

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

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## Abstract

We use a Smooth Transition VAR to capture the non-linear features often displayed by the economy when reacting to a fiscal shock by letting our model fluctuate around a continuum of intermediate phases between two extreme states of the financial cycle. Using generalized impulse response analysis, we examine the non-linear effects of unanticipated government expenditure shocks on U.S. GDP, controlling for private credit and public debt. We also perform a scenario analysis to investigate shock responses in typical recessions and expansions. We find that (i) the results support the inclusion of a measure of fiscal burden in the model; (ii) once allowing for non-linearity the GDP response to fiscal shocks is asymmetric in sign and magnitude; (iii) there exists a cap effect with regard to how expansionary a fiscal policy can be and such cap appears non-linearly related to the public debt dynamic; (iv) the scenario analysis shows stronger multipliers in typical recessions.

JEL Classifications: 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 stances 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. Recently 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 undertake fiscal consolidations.

The heterogeneity of the related results presented in the recent literature has been extensively surveyed by Favero and Karamysheva (2017). Going through the plethora of empirical estimates produced by different model specifications, they consider both the VAR approach (the classic version by Blanchard and Perotti (2002), the sign restricted version of Mountford and Uhlig (2008), and the expectations-augmented one by Ramey and Shapiro (1999), and Fisher and Peters (2009)) and the narrative approach (the seminal work by Romer and Romer (2010) later extended by Pescatori et al. (2011), the focus on fiscal policy mix of Leeper (2010), the attempt to retrieve better tax multipliers of Favero and Giavazzi (2012), and the focus on tax mix of Mertens and Ravn (2014)). They conclude that a unique fiscal multiplier does not exist, due to the sensitivity of the estimates to model specification and identification restrictions, and that much more attention should be paid to the dynamics. Such a remark seems to find a natural answer in the line of inquiry assuming time-varying fiscal multipliers, or rather multipliers contingent on some state variable -usually the business cycle.

This research contributes the field of the state contingency of fiscal multipliers, with a focus on whether the economy reacts differently in different phases of the financial cycle through expansion or contraction. Specifically, we consider an economy that fluctuates with 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 and by the inclusion in the model of a measure of fiscal burden. We also compare the results of our non-linear model to those based on a linear one across two different specifications.

We focus on the financial cycle in an effort to, as remarkably 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 financial turmoil brought about sizeable output losses. Arcand et al. (2015) consider whether there is a threshold over which the growth of the financial sector is detrimental to output growth. Complementing their study we investigate the medium-term combined effect of credit fluctuations and fiscal stimuli imparted to the economy. We find a number of interesting results. Government expenditure multipliers are heavily influenced by the cycle, but we are not able to unambiguously confirm the common notion of stronger multipliers in recessions. It also appears that the results are strongly sensitive to the choice of including a measure of fiscal space based on public debt into the model specification.

The emphasis on public debt is born out naturally from our intention to take the financial environment seriously. While the link between credit and the business cycle was extensively investigated by Kiyotaki and Moore (2015), 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, giving somewhat new breath to the discoveries of Reinhart and Rogoff (2010). A recent analysis on such interaction can be found in the work of Poghosyan (2015), whose finding -an asymmetrical relation between financial and debt cycles- complements our own evidence of an asymmetrical and non proportional output reaction to different magnitudes of fiscal stimulus. Moreover, Ilzetzki et al. (2013) find that public debt acts as a state variable in estimating scale multipliers and where state owned debt is high, fiscal multipliers tend to be low and fiscal policy ineffective.

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 representations of phenomena closer to reality -and the reality itself is indeed non-linear.<sup>1</sup> Departing from AG our focus is on the financial cycle rather than the business cycle, and we include private credit and the public debt among the variables of interest. Furthermore, unlike AG we choose to use the generalized impulse response functions -GIRF- analysis pioneered by Koop et al. (1996). This powerful tool allows us to use the entire sample history to study the response of a truly fluctuating economy, accounting for the possibility that the shock itself is able to change the way in which the variables interact. Pesaran and Shin (1998) and Warne (2008) prove that GIRF analysis does not require that we identify any structural shock. We also perform a scenario analysis exercise, investigating what happens if a fiscal shock is delivered in an alternative setting (the so called scenario) of typical recession/expansion; this amounts to triggering fiscal stimulus while being in a specific phase of the cycle.

The evidence drawn from GIRF analysis strongly suggests taking into account the financial environment and the timing of any fiscal stimulus. Interestingly, we find that sizeable shocks are not always more effective than smaller ones, a cap effect featured in all our specifications. Knowing the way in which a specific fiscal operation will affect the economy, given the current macroeconomic conditions, is key in helping policy makers make informed choices. To further emphasize the importance of an effective fiscal policy, we only need to consider the European Union situation, where the Member States are delegating monetary policy to a supranational institution, the ECB, and therefore have only fiscal policy to rely on to offset any shock hitting the economy.

The rest of this paper is organized as follows. Section 2 details the model and the data, and Section 3 presents the empirical results. Section 4 concludes.

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<sup>1</sup>A more compelling case for a change of perspective in economic modelling can be found in Chiu and Hoke (2016).

## 2 Methodology

This section presents the model and discusses generalized impulse response analysis that will be used to investigate its dynamics.

### 2.1 The smooth-transition VAR model

Our model is a Smooth Transition VAR (henceforth STVAR) as in AG. The smooth-transition VAR is a multivariate extension by Dijk et al. (2002) of a univariate specification proposed by Teräsvirta and Granger (1993). AG extend it, allowing the variance covariance matrix of the innovation process to follow the same smooth transition mechanism. The econometric specification is as follows:

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

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

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

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

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

where  $\mathbf{\Pi}_E$  and  $\mathbf{\Pi}_C$  are the coefficient matrices corresponding to the extreme states of the cycle;  $\mathbf{X}$  is the data matrix;  $z$  is the switching variable, ruling the transition on the cycle;  $0 \leq F \leq 1$  is the exponential transition function and  $\gamma$  is the parameter controlling the speed of the transition; the subscripts  $E$  and  $C$  refer respectively to expansion and contraction phases of the cycle; the order of the lag polynomial is four.

The model allows the shocks to propagate via two channels: a dynamic one, through the lag polynomials  $\mathbf{\Pi}_E(L)$  and  $\mathbf{\Pi}_C(L)$  in equation (1), and a contemporaneous one, via the state contingent shock covariance matrix  $\mathbf{\Omega}_t$  in equations (2)-(3). The latter feature makes the model highly non-linear.

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 the covariance matrices  $\mathbf{\Omega}_E$  and  $\mathbf{\Omega}_C$ , the approach roots in building up a sequence of guesses leading to the highest likelihood.

### 2.2 Impulse response functions

We use the generalized impulse response analysis 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 generalized impulse response function is defined as the expectation of the realization of  $\mathbf{X}_t$  conditional on the History and the Shock over a baseline consisting of the conditional expectation on just the History:

$$GI_{\mathbf{X}}(h, s_t, \mathcal{H}_{t-1}) = \text{E}[\mathbf{X}_{t+h} \mid \mathcal{H}_{t-1}, s_t] - \text{E}[\mathbf{X}_{t+h} \mid \mathcal{H}_{t-1}], \quad (4)$$

for the horizon  $h = 0, 1, \dots$

$GI_{\mathbf{X}}(h, s_t, \mathcal{H}_{t-1})$  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. This approach does not

require identification of any structural shock, as detailed in Pesaran and Shin (1998) and Warne (2008), and therefore it maps the model dynamics to a government expenditure equation residual shock.

The GIRF analysis is optimal to account for the non linearity of our model. 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 it requires selecting one specific value of the transition 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.

### 3 Empirical analysis

In what follows we present the variables and the data included in the analysis, and discuss our financial cycle estimation strategy. A selection of empirical results is also presented.

#### 3.1 Variables and data

We use U.S. quarterly data from 1966Q1 (1952Q2, for the specification 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.

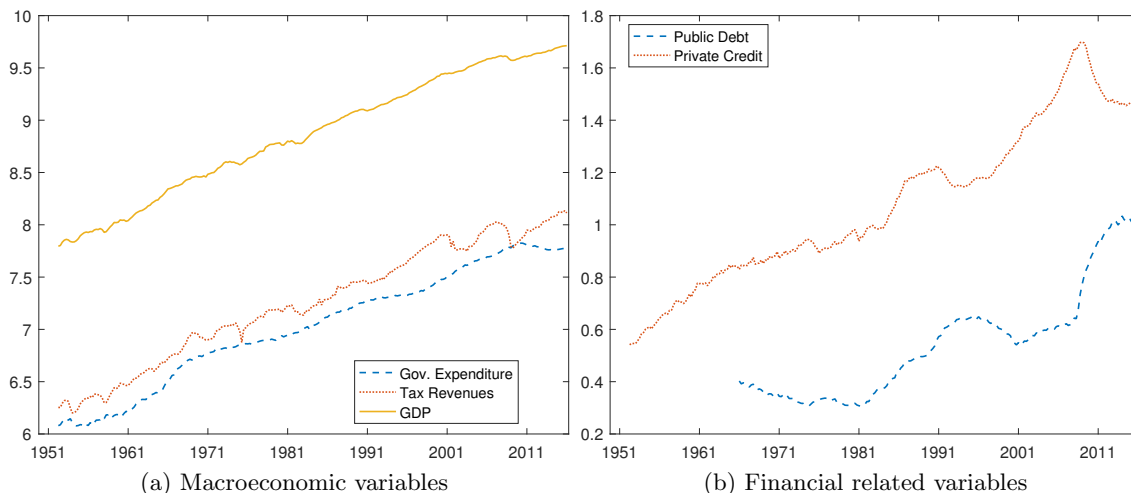


Figure 1: Data series, log real data of (a) Government Expenditure, Tax Revenues, GDP, and (b) Public Debt, Private Credit (both normalized by GDP)

The choice of government expenditure, tax revenues and GDP is standard in the VAR literature related to fiscal multipliers starting with Blanchard and Perotti (2002). Since our estimation of the financial cycle relies on private credit to non financial institutions, this is included in the VAR to allow the dynamic computation of non-linear impulse responses. We choose specifically public debt in light of its relationship with fiscal multipliers identified by Perotti (1999) and Ilizetzi et al. (2013), both finding that high levels of fiscal burden (debt-to-gdp ratio) are able to impair fiscal policy shrinking the size of fiscal multipliers. Furthermore, we believe that controlling for public debt is a natural choice to complement the deficit dynamics. We estimate the model in first differences to ensure stationarity.

