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Estimating the Impact of the Financial Cycle on Fiscal Policy

We investigate the impact of the financial cycle on the effectiveness of fiscal policy. We estimate fiscal multipliers for different type of government spending that depend on different states of the financial cycle. We find that government investment becomes substantially more effective during a downturn in the financial cycle, whereas during an upturn we obtain negative multipliers. When we also condition on the state of the business cycle our results for government investment remain essentially unchanged.

We obtain smaller multipliers for government consumption that do not depend on the state of the financial cycle. However, during a downturn of the financial cycle and a business cycle bust, government consumption can be very effective in stimulating output.

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Abstract

We investigate the impact of the financial cycle on fiscal policy. Our contribution to the existing literature is three fold. First, we estimate fiscal multipliers that depend on different states of the financial cycle. Second, to obtain our estimates we extend the TVAR method from a single country to a panel. Third, we investigate the fiscal multipliers of different types of government spending. We find that the multipliers for government investment are influenced substantially by the state of the financial cycle. In an upturn they are negative, while in a downturn they are positive. When we also condition on the state of the business cycle our results for government investment remain essentially unchanged. We obtain smaller multipliers for government consumption. Although these multipliers do not depend on the financial cycle, jointly conditioning on the financial and business cycles does produce multipliers which vary over the states of both cycles.

Key words: Government Spending Multipliers, Asset Markets, Credit Markets, Financial cycles, Panel TVAR.

JEL classification: C33, E62, G15.

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1 Introduction

The near meltdown of the financial system that proceeded the Great Recession has stimulated research into the effects of financial markets on macroeconomic conditions and fiscal policy. Recent work has found evidence that financial cycles play a significant role in the evolution of macroeconomic variables (Claessens *et al.* (2012), Borio (2014) and Cerutti *et al.* (2017)). Several central bankers have also discussed the effects of the financial cycle on macroeconomic policy (Gieve (2008), Danthine (2012), and Praet (2016)). In addition, there is an existing body of research investigating the effects of the business cycle on the size of the fiscal multiplier, e.g., Auerbach & Gorodnichenko (2012). However, the intersection of these two research areas exploring the impact of the financial cycle on the size of the fiscal multiplier remains as yet unexplored and is the topic of this paper.

This paper contributes to the existing literature on fiscal multipliers in three ways. Firstly, we provide estimates of fiscal multipliers that are contingent on various states of the financial cycle. Recent related research investigates the impact of credit conditions or financial frictions on fiscal multipliers (Fernández-Villaverde (2010), Carrillo & Poilly (2013), Dosi *et al.* (2013), Ferraresi *et al.* (2015) and Borsi (2018)) or the channels through which financial cycles can affect budgetary components (Benetrix & Lane (2011), Budina *et al.* (2015) and Gechert & Mentges (2018)). Secondly, we base our estimates for the fiscal multipliers on a panel TVAR, as opposed to the one-country TVAR analysis currently mostly conducted in the literature (see, e.g., Balke (2000), Baum *et al.* (2012), and Ferraresi *et al.* (2015)). This supplies us with more observations allowing us, for example, to disentangle interactions between cycles stemming from the financial sector and those from the real economy. Finally, we contribute to the modest body of literature on fiscal multipliers for different types of government spending (e.g. Gonzalez-Garcia *et al.* (2013) and Alichi *et al.* (2019)) and provide a new set of empirical estimates.

For government investment we find a significantly larger multiplier during a downturn in the financial cycle, while during an upturn the multiplier even becomes negative, falling to -0.5. This suggests that government spending crowd-outs private activity during a financial upturn, and lends support to the findings of Leeper *et al.* (2010) and Abiad *et al.* (2016). They show that government investment can be more effective in stimulating output than other forms of government spending resulting from the crowding-in of private investment, especially in a financial downturn when investment in productive capital is hampered. Our estimates of the fiscal multipliers based on government consumption, however, do not significantly change over the state of the financial cycle, for the downturn and upturn regimes the multipliers peak around 0.5 and 0.3, respectively, and go to zero after roughly seven quarters.

