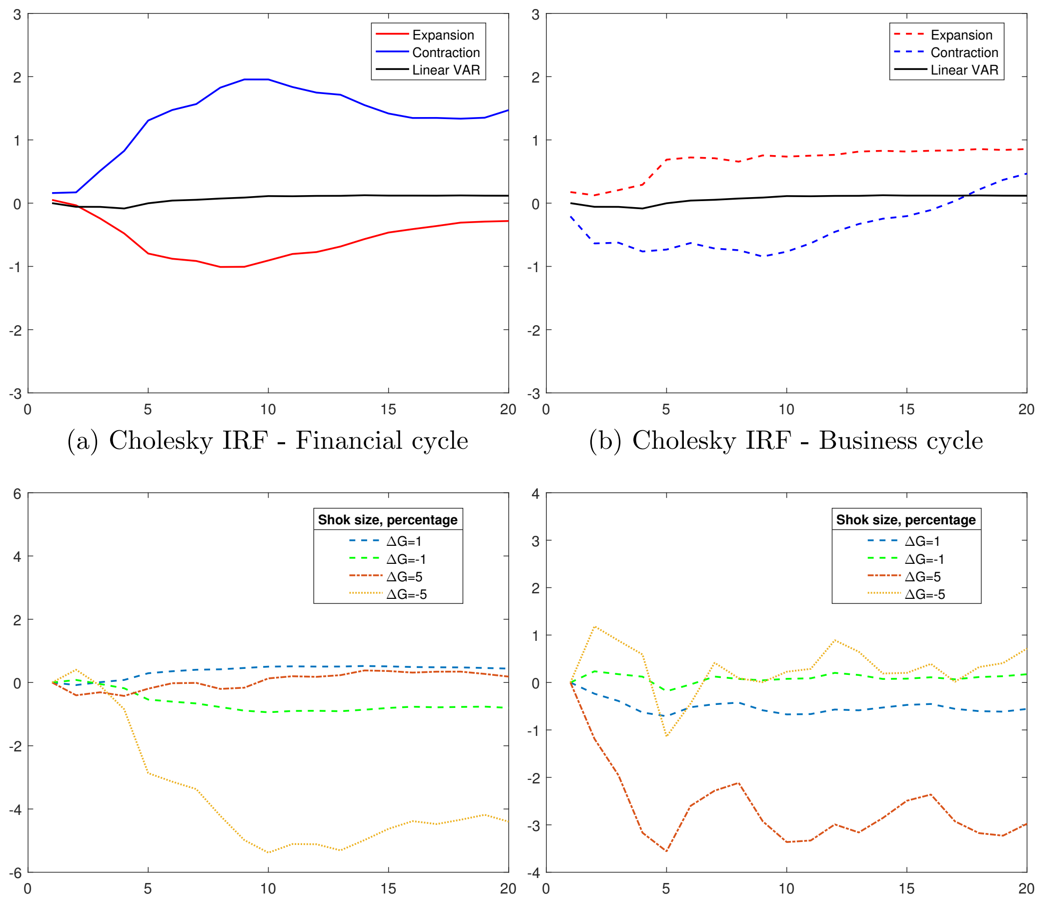
(d) Typical recession - Financial cycle

Figure 4: *Scenario analysis* Cumulative Generalized Impulse Responses to a shock triggered in a median recession/expansion quarter. STVAR includes public expenditure, tax revenues, GDP and private credit.

Interestingly, triggering a shock in a median recession/expansion does not produce striking differences, especially on the side of the business cycle. The financial cycle-driven results vary notably only for positive government expenditure shocks and we can observe a larger reaction in financial cycle *typical recessions*.

4.2 Specification 2

Rather than including the public debt as it is, we choose to normalize it by GDP to get not a measure of the debt *per se*, but an indicator of debt sustainability relative to the size of the economy.