### 3.2 The financial cycle

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 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.

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 model specification, an essential condition to use the generalized impulse response analysis. To allow a comparison, we also include an estimate of the business cycle obtained as in AG.

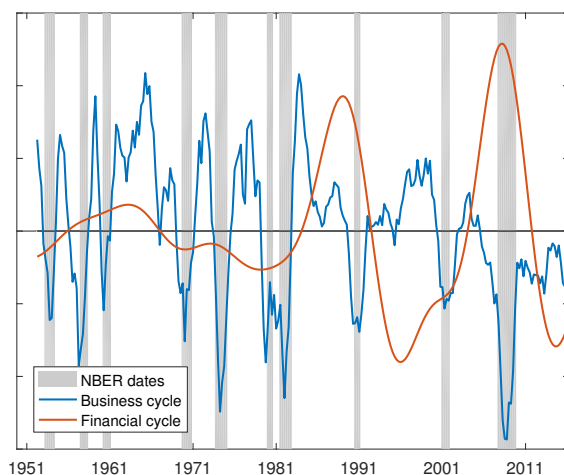


Figure 2: *Business and financial cycles (normalized), NBER recessionary periods* The business cycle is the  $MA(7)$  of the output growth; the financial cycle is obtained via a band pass filter extracting the components fluctuating with frequency 32-120 quarters.

### 3.3 Impulse responses

Our focus is on the response of GDP to a government expenditure shock. We will present results for a baseline model, the standard linear VAR, and for the non-linear STVAR. Two specifications will be considered for the set of  $\mathbf{X}_t$  variables, namely  $\mathbf{X}_t = [g_t, \tau_t, y_t, Pc_t]$  and  $\mathbf{X}_t = [g_t, \tau_t, d, y_t, Pc_t]$ , where all variables are first differences of the log real series.  $g$  is government expenditure;  $\tau$  is tax revenues;  $y$  is GDP;  $Pc$  is private credit (normalized by GDP);  $d$  is public debt (normalized by GDP). The STVAR model will be augmented by an estimate of the financial cycle, denoted by the variable  $z_t$ . We consider shocks of  $\pm 1\%$  and  $\pm 5\%$  to U.S. government expenditure, roughly corresponding to  $\pm 0.15\%$  and  $\pm 0.8\%$  of GDP. While the larger shock may look *too large*, 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 The Congress of the United States - Congressional Budget Office (2012).

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 imposed 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 augmented with the public debt variable.

### 3.3.1 Government expenditure shocks not controlling for public debt

We start by presenting results for the case where  $\mathbf{X}_t = [g_t, \tau_t, y_t, Pc_t]$ .

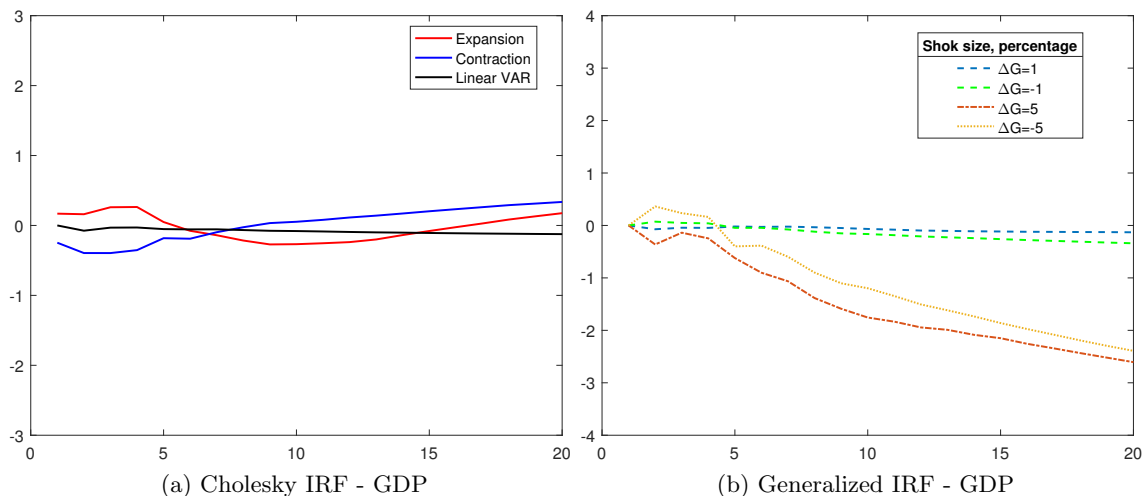


Figure 3: *Specification 1* Cumulative orthogonalized (a) and generalized (b) impulse responses. Percentage GDP response to a unit standard deviation (a) or to a percentage of public government expenditure shock (b). STVAR includes public expenditure, tax revenues, GDP and private credit.

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, disappears. The results even feature 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 further dynamics to the result. An economy fluctuating with 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. To substantiate our intuition, it is useful to look at the private credit response to the same fiscal stimuli.

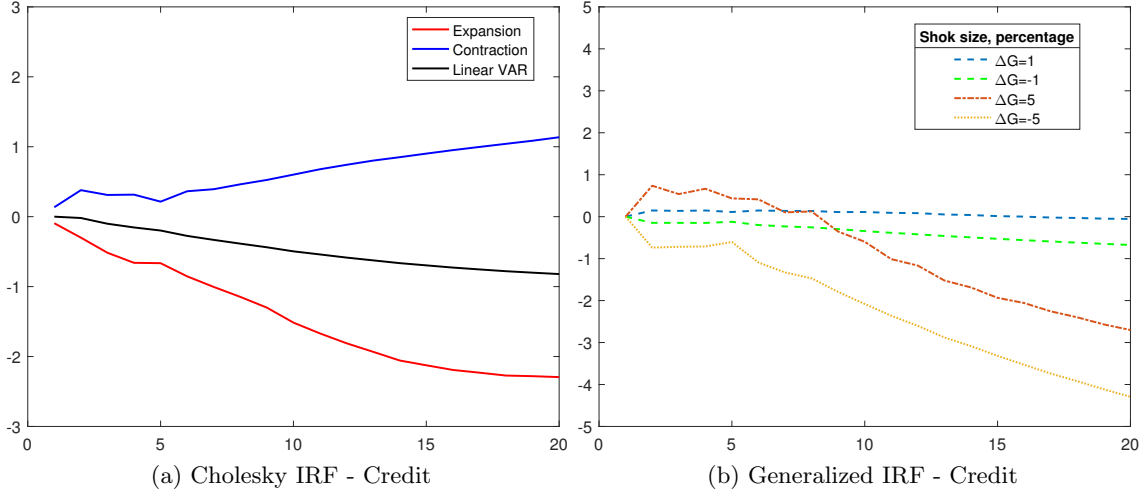


Figure 4: *Specification 1* Cumulative orthogonalized (a) and generalized (b) impulse responses. Percentage private credit response to a unit standard deviation (a) or to a percentage of public government expenditure shock (b). STVAR includes public expenditure, tax revenues, GDP and private credit.

The orthogonal IRF pairs a fiscal shock with a private credit growth in extreme contraction phases and a decline in financial environment booms, which is coherent with a consumption smoothing reaction in the short-medium term, when we take out the non-linear features of the model. This interpretation also serves the purpose to explain the relatively small GDP reaction to the fiscal shock and its most peculiar feature, the inversion of relative size of effects, which is paired with a faster credit growth/decline.

The GIRF analysis, on the other hand, suggests that the economic decline is driven by the negative trend of private credit following all size and signs of shocks. The model seems here to capture more of a general trend of the economy rather than the specific reaction to a fiscal policy, albeit there are differences in the speed of decline between positive and negative fiscal shocks: when the shock is positive the decline is less steep and therefore closer to the orthogonal contractionary response, mirroring the orthogonal case in which the relative size in a contraction is smaller than in an expansion. This latter feature complements what can be observed in the GDP related GIRF: a positive shock is more recessionary than a negative one.



### 3.3.2 Scenario analysis, not controlling for public debt

Interestingly, triggering a shock in a median recession/expansion does not produce striking differences. The financial cycle-driven results vary notably only for positive government expenditure shocks and we can observe a larger (or *less negative*) reaction in *typical recessions*.

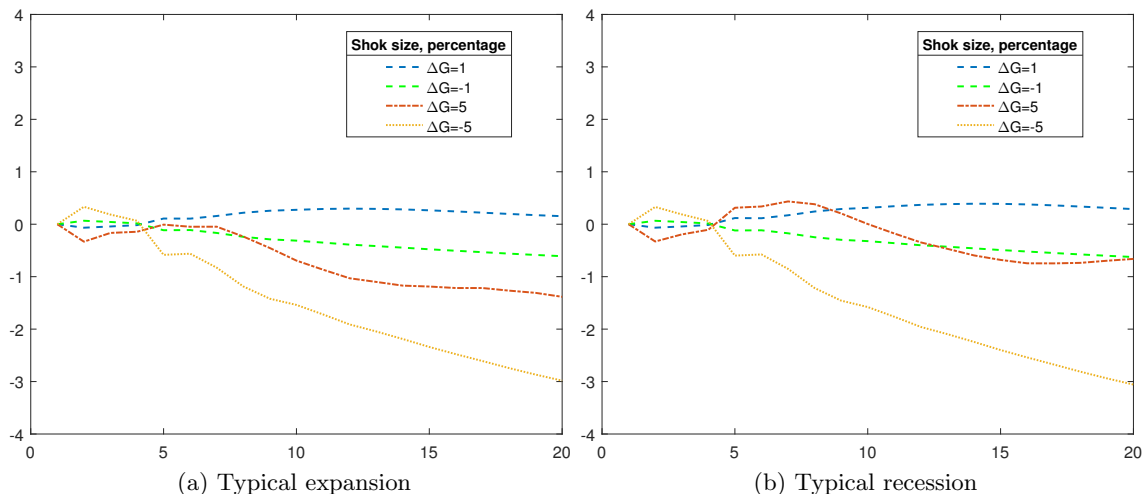


Figure 5: *Scenario analysis* Cumulative generalized impulse responses to a shock triggered in a median recession/expansion quarter. STVAR includes public expenditure, tax revenues, GDP and private credit.