To ensure that our findings are not the result of omitted variable bias driven by the correlation between the financial and business cycles, we also obtain estimates of the fiscal multiplier conditional on both the financial and business cycle.This results in multipliers for four possible states: both cycles being in a downturn, both in an upturn, and the two mixed cases of one cycle being in an upturn while the other is in a downturn. Our finding that the state of the financial cycle influences the fiscal multiplier for government investment remains robust in the presence of this additional control for the state of the business cycle. However, during a business cycle recession the fiscal multiplier seems to be somewhat larger in both a financial cycle downturn and upturn.

In case of government consumption conditioning on the state of both the financial and business cycle permits us to detect a substantial difference in the multiplier. Specifically, given that the financial cycle is in a downturn, in a business cycle expansion the multiplier becomes negative, while in a recession it increases after impact and remains positive. The dependence on the state of the business cycle during an upturn in the financial cycle is on the other hand weaker. Finally we note that our main results also stand up to a battery of other robustness checks.

The remainder of the paper is structured as follows. Section 2 provides a review of the literature, and Section 3 presents the empirical methodology. In Section 4 we describe the data we use in our analysis, in Section 5 we discuss our baseline results, followed by the presentation of our robustness checks in Section 6. Finally, in Section 7 we end with some concluding remarks.

2 Literature review

The empirical estimates of fiscal multipliers depend heavily on the econometric approach. Most estimates are based on a narrative approach (Ramey & Shapiro (1998), Romer & Romer (2010), and Ramey (2011b)), DSGE-models (e.g., Cogan *et al.* (2010), Christiano *et al.* (2011), and Leeper *et al.* (2017)) or structural (S)VAR models. Most of the (S)VAR literature uses a recursive model specification such as a Cholesky decomposition to estimate fiscal multipliers (for example, Ilzetzki *et al.* (2013)), or more complicated identification strategies (e.g., Blanchard & Perotti (2002)). Recent literature employs a threshold model, such as a threshold VAR, or TVAR, to define different regimes (for instance, Auerbach & Gorodnichenko (2012), and Ferraresi *et al.* (2015)). Our work also follows this latter approach, but we then generalize the TVAR to a panel TVAR. There are only a few empirical papers that look into the effectiveness of different categories of government spending as we do here. Valuable overviews on fiscal multipliers are provided by Hebous (2011), Ramey (2011a), Batini *et al.* (2014), and Gechert & Rannenberg (2018).

Our research follows a growing literature on the linkages between financial markets and fiscal policy. For instance, Afonso *et al.* (2018) use debt-to-GDP ratios to show that expansionary fiscal policy has a larger impact on output during a high-stress regime, potentially as a result of counter-cyclical fiscal policy offsetting reduced credit flows. Ferraresi *et al.* (2015) corroborate this finding for the US with significantly larger output responses during a tight credit regime. They report a peak multiplier of over 4 during periods of tight credit, and of only 1 for the normal credit regime.[1] Borsi (2018) finds large multipliers during credit crunches, with a peak estimate of nearly 4, as opposed to 0 during credit expansions for a panel of 24 OECD economies over the period 1985-2012. Using an New-Keynesian DSGE model Fernández-Villaverde (2010) find stronger output responses from government expenditure in an environment of financial frictions, coming from a real wealth effect and lower finance premiums which minimizes the crowding-out of private investment. Related work has focused on the linkages between financial vulnerabilities, monetary policy, and fiscal policy, see for example Balke (2000) and Aikman *et al.* (2016).