(a) Cholesky IRF - Financial cycle (b) Cholesky IRF - Business cycle

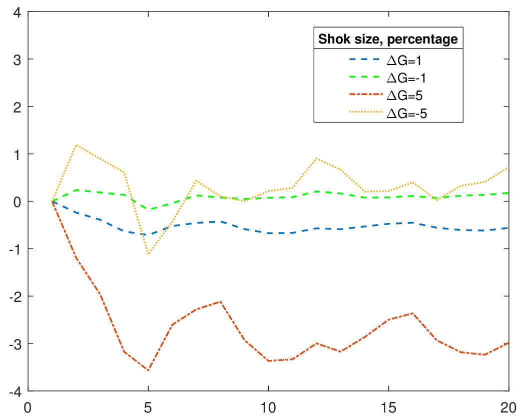
(c) GIRF - Financial cycle (d) GIRF - Business cycle

Figure 5: *Specification 2 - Financial and business cycle* Cumulative orthogonalized (a and b) and generalized (c and d) impulse responses. Percentage GDP response to a unit standard deviation (a and b) or to a percentage of public government expenditure shock (c and d). STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

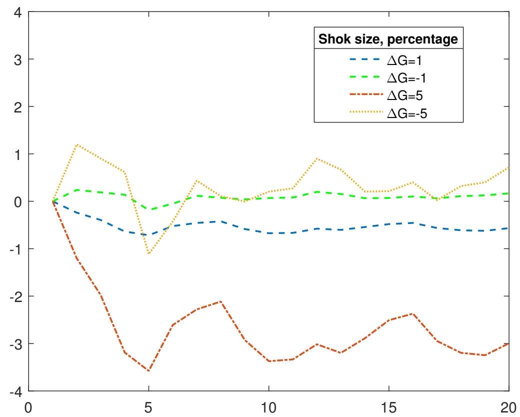
Augmenting the classic three variables specification with public debt produces opposite results between the two cycles. On one hand, when the financial cycle is considered, we find again the classical result of stronger multiplier during a slack period. However, when the business cycle is ruling, the finding clearly reverses and we obtain definitely stronger multipliers during expansions.
Again, the linear VAR response is approximately an average of the more extreme output reactions.

When we let the economy free to fluctuate, the business cycle shows qualitatively no difference with the previous specification: positive shocks cause a negative reaction and negative shocks, however big, yield a small positive effect. On the other hand, the financial cycle results are straightforward: a negative shock produces a negative GDP reaction, while an increment in government expenditure shows a positive response.
However, the data show a cap to the effect of a larger positive shock, given that a +5% government expenditure shock is slightly less effective of a +1% shock.

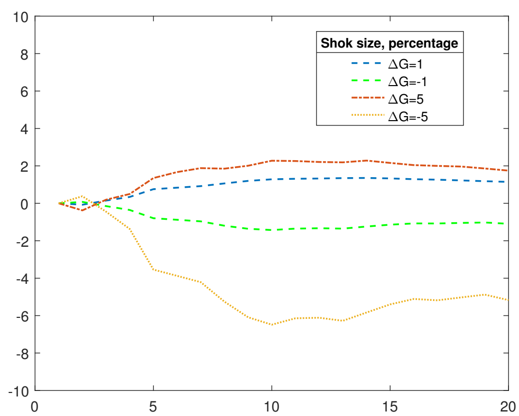
4.2.1 Scenario analysis



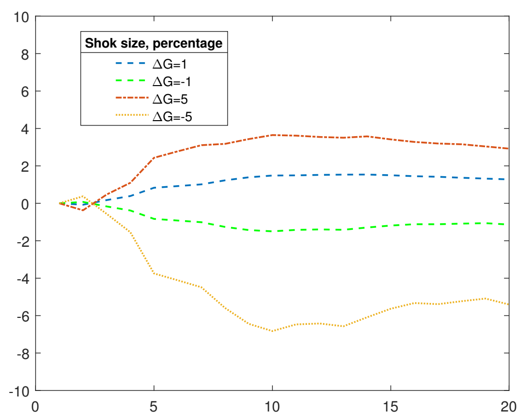
(a) Typical expansion - Business cycle



(b) Typical recession - Business cycle



(c) Typical expansion - Financial cycle



(d) Typical recession - Financial cycle

Figure 6: *Scenario analysis* Cumulative Generalized Impulse Responses to a shock triggered in a median recession/expansion quarter. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

The most striking result is certainly that the nature of the quarter in which the shock is triggered makes virtually no difference in output response, while, as observed in the main specification, the difference in behaviour between business and financial cycle remains substantial.

We can confirm the presence of asymmetries between larger negative and positive shocks in the financial cycle-guided results, along with, mirroring the previous specification, the presence of a cap for the effect of larger positive shocks. Furthermore, typical recessions again feature a slightly larger response to positive shocks.