### 3.3.3 Government expenditure shocks controlling for public debt

Next we change the model specification to  $\mathbf{X}_t = [g_t, \tau_t, d, y_t, Pc_t]$ , augmenting the previous specification with public debt. Rather than including it as it is, we choose to normalize it by GDP to get not a measure of the debt *per se*, but an indicator of fiscal burden relative to the size of the economy.

Since the sample size is now shorter due to data availability, we re-estimate the model using the previous specification on the new sample. We find that the results are mostly unchanged, thus strengthening the conclusion that the difference between the two different specifications are not induced by the difference in the sample size.

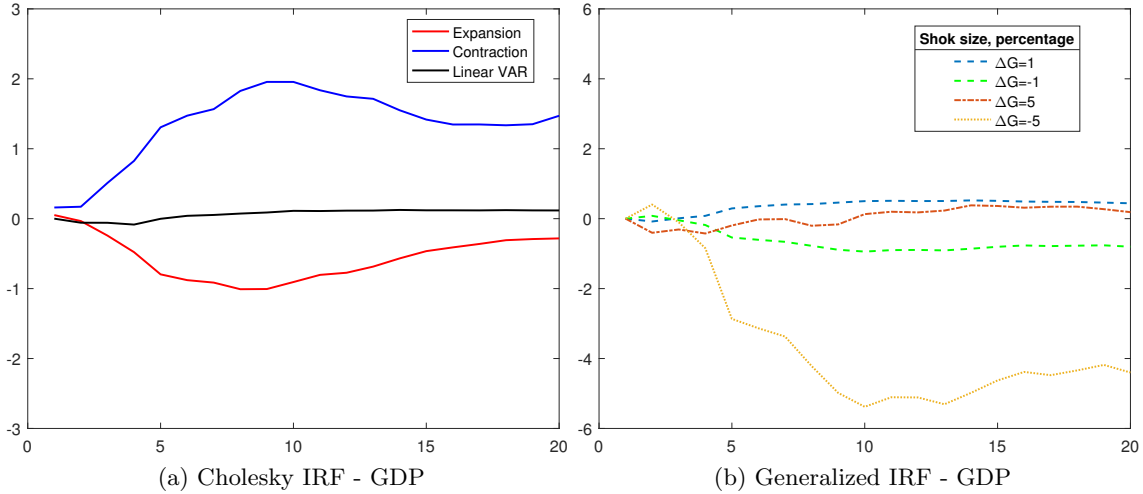


Figure 6: *Specification 2* Cumulative orthogonalized (a) and generalized (b) impulse responses. Percentage GDP response to a unit standard deviation (a) or to a percentage of public government expenditure shock (b). STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

Augmenting the classic three variables specification with public debt, we find again the classical result of a stronger multiplier during a slack period. Again, the linear VAR response is approximately an average of the more extreme output reactions. When we allow the economy to fluctuate, the results are straightforward: a negative shock produces a negative GDP reaction, while an increase in government expenditure shows a positive response. However, the data show a cap with regard to the effect of a larger positive shock, given that a +5% government expenditure shock is slightly less effective than a +1% shock.

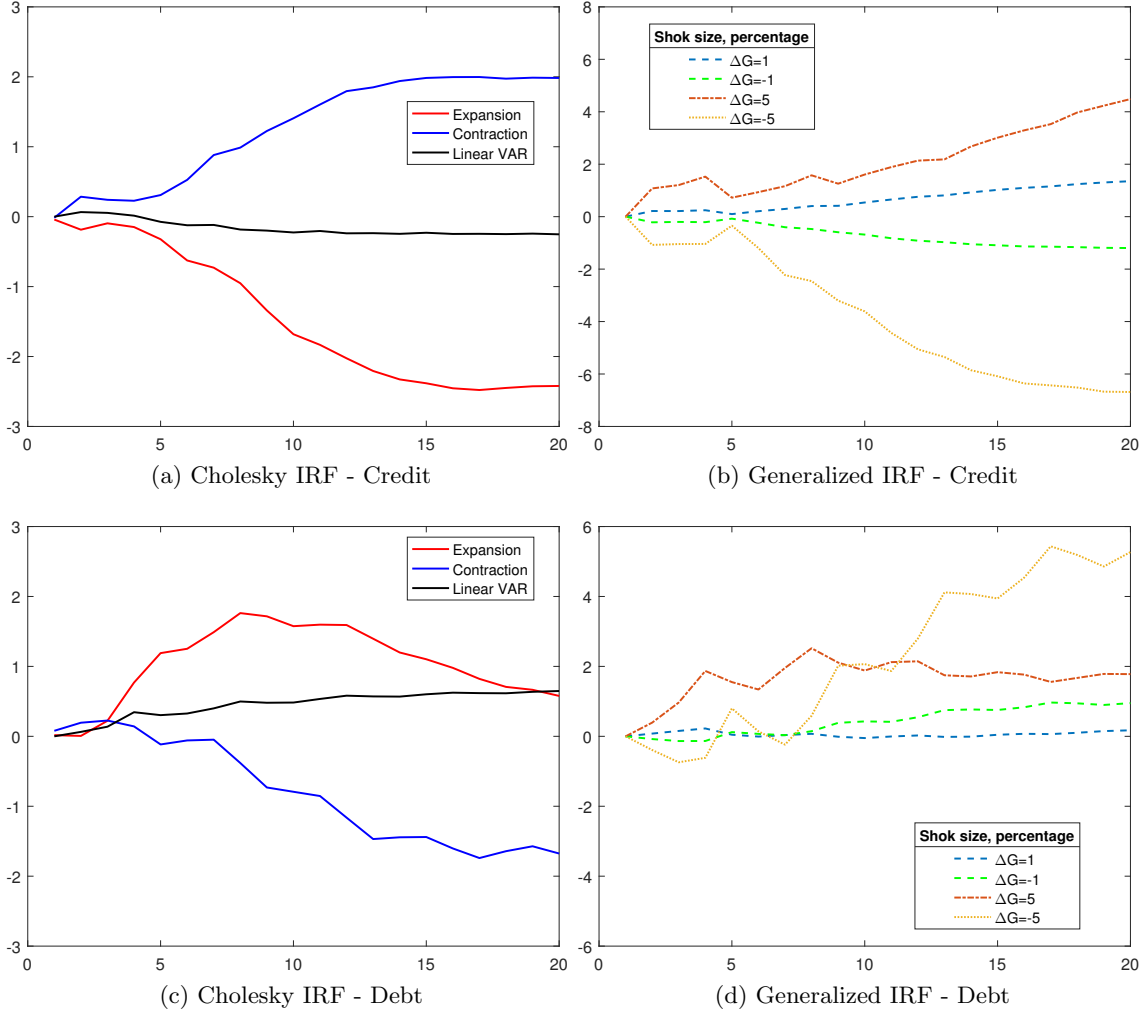


Figure 7: *Specification 2* Cumulative orthogonalized (a, c) and generalized (b, d) impulse responses. Percentage private credit (a, b) and debt (c, d) response to a unit standard deviation (a, c) or to a percentage of public government expenditure shock (b, d). STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

The private credit response obtained via orthogonal IRFs is qualitatively comparable to the one observed in the previous specification, even if larger in magnitude. The debt evolution is instead pro-cyclical: growing in financial cycles booms and contracting in financial cycles downturns. If we consider that, according to our estimates of the cycles shown in Figure 2, the financial and business cycles often show opposite behaviour, this is indeed a counter-cyclical behaviour of debt with respect to the business cycle.

The message from GIRFs analysis is, at least credit-wise, straightforward: positive government expenditure shocks are paired with an increase in private credit and negative ones are coupled with a decrease. The debt dynamics show more diversity: a positive policy shock is matched with a relatively moderate increase in the public debt, while a negative one exhibits a slower growth speed with higher totals after the 10th quarter. If we take into account the GDP reactions, we have two main elements to consider: first, larger shocks trigger larger reactions only if negative; when the policy shock is positive, the GDP response meets what we called *cap effect* and it is smaller than the effect of a reduced shock. Second, larger shocks are paired with more than proportional increases in public debt. The main intuition is that the increase in debt strengthens the contractionary side:

if the shock is negative, the GDP reaction will be deeply negative, where instead if the shock is positive, the increase in debt will cap its expansionary effect.

### 3.3.4 Scenario analysis, controlling for public debt

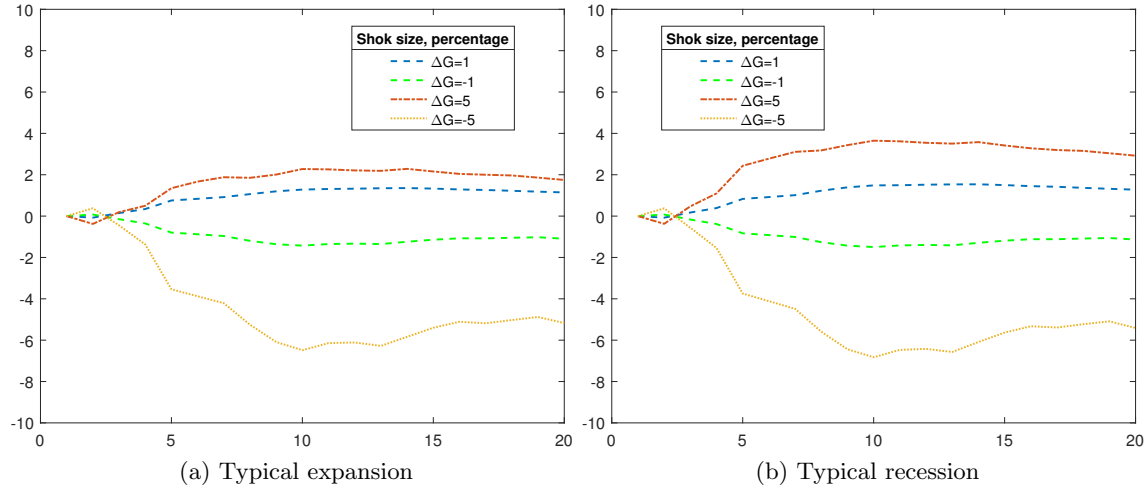


Figure 8: *Scenario analysis* Cumulative generalized impulse responses to a shock triggered in a median recession/expansion quarter. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

The most striking result is certainly that the nature of the quarter in which the shock is triggered makes very little difference in output response. Typical recessions still feature a slightly larger response to positive shocks, a phenomenon already shown in the previous specification.