Our examination of the effect of the financial cycle on fiscal multipliers is closely related to a number of existing studies of whether fiscal multipliers are regime-dependent, in particular to those studies exploring the differential effects of booms and busts in the business cycle on fiscal multipliers. For instance, Auerbach & Gorodnichenko (2012) find multipliers in the US exceeding unity during recessions and multipliers of less than 0.5 during expansions. This finding is corroborated by Baum *et al.* (2012) on a country-by-country basis for G7 countries, by Coenen *et al.* (2012) for automatic stabilizers in the Euro Area, and for fiscal consolidations by Callegari *et al.* (2012). Ramey & Zubairy (2018) on the other hand find that multipliers do not substantially change across the state of the economy, except for the zero lower bound state for which multipliers peak around 1.5. Other work on regime-dependent fiscal multipliers, such as for the relative openness of economies or the level of indebtedness, can be found in Beetsma *et al.* (2008), Corsetti *et al.* (2012) and Ilzetzki *et al.* (2013). A meta-analysis on regime-dependent fiscal multipliers is provided by Gechert & Rannenberg (2018).

Only a few papers have empirically investigated the relationship between fiscal policy and financial cycles. Gechert & Mentges (2018) argue that fiscal multiplier estimates may be biased by not controlling for the effects of financial cycles in the existing analyses. In a similar vein, Budina *et al.* (2015) show that ignoring the impact of financial cycles encourages pro-cyclical fiscal policies. To our knowledge, we are the first to explicitly investigate whether the impact of government spending depends on the state of the financial cycle, opposed to only credit conditions, while at the same time controlling for the endogenous relationship between financial cycles, fiscal policy and output dynamics. We note that Claessens *et al.* (2012) and Antonakakis *et al.* (2015) argue that business cycles and financial cycles are correlated, and for this reason we also investigate how our fiscal multiplier estimations change over the financial cycle when we

[1] The term "tight" for the credit regime suggests that the mechanism is supply driven, whereas it is also possible that the low level of credit is at least partially due to low demand.

also control for the booms and bust of the business cycle. To achieve this we extend the panel TVAR that we use to be dependent on four possible states defined by the financial and business cycles. We introduce our panel TVAR in the following section.

3 The TVAR model specification

To investigate the size of government multipliers in different phases of the financial cycle, we use a TVAR model. This method is a regime switching VAR model, where the threshold can be endogenously or exogenously estimated. The method can capture non-linearities in the data and is for example used by Balke (2000) and Ferraresi *et al.* (2015), who both investigate the effect of different levels of available credit on the economy of individual countries. In our research we extend the TVAR to model a panel of countries. We are, to our knowledge, the first to propose this panel approach.[2]

The advantage of using a panel TVAR is that we have more observations at our disposal. This allows us to do multiple sample splits. For example we have sufficient observations to feasibly split our sample into four sub-samples defined by the bust and boom regimes of the business cycle together with the expansionary and contractionary regimes defined by the financial cycle. In this case we are able to check that the estimated dependence of the fiscal multiplier on the financial cycle is not the product of omitted variable bias caused by the omission of the business cycle from the analysis. Other papers, such as Ferraresi *et al.* (2015), do not control for the business cycle in this way.

Our baseline two regime panel TVAR model has the following form:

$$\begin{aligned} Y_{it} = &\left(A^1 Y_{it} + \sum_{l=1}^{L} B^{1,l} Y_{i,t-l} + \varepsilon_{it}^1 \right) I\left[f_{i,t-\delta} \leq \gamma\right] + \\ &\left(A^2 Y_{it} + \sum_{l=1}^{L} B^{2,l} Y_{i,t-l} + \varepsilon_{it}^2 \right) I\left[f_{i,t-\delta} > \gamma\right], \end{aligned} \tag{1}$$

where $i = 1...N$ varies over countries and $t = 1...T$ varies over time. The model is estimated for two different regimes using an indicator function. For example, $I\left[f_{i,t-\delta} \leq \gamma\right]$ switches to one if the financial cycle, f_{it}, is smaller or equal to the threshold value γ at time $t-\delta$. Theoretically it is not realistic to assume that the state of the financial cycle of one or more quarters ago influences the fiscal multiplier today. For this reason we set $\delta = 0$.[3] The threshold value γ can either be set exogenously or estimated endogenously via, for example, maximum likelihood

[2] Our code is based on that of Gabriel Bruneau, freely available from his homepage.