5 Conclusions and remarks

We used a Smooth Transition VAR to allow the economy to fluctuate alongside the business and the financial cycle. We believe that this choice has proven its worth: the main conclusion we obtain from our empirical evidence is that controlling for private credit and public debt brings interesting asymmetries to light, both between positive and negative shocks and in the response to larger government expenditure variations.

The business cycle results are unaffected from the inclusion of public debt in the model specification and seem to endorse expansionary budget cuts à la Alesina and Ardagna (2012), albeit the gain of such cuts remains capped for more consistent expenditure reductions. On the other hand, cutting the public expenditure produces, if we pay attention to the financial cycle, a GDP contraction, whereas positive shocks again do not feature an effect proportional to the size of the intervention.

The asymmetries and the interesting cap effect are preserved in the scenario analysis. Triggering a fiscal shock in a median expansionary/recessionary quarter has no effect on both business cycle-driven results and financial cycle-moved responses to negative shocks, for both specifications. However, when a positive government expenditure shock is imparted to the economy under the financial cycle, the GDP reactions are larger under a typical recession, thus recovering part of the classic argument of stronger multipliers in recessions.

The overall lesson we take from our evidence is that of caution: if working with linear models is too simple, introducing non-linearities and allowing the economy to adjust its own dynamics over time produces more questions than answers and urges for prudence in giving clear cut answers when policy advice is to be given. Caution should be exercised even comparing results. We find natural to compare results produced by economies ruled by the same cycle under different specifications. A straightforward quantitative comparison between the two different cycles, on the other hand, is weak to the differences in cycle estimation and smoothing; furthermore, the two cycles are not always synchronized, with some notable discordances detailed in Figure 2.

The next natural step of this research would be to find a way to combine the two cycles, a task which is hardly trivial: if it is obvious that any economy lives subject to a real and a financial oscillation, the weight of the relative influences is still obscure. A further investigation of this matter would prove of great value in casting new light both on the real-financial interplay and on the interaction of macroeconomic variables.

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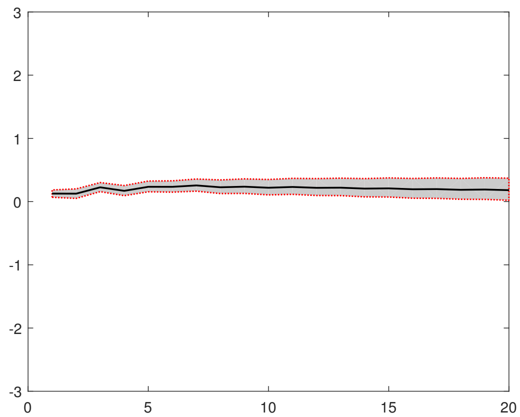
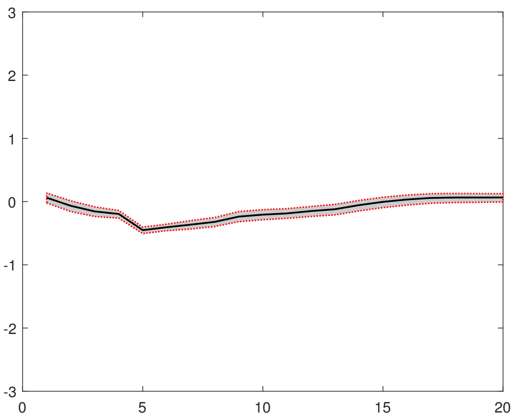
A Specification 1