We can confirm the presence of asymmetries between larger negative and positive shocks along with the presence of a cap with regard to the effect of larger positive shocks, mirroring the previous specification.

## 4 Conclusion

A Smooth Transition VAR was adopted to allow the economy to fluctuate with the financial cycle. This choice is believed to have 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. Thus, the rich dynamics of public debt should not be excluded from the model.

Results show that cutting public expenditure produces a GDP contraction, whereas positive shocks do not feature an effect proportional to the size of the intervention, a phenomenon we term as *cap effect*. Investigating the dynamics of private credit highlights its positive relationship with GDP and supports the intuition that credit is used to smooth consumption supporting GDP. The traditional result of stronger fiscal multipliers in recessions may then be rooted in the credit dynamics.

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 responses to negative shocks, for both  $\mathbf{X}_t = [g_t, \tau_t, y_t, Pc_t]$  and  $\mathbf{X}_t = [g_t, \tau_t, d, y_t, Pc_t]$ . However, when a positive government expenditure shock is imparted to the economy, the GDP reactions are larger under a typical recession, thus recovering part of the classic argument of stronger multipliers in recessions.

The overall message from the presented 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. Specifically, the dynamics generating the so called *cap effect* appear worth of deeper investigation and consideration, even more because our results show a direct, albeit non-linear, connection with the public debt dynamic, raising a flag not only on the size of a policy measure, but on the way in which it is financed. Such a phenomenon, detectable only because of the non-linear nature of the model, directly challenges the efficiency (if not the efficacy altogether) of any public intervention in the economy.

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# Appendix

## A Additional figures and results

### A.1 Not controlling for public debt: Orthogonal Impulse Response

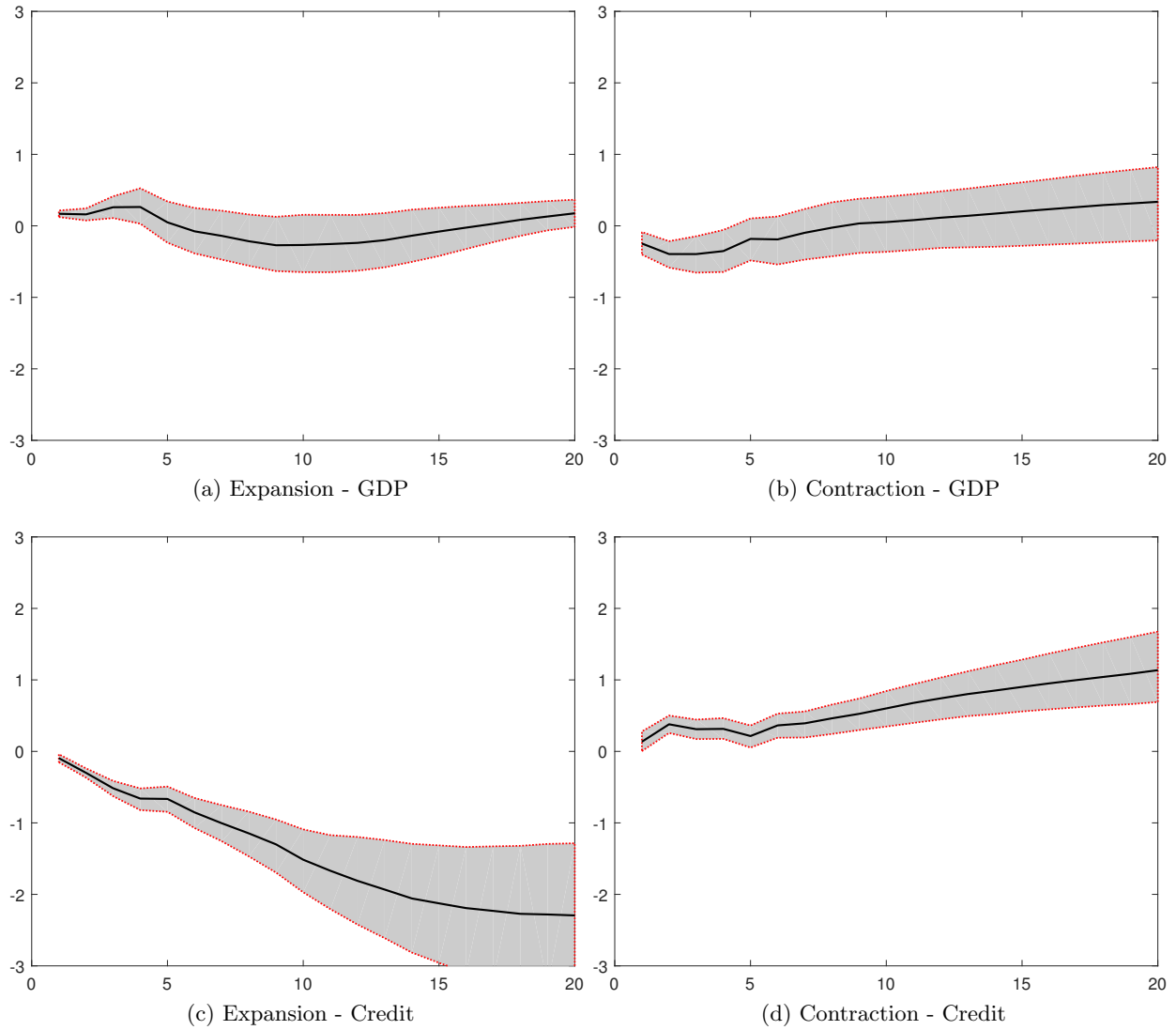


Figure 9: *Specification 1* Cumulative orthogonalized impulse responses to a unit standard deviation with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.



## A.2 Not controlling for public debt - Shorter sample: Orthogonal Impulse Response

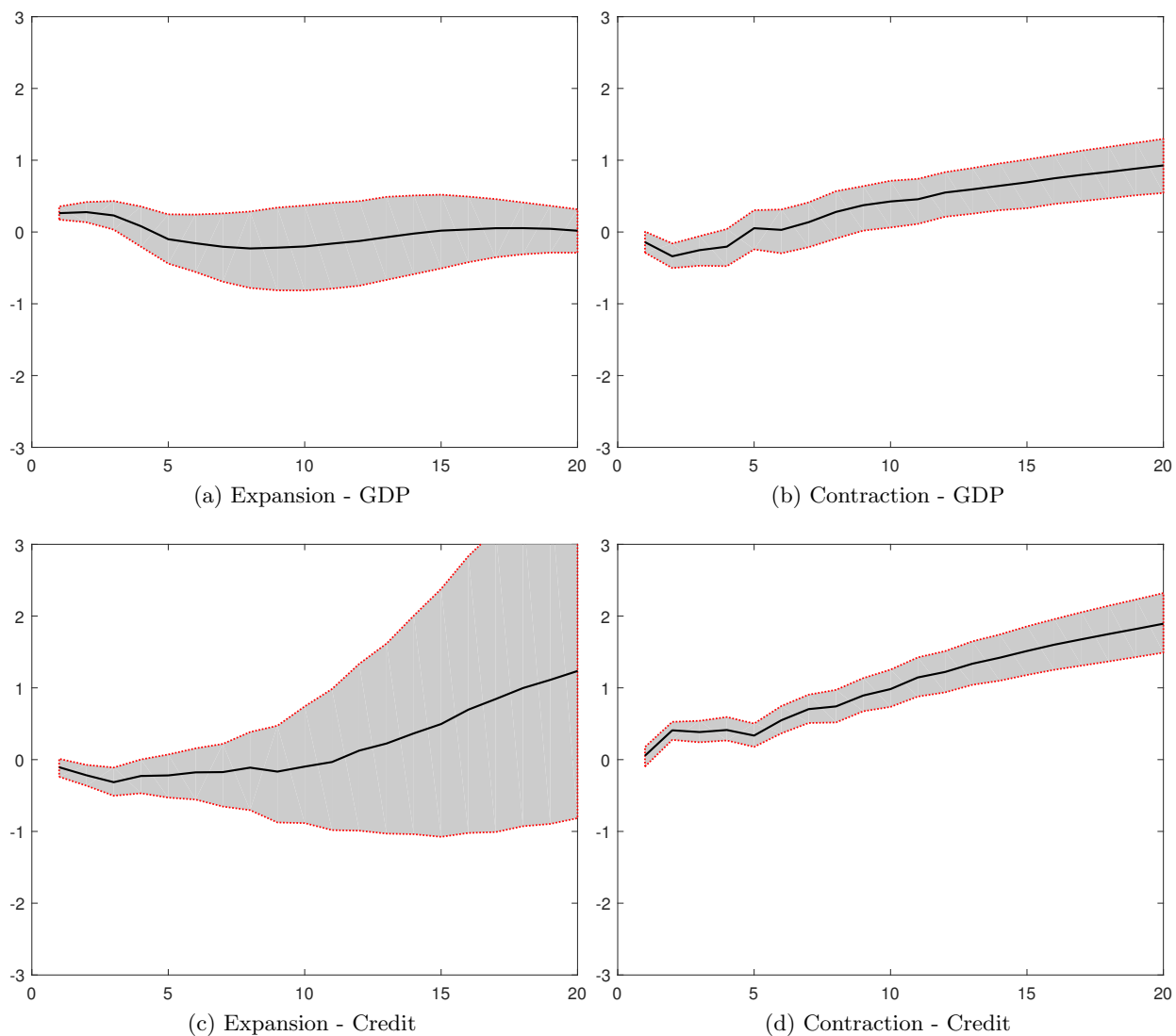


Figure 10: *Specification 1 - Shorter sample* Cumulative orthogonalized impulse responses to a unit standard deviation with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