[3] We have also experimented with other values for δ ranging between 1 and 4, however this does not influence our main results.

(see Hansen (1996, 1997) and Tsay (1998)). In our baseline model we set $\gamma = 0$, implying that the financial cycle does not lead to deviations from the long-term trend in the economy. Endogenously estimating γ results in an estimate close to zero and does not influence our results, as we show in Section 5.

The vector with endogenous variables is ordered as follows $Y_{it} = [ge_{it}, y_{it}, \pi_{it}, i_{it}]'$. We use ge_{it} to denote the log of real government expenditure. For the definition of ge_{it} we follow Ilzetzki *et al.* (2013) and work with two variants: the expenditure is either given by government consumption: $ge_{it} = gc_{it}$, or it is given by government investment and consumption separately: $ge_{it} = [gi_{it}, gc_{it}]'$. The variable y_{it} denotes the log of real GDP. We then denote inflation by π_{it}, and the real interest rate by i_{it}. We include these last two variables to capture the monetary policy channel. All endogenous variables are demeaned on a country level and ge_{it} and y_{it} are de-trended to ensure that all variables are stationary (see Section 4 for details). We impose $L = 4$ lags for all four endogenous variables. The Schwarz-Bayesian and Hannan-Quinn information criteria suggest that 5, and in some cases 6, is the optimal number of lags and our results are robust for this specification as well.

We identify the covariance matrix of ε^1_{it} and ε^2_{it} using a Cholesky decomposition. The choice and order of variables is comparable to Ilzetzki *et al.* (2013), Ferraresi *et al.* (2015) and Afonso *et al.* (2018). The latter paper also includes an endogenous variable capturing the condition of the financial market as the last variable. As an additional robustness check we therefore also include the financial cycle variable as an additional last endogenous variable in Section 6.4. Blanchard & Perotti (2002) argue that government expenditure requires at least one quarter to react to shocks in other macro variables. We adopt this approach and order government expenditure as the first endogenous variable.

To construct cumulative fiscal multipliers, we follow Ilzetzki *et al.* (2013). First, we construct the cumulative impulse response functions (IRF) due to a government expenditure shock, ge_{it}, of 1% of real GDP, y_{it}, where we use the median of 1000 bootstrapped cumulative IRFs. Next, we discount the cumulative IRFs by the median of the short term interest rate in the sample. Finally, we divide the cumulative IRF of y_{it} by the cumulated ge_{it} over the horizon and scale it with the mean of real government expenditure over the mean of real GDP. We do this for each regime separately. All figures include 68% bootstrapped confidence bands.

We have chosen to base our analysis on quarterly instead of yearly data. Beetsma *et al.* (2008) argue in favor of using yearly data, because government budgets are set on a yearly and not on a quarterly basis letting the identifying shocks in the annual data be closer to the true shocks. Furthermore, it is more likely that shocks in government expenditure are foreseen on a quarterly basis. Finally, quarterly data may also introduce more measurement error, for example, due to interpolation given that not all data is available on a quarterly basis, especially in the earlier years. Hence, the use of quarterly data may introduce an endogeneity problem. However, there are two advantages of using quarterly data that let us decide to use quarterly data. First, it results in a less strict identification assumption: realistically government expenditure will not contemporaneously react to shocks in output on a quarterly basis. Second, it results in more observations. This is important because it allows us to do more than one sample split, for example disentangle interactions between cycles stemming from the financial sector and those from the real economy. In Section 6.1 we show that our main results do not change when we use yearly data. We discuss the data in the following section.