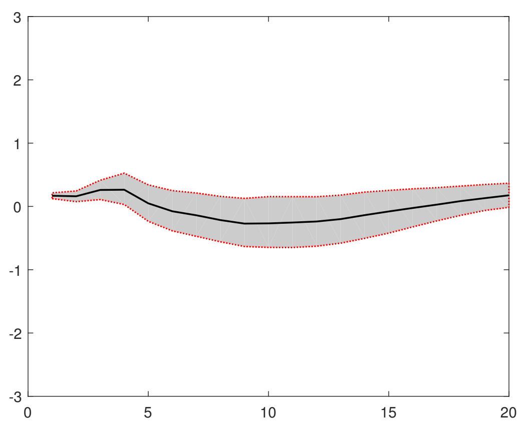
A.1 Orthogonal Impulse Response



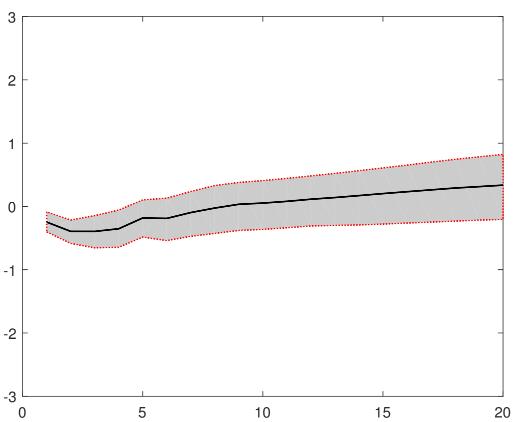
(a) Business cycle - Expansion



(b) Business cycle - Contraction



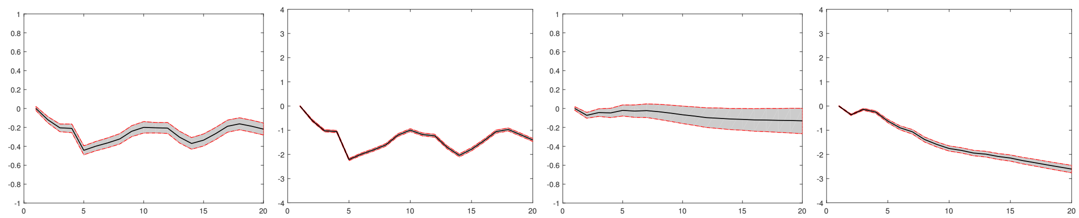
(c) Financial cycle - Expansion



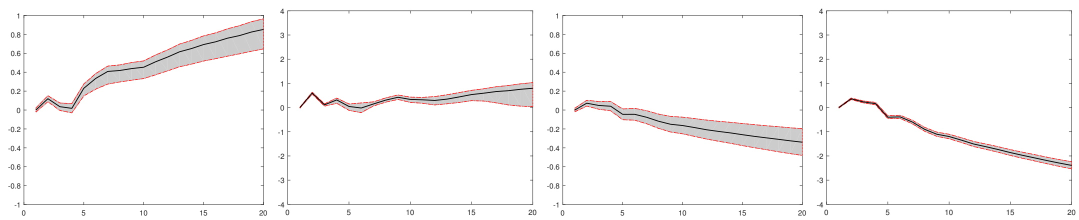
(d) Financial cycle - Contraction

Figure 7: *Specification 1 - Financial and business cycle* Cumulative orthogonalized impulse responses to a unit standard deviation with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