### A.3 Not controlling for public debt: generalized impulse response

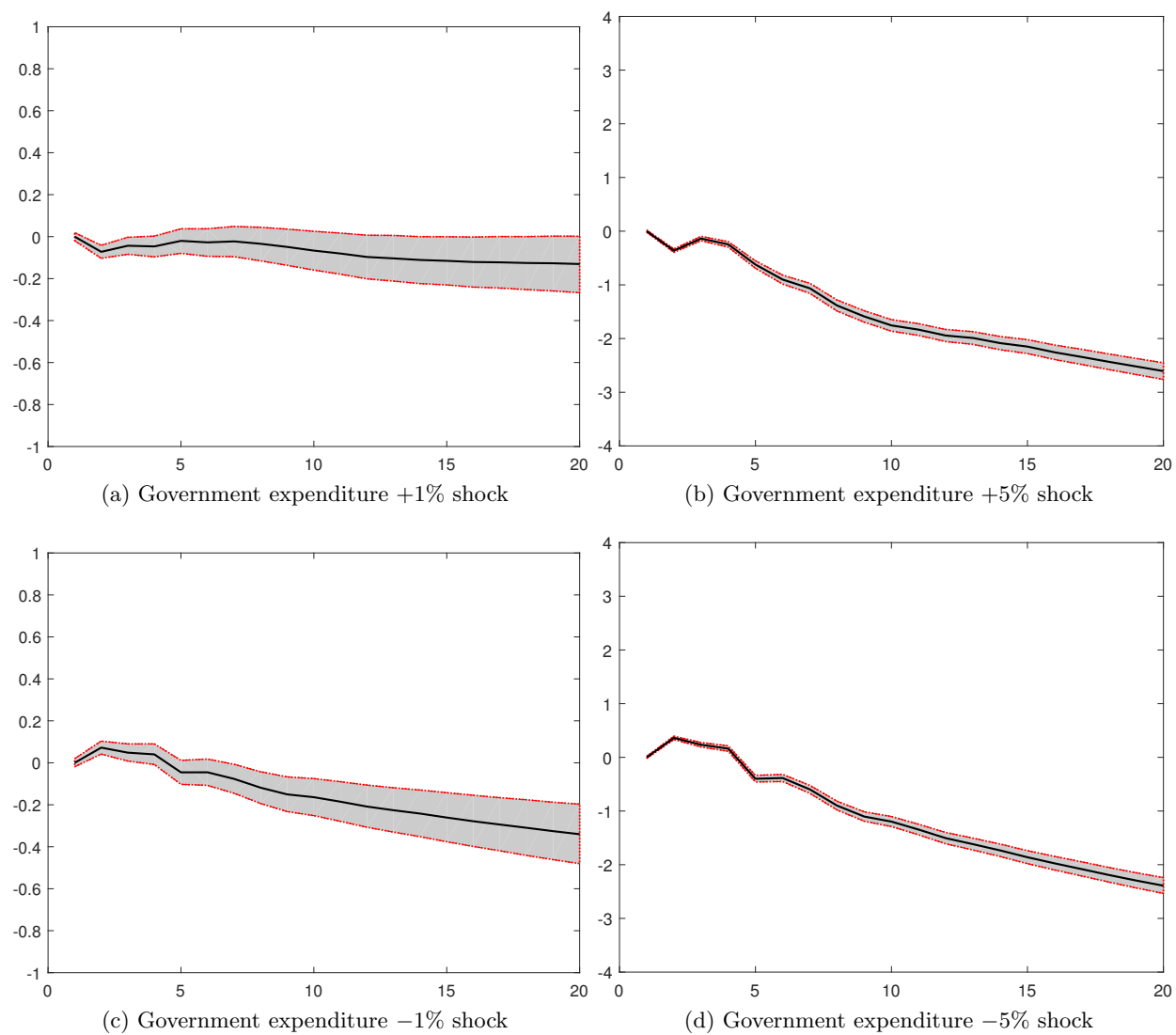


Figure 11: *Specification 1: GDP* Cumulative generalized impulse responses. Percentage GDP response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

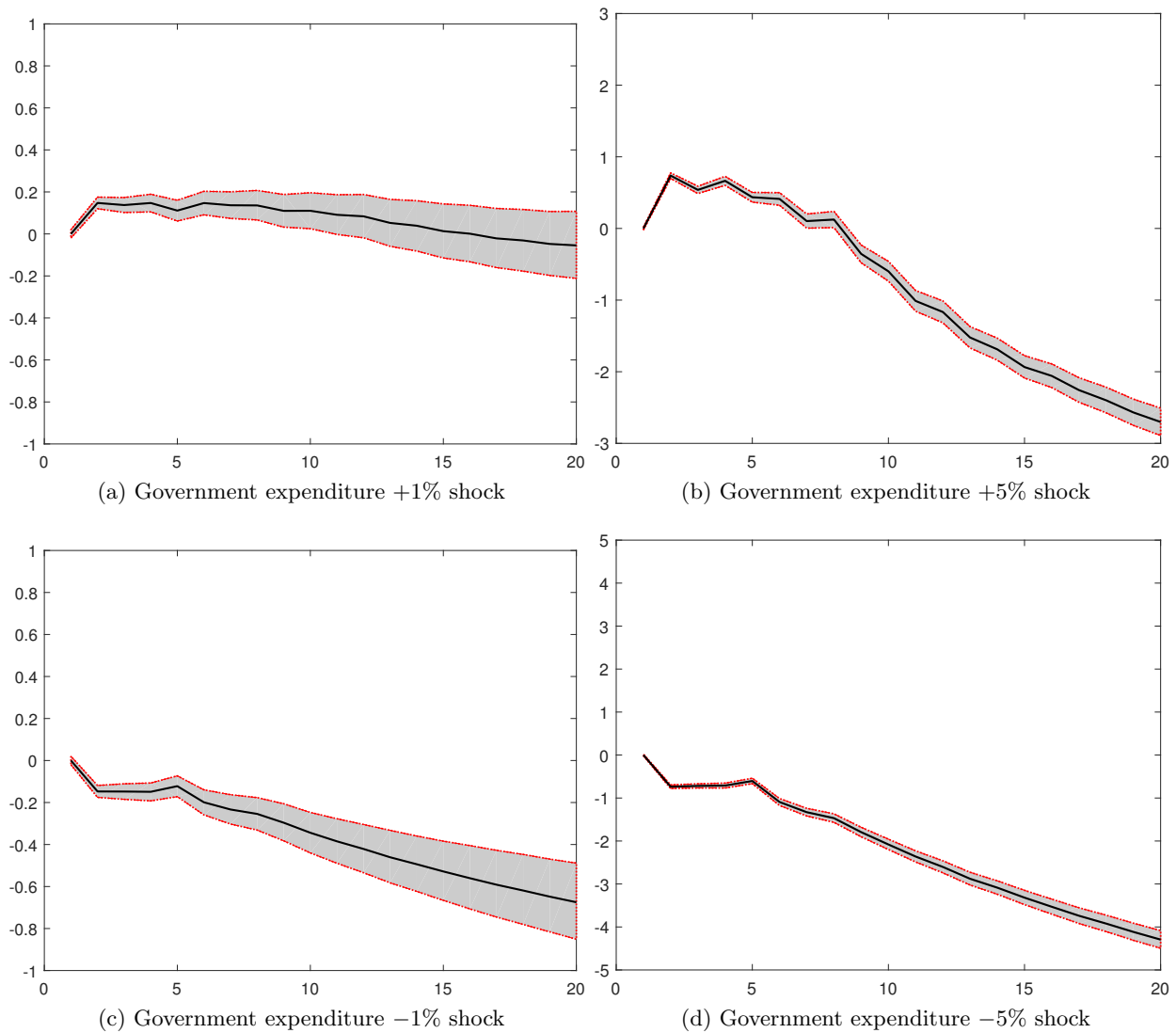


Figure 12: *Specification 1: private credit* Cumulative generalized impulse responses. Percentage private credit response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