4 The data

Our main sample comprises 18 advanced economies[4] over the period 1956q1-2017q4. These countries are selected to ensure that the assumption of homogeneity across the countries in our panel is realistic. This unbalanced panel yields a total of 3707 observations. To identify the main features of financial cycles we work with quarterly data and include as many observations as possible to obtain the maximum number of full financial cycles of each country.

4.1 Construction of the financial cycle

We primarily use financial cycle estimates based on a state space model produced by CPB Netherlands Bureau for Economic Policy Analysis, see Luginbuhl *et al.* (2019). We also use estimates of the BIS as a robustness check. The amplitudes of both financial cycle measures of each country are normalized by dividing by the country-specific absolute maximum amplitude. This ensures that the endogenous threshold value γ is not driven by large outliers. This does not influence our main results. Given the central role the CPB financial cycle estimates play in this research, we briefly discuss them here.

Our financial cycles, f_{it} are estimated from a bi-variate state space model for each country i. The bi-variate model for each country is for total outstanding credit to the private non-financial sector and the housing price index. Both of these series are published by the Bank of International Settlements, or BIS, on a quarterly basis. For earlier values, when no quarterly values are available, the authors rely on the yearly credit data published in Jordà *et al.* (2017) and the yearly house price indices published in Knoll *et al.* (2017).[5]

Each of the two series in these country models has an unobserved trigonometric cycle components to model the financial cycle, and another one to model the business cycle. The former

[4] Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, South-Korea, Spain, Sweden, Switzerland, United Kingdom, United States

[5] The estimation method is able to accommodate the missing values that the use of this yearly data necessarily entails, see Luginbuhl *et al.* (2019) for details.

typically has a period of 15 to 20 years and the latter between 5 and 10 years. In this way it is possible to control for the effects of the business cycle when estimating the financial cycle in each series. To identify *the* financial cycle for country i the authors make use of rank reduction on the covariance matrix of the financial cycle components' disturbance vector. Further details of their model can be found in Appendix A.

The BIS also produces a financial cycle index for each country in our panel, see Drehmann *et al.* (2012) for details.[6] This index is similar to the financial cycle estimates of Luginbuhl *et al.* (2019), the average correlation coefficient between the BIS indices and their financial cycle estimates is 0.73; see Table C.1 in Appendix C.2 for correlation coefficients on a country level. The disadvantage of the BIS indices, however, is that they are only available starting in 1970. The use of the BIS financial cycle index in our analysis therefore involves a significant loss of data.[7] This in turn reduces our ability to obtain reliable estimates of the fiscal multipliers from our model. Nonetheless we also obtain estimates of the fiscal multipliers using the BIS financial cycle indices as a robustness check.

4.2 Other data

To fully benefit from the relatively long time-series we estimate for the financial cycle, we need to obtain the longest sample period possible for the endogenous variables. To this end, we combine data from different sources on government investment, government consumption and GDP. See Appendix B Tables B.1 and B.2 for a full description of the combined series. In the case of government investment, we derive our final series by splicing the series from Oxford Economics to the earlier available, discontinued, series for real government investment from the OECD Economic Outlook (EO76/78). Government consumption, real and nominal GDP, are downloaded from the OECD Quarterly National Accounts. We then splice quarterly series to the earlier available quarterly series of annual stocks. Data on the CPI is downloaded from Main Economic Indicators of the OECD. We obtain the inflation rate from the CPI by taking logarithmic differences between t and $t-4$. Policy rates are compiled from national sources, we create our real interest rate variable (i_{it}) by deducting inflation from the policy rate.

A more detailed description of data sources and starting dates per country is available in the appendix. All data are seasonally adjusted.[8] We deflate the nominal data using the CPI index, after which we transform the data by taking logarithms. Furthermore, we correct for country specific means in all series. All variables are non-stationary, with the exception of inflation and the real interest rate.

[6]The BIS provided us with their financial cycle estimates.

[7]We lose in total 366 observations.