A.2 Generalized impulse response



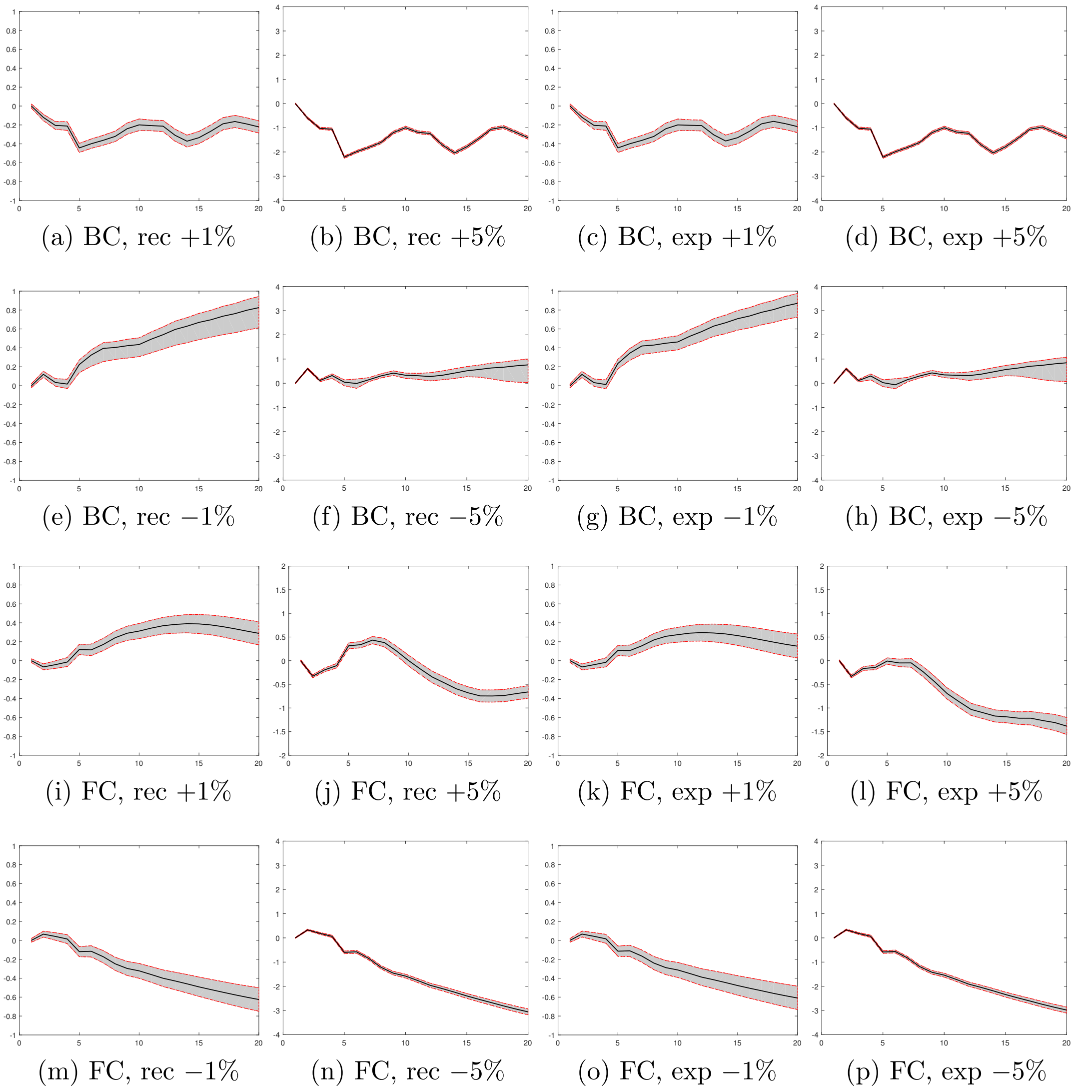
(a) BC, +1% (b) BC, +5% (c) FC, +1% (d) FC, +5%



(e) BC, −1% (f) BC, −5% (g) FC, −1% (h) FC, −5%

Figure 8: *Specification 1 - Financial and business cycle* Cumulative generalized impulse responses. Percentage GDP response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