#### A.4 Not controlling for public debt - Shorter sample: generalized impulse response

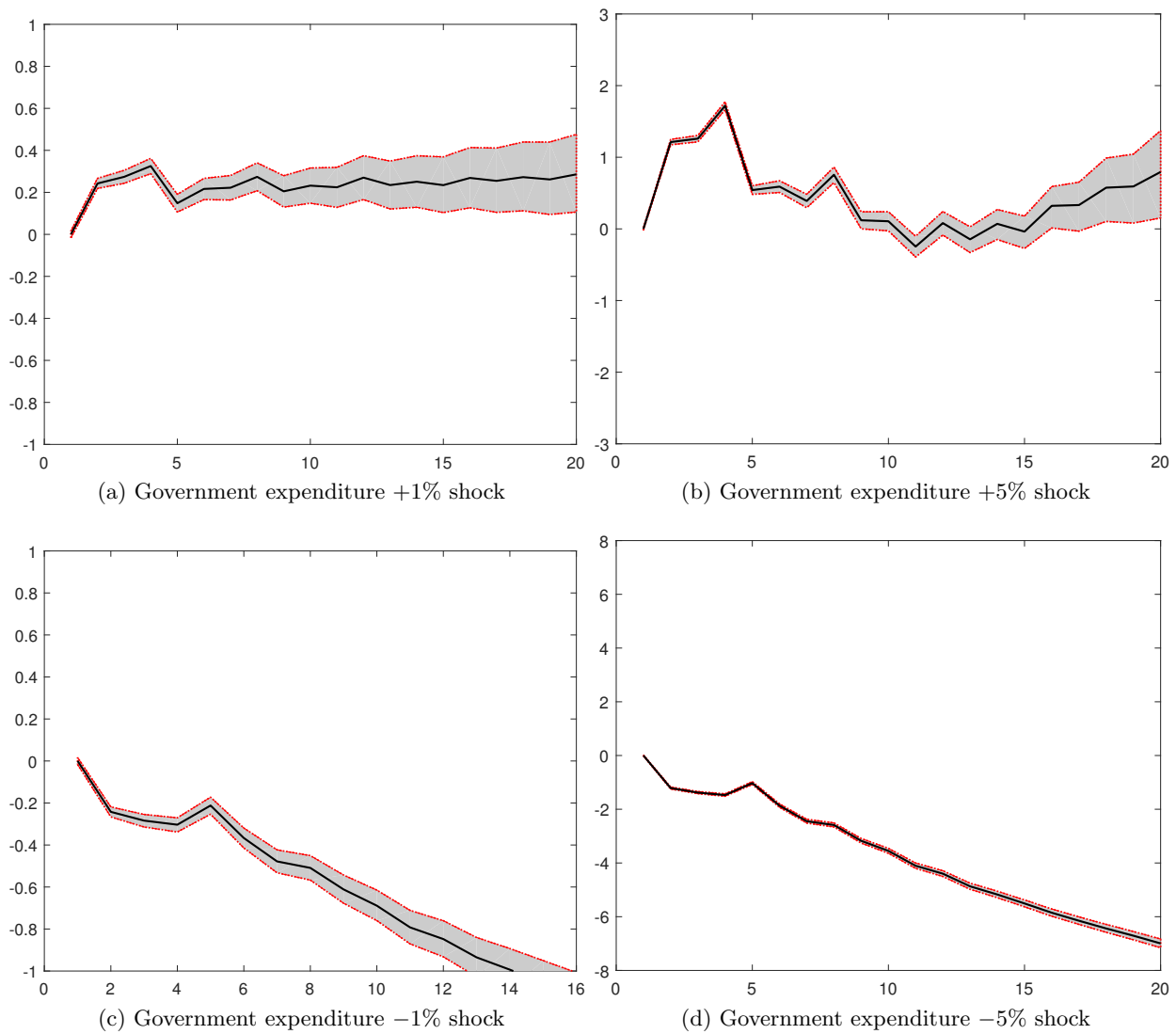


Figure 13: *Specification 1 - Shorter sample: GDP* Cumulative generalized impulse responses. Percentage GDP response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

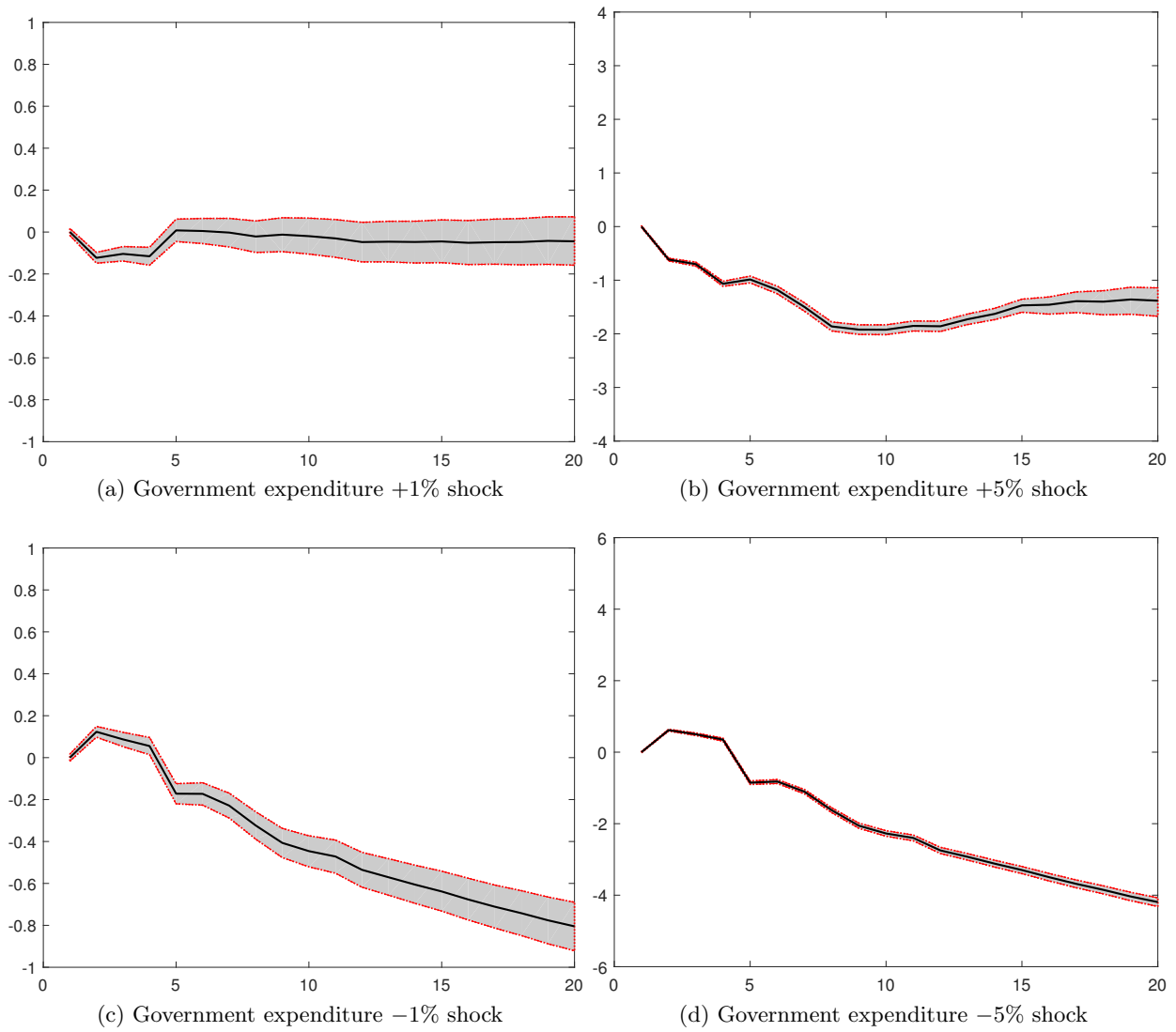


Figure 14: *Specification 1 - Shorter sample: private credit* Cumulative generalized impulse responses. Percentage private credit response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

## A.5 Not controlling for public debt: Scenario Analysis

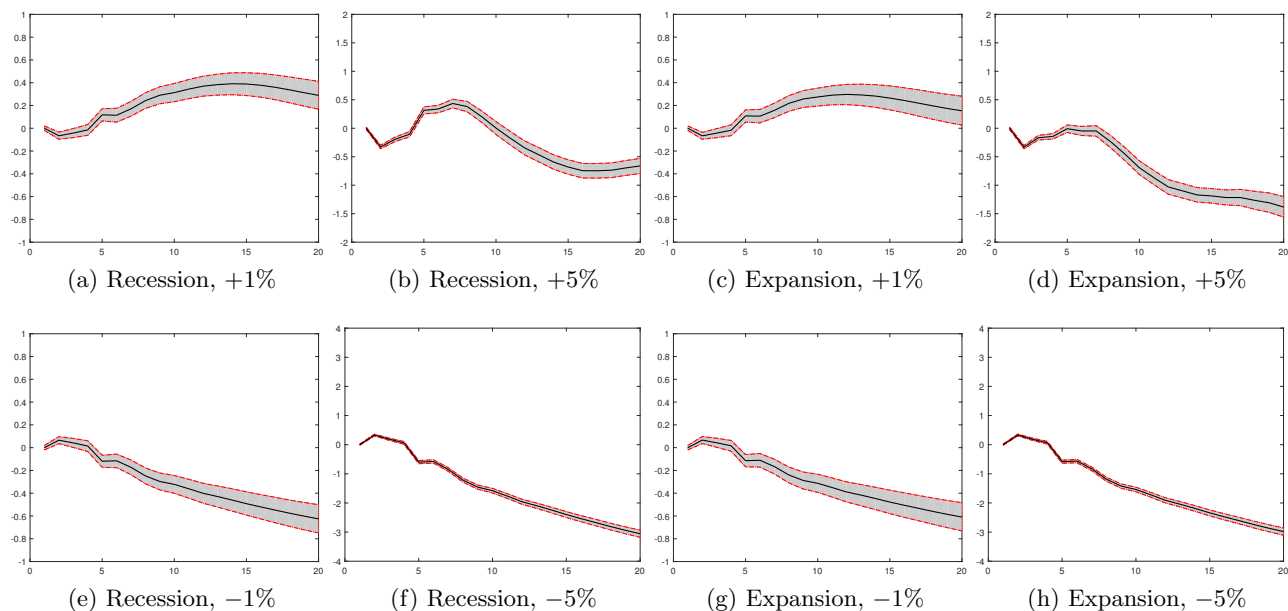


Figure 15: *Scenario analysis* Cumulative generalized impulse responses to a shock triggered in a median expansion/recession quarter, with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.