A.3 Scenario Analysis



(a) BC, rec +1% (b) BC, rec +5% (c) BC, exp +1% (d) BC, exp +5%

(e) BC, rec −1% (f) BC, rec −5% (g) BC, exp −1% (h) BC, exp −5%

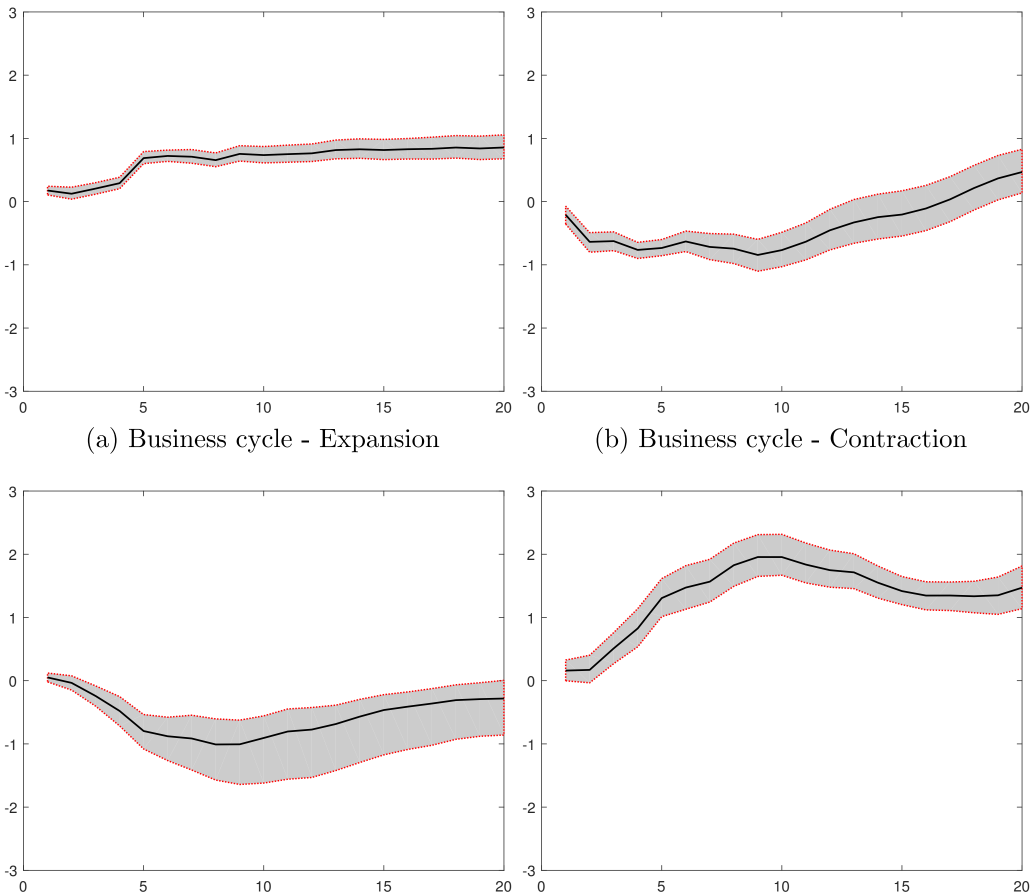
(i) FC, rec +1% (j) FC, rec +5% (k) FC, exp +1% (l) FC, exp +5%

(m) FC, rec −1% (n) FC, rec −5% (o) FC, exp −1% (p) FC, exp −5%

Figure 9: *Scenario analysis* Cumulative Generalized Impulse Responses to a shock triggered in a median expansion/recession quarter, with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

B Specification 2

B.1 Orthogonal Impulse Response



(a) Business cycle - Expansion

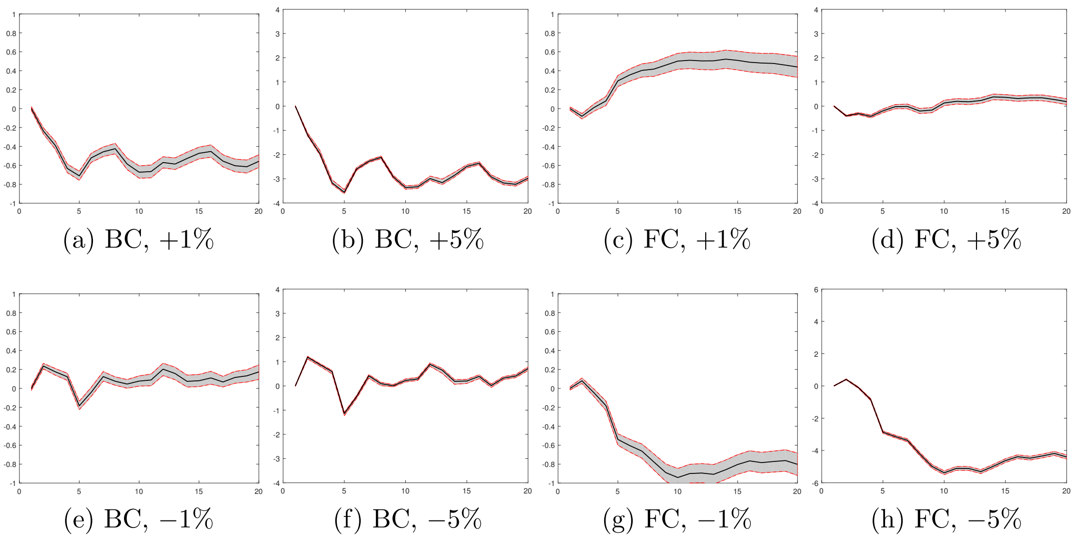
(b) Business cycle - Contraction

(c) Financial cycle - Expansion

(d) Financial cycle - Contraction

Figure 10: *Specification 2 - Financial and business cycle* Cumulative orthogonalized impulse responses to a unit standard deviation with confidence bands at 5th and 95th percentile. STVAR includes public expenditure,tax revenues, public debt, GDP and private credit.