## A.6 Controlling for public debt: Orthogonal Impulse Response

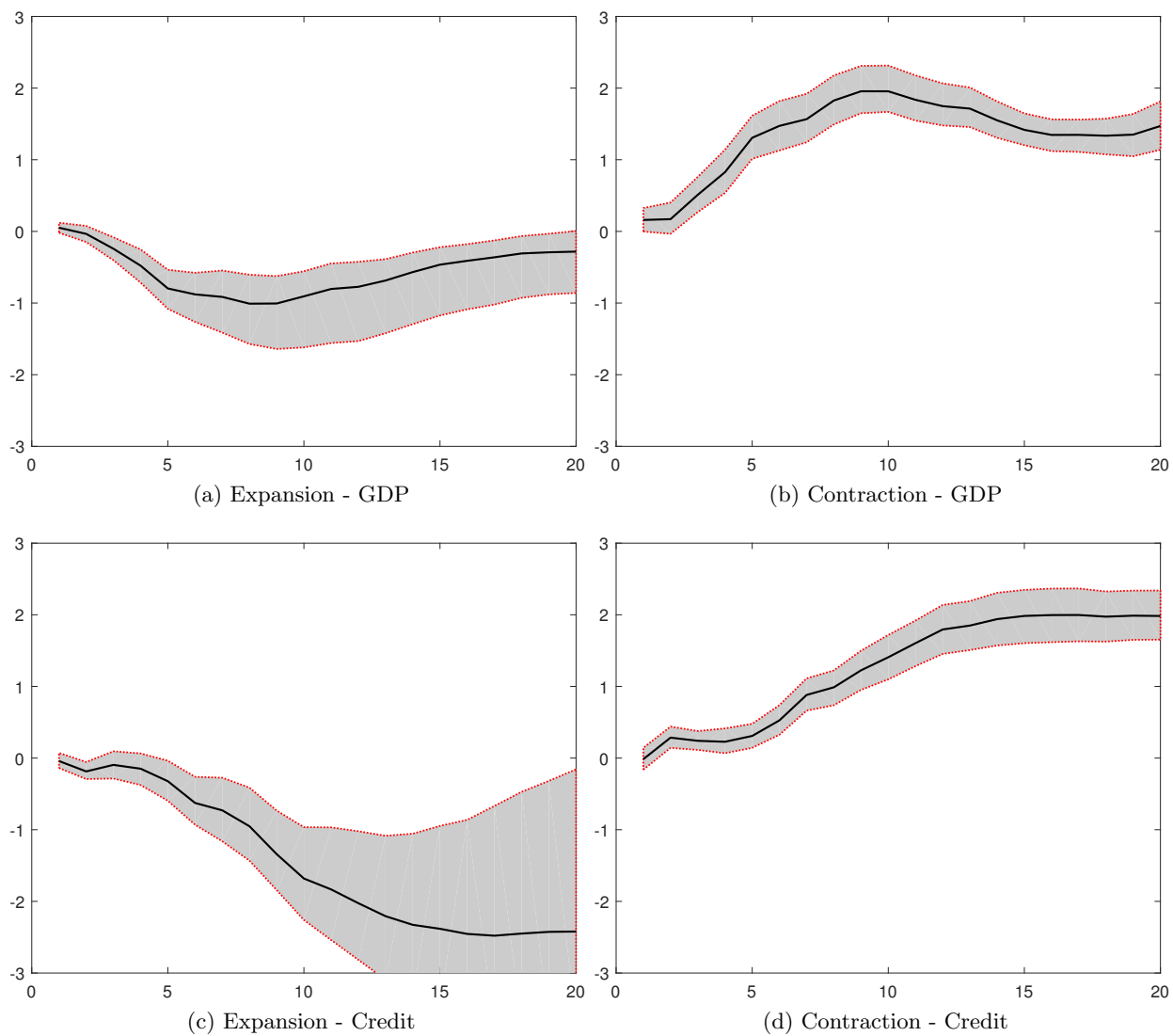


Figure 16: *Specification 2* Cumulative orthogonalized impulse responses to a unit standard deviation with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

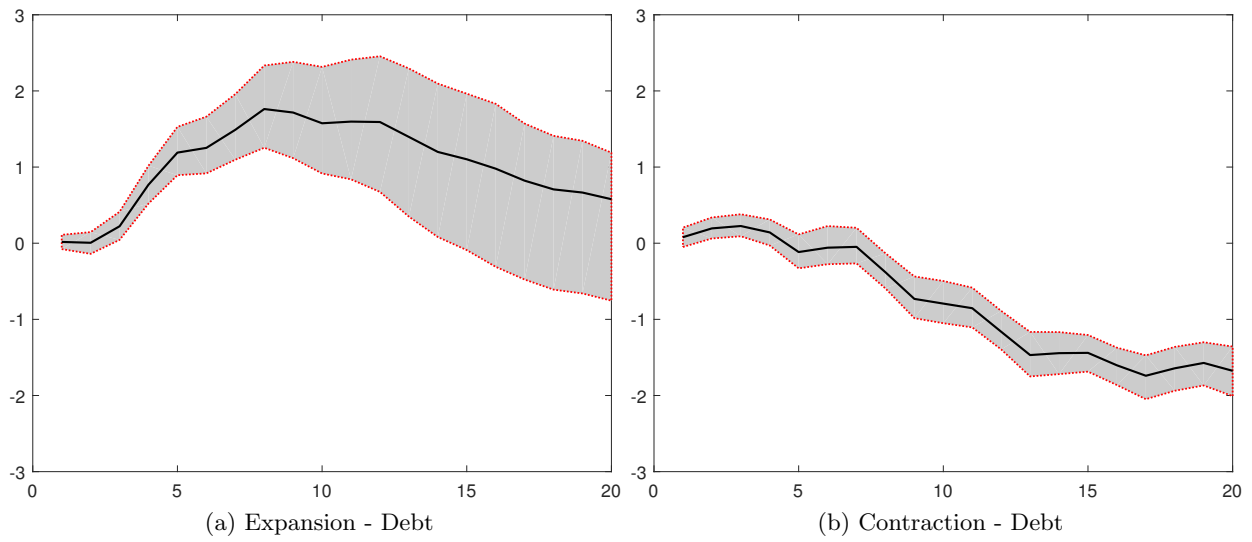


Figure 17: *Specification 2* Cumulative orthogonalized impulse responses to a unit standard deviation with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.



## A.7 Controlling for public debt: generalized impulse response

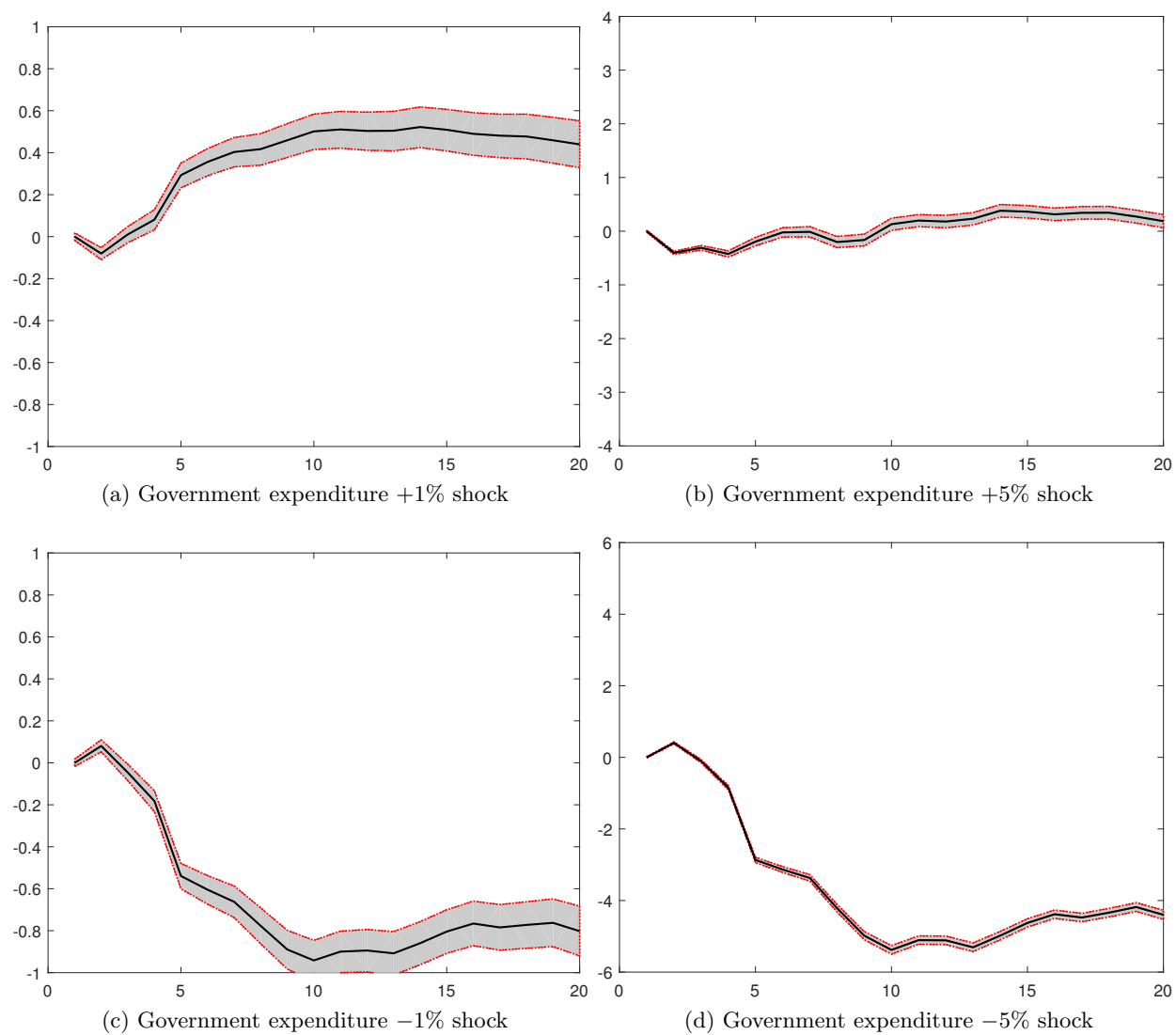


Figure 18: *Specification 2* Cumulative generalized impulse responses. Percentage GDP response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