B.2 Generalized impulse response

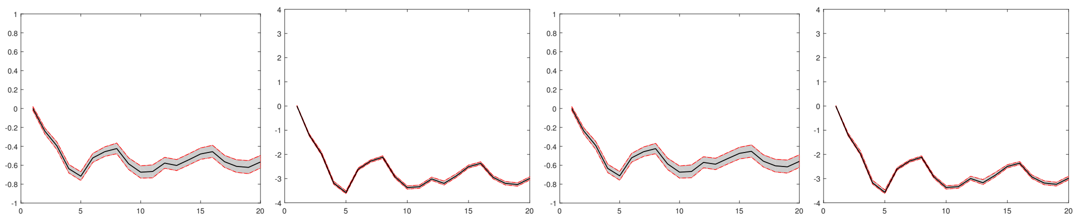


(a) BC, +1%   (b) BC, +5%   (c) FC, +1%   (d) FC, +5%

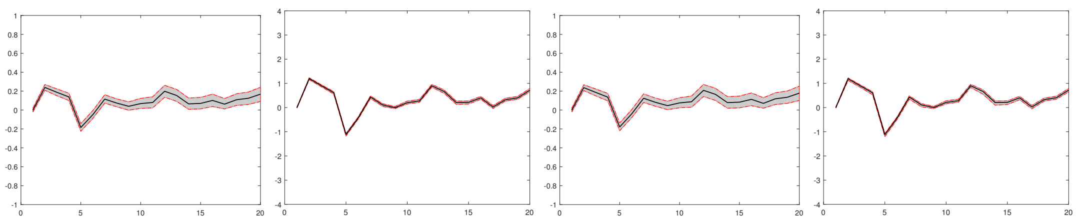
(e) BC, −1%   (f) BC, −5%   (g) FC, −1%   (h) FC, −5%

Figure 11: *Specification 2 - Financial and business cycle* Cumulative generalized impulse responses. Percentage GDP response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure,tax revenues, public debt, GDP and private credit.

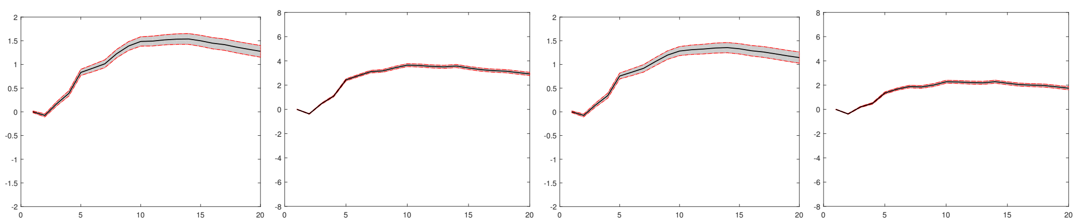
B.3 Scenario Analysis



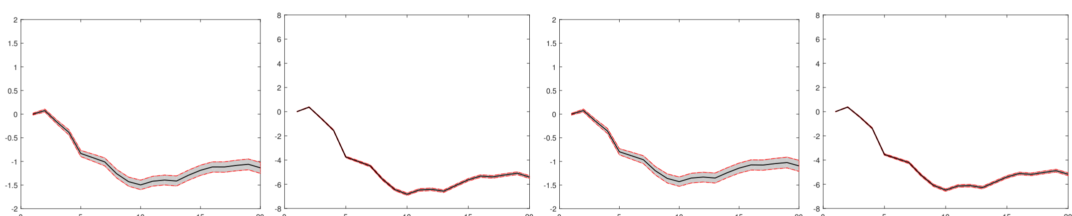
(a) BC, rec +1% (b) BC, rec +5% (c) BC, exp +1% (d) BC, exp +5%



(e) BC, rec −1% (f) BC, rec −5% (g) BC, exp −1% (h) BC, exp −5%



(i) FC, rec +1% (j) FC, rec +5% (k) FC, exp +1% (l) FC, exp +5%



(m) FC, rec −1% (n) FC, rec −5% (o) FC, exp −1% (p) FC, exp −5%

Figure 12: *Scenario analysis* Cumulative Generalized Impulse Responses to a shock triggered in a median expansion/recession quarter, with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.