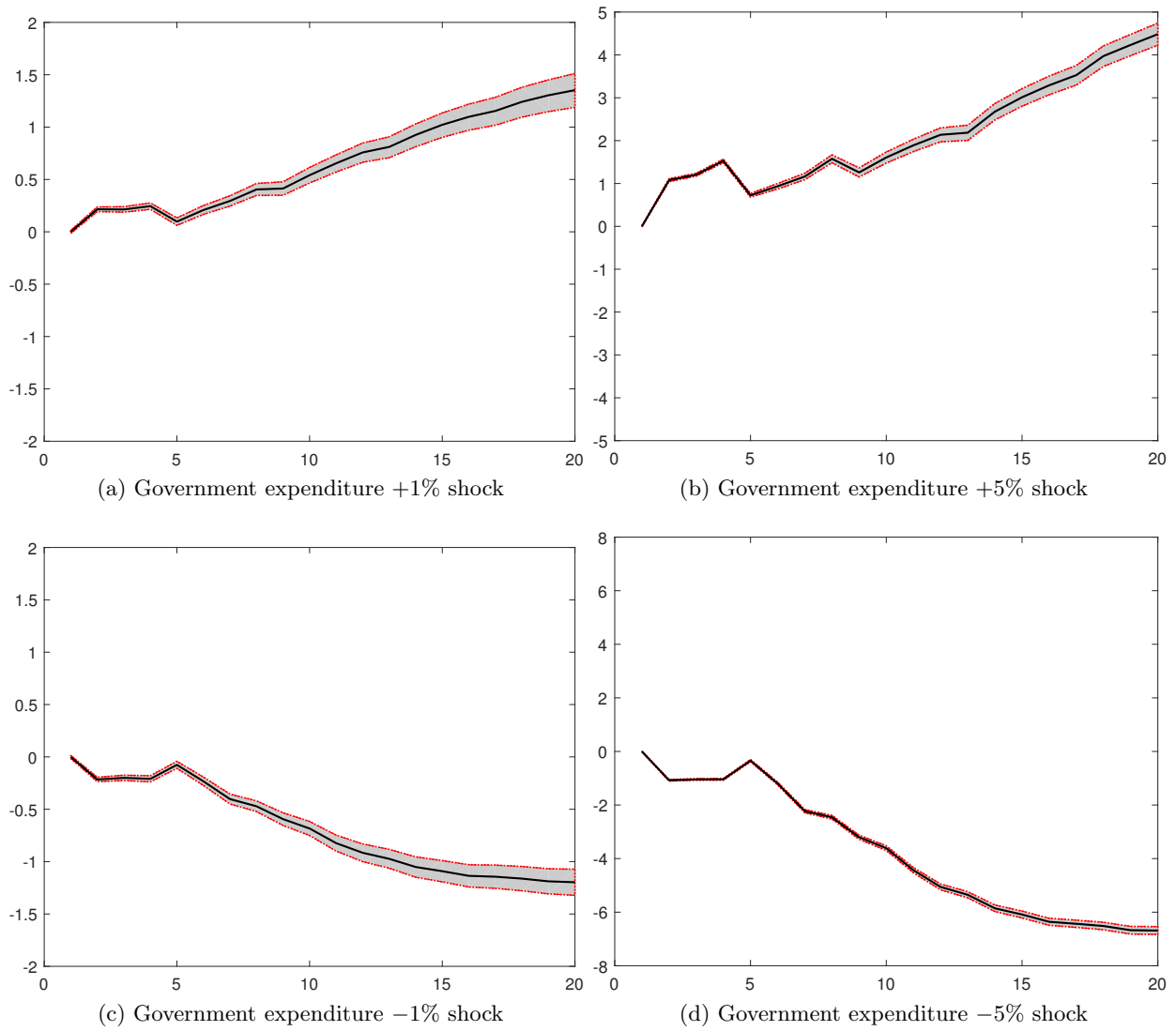


Figure 19: *Specification 2: credit* Cumulative generalized impulse responses. Percentage private credit response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

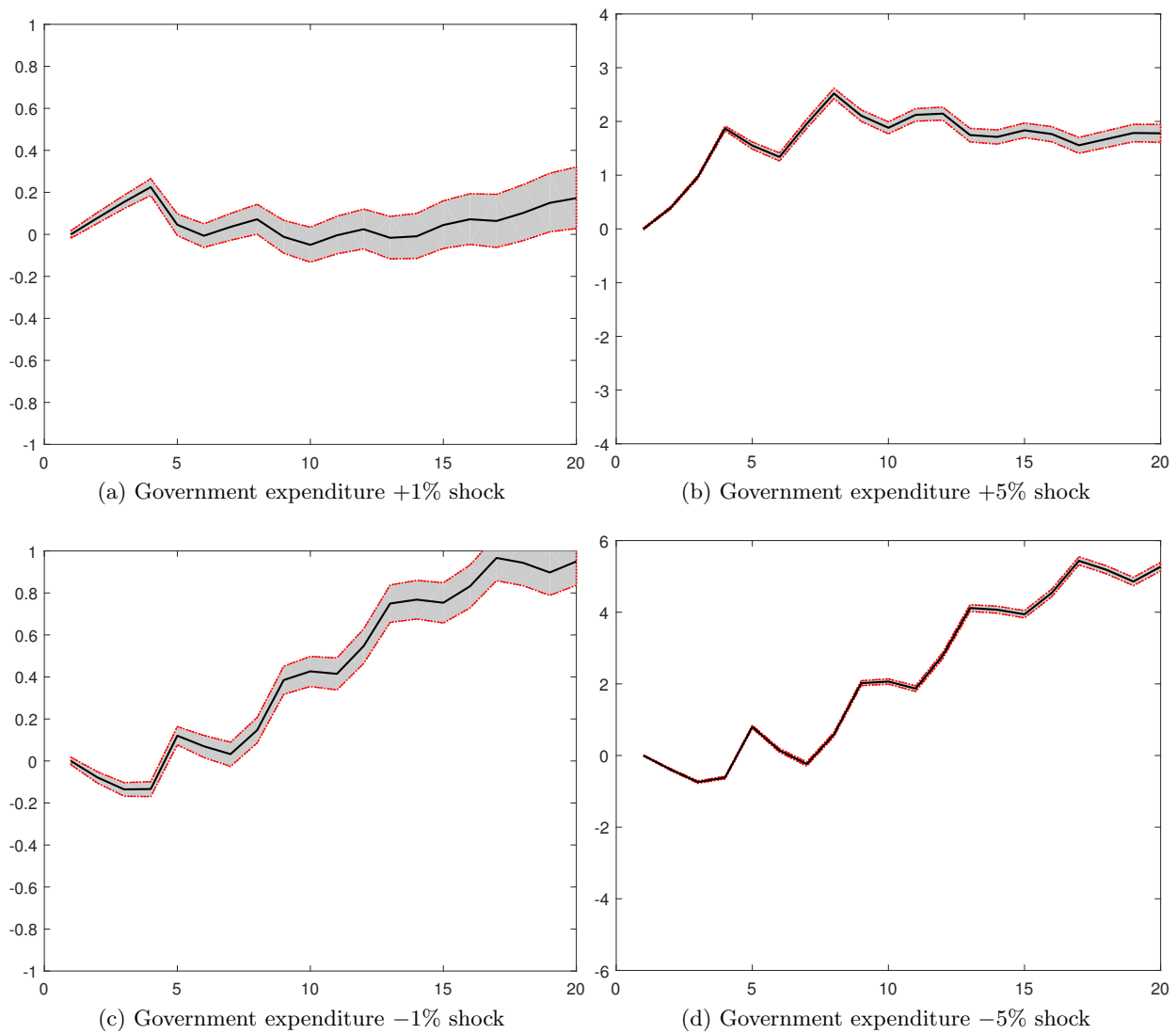


Figure 20: *Specification 2: debt* Cumulative generalized impulse responses. Percentage public debt response to a percentage of public government expenditure shock with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, public debt, GDP and private credit.

## A.8 Controlling for public debt: Scenario Analysis

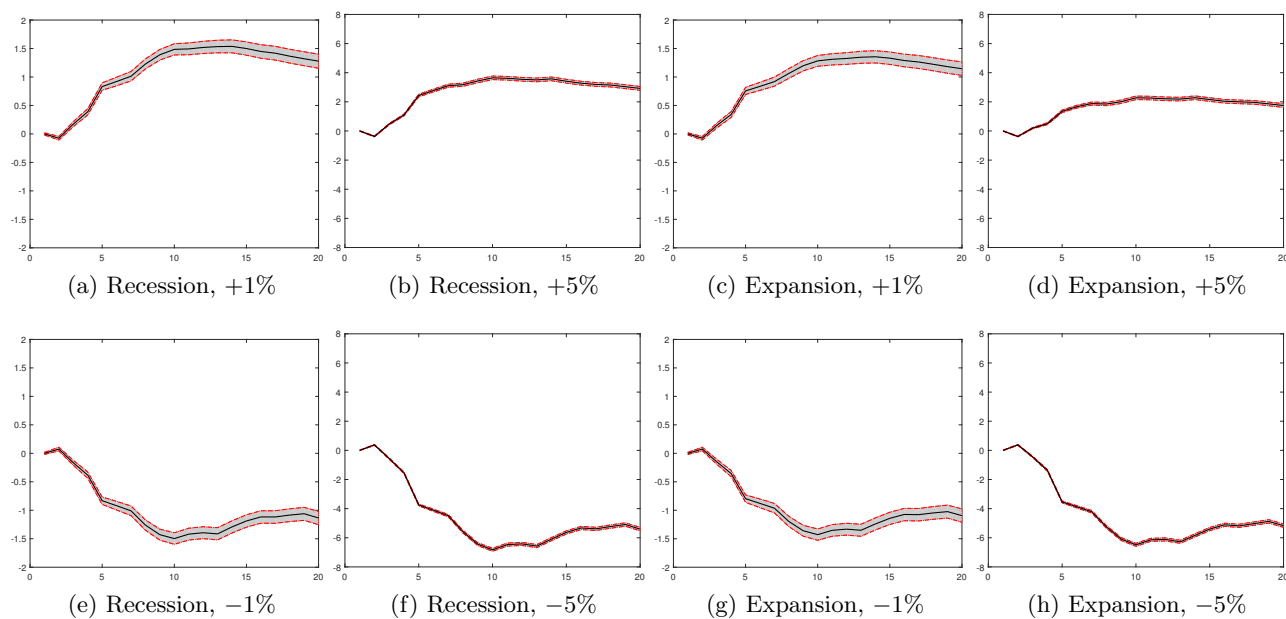


Figure 21: *Scenario analysis* Cumulative generalized impulse responses to a shock triggered in a median expansion/recession quarter, with confidence bands at 5th and 95th percentile. STVAR includes public expenditure, tax revenues, GDP and private credit.