[8]When necessary we seasonally adjust the data using the X-12 algorithm.

We detrend the non-stationary variables using an HP-filter with a λ of 1600[9]. After detrending, all data is stationary with unit roots rejected at the 99% level for all variables using an Augmented Dickey-Fuller test and the Phillips-Perron test. We do not detrend using linear trends because the data series show strong non-linear behavior. However, as is pointed out by Hamilton (2018), detrending the data with the HP-filter has several drawbacks. For this reason we also apply his proposed method for detrending as a robustness check. This involves regressing the variable to be detrended at date $t+h$ onto the four most recent values $t-p, \ldots, t$. The residuals from this regression are the detrended variable.[10] The drawback of the projection method of Hamilton (2018) is that its use implies a loss of observations. For this reason, we will use the HP-filter for detrending in the remainder of the paper. In any case, as we discuss in the following section, our results do not change substantially when we employ the projection method to detrend the data.

5 The baseline results

In this section we discuss our estimates of the cumulative fiscal multipliers for government investment (GI) and government consumption (GC). We present estimates for our baseline model, as well as for three primary alternative model specifications as robustness checks. In Table 1 we list the summary statistics for these multipliers. In the case of the alternative specification listed in the table as "BIS", these results are based on the financial cycle estimates of the BIS. The rows denoted by "End. Thres" refer to the results we obtain when we allow for an endogenous threshold. Lastly Table 1 includes results based on the projection method for detrending the non-stationary data as proposed by Hamilton (2018). These results are given in the rows denoted by "Proj.". We first discuss the results for GI, for which we arguably obtain the strongest results, followed by the results for GC. We end the discussion of our main results in Section 5.3, where we look for evidence that our results are driven by omitted variable bias potentially caused by the correlation between the financial and business cycles. In Section 6 we present the results of more detailed robustness checks.

5.1 Government investment

Our estimates show a striking difference between the cumulative fiscal multiplier for government investment (GI) in a downturn of the financial cycle compared to the multiplier in an upturn. In Figure 1 we can clearly see that the confidence bands of the cumulative multiplier of GI in the upturn and downturn do not overlap. In fact, this is also the case when we increase the

[9]Using other values for λ yields qualitatively similar results.

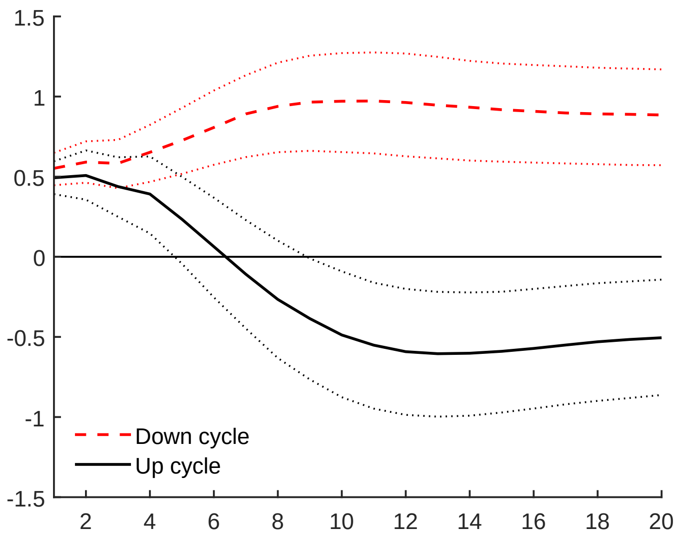
[10]We follow Hamilton (2018), who advises to use $p = 3$ and $h = 8$ for quarterly data.

Table 1: Summary of cumulative fiscal multipliers for different models based on (1)

Multiplier at	Impact		8Q		End (20Q)		Max	
Fin. Cycle	Down	Up	Down	Up	Down	Up	Down	Up
GI-Baseline	0.55**	0.49**	0.94**+	−0.27+	0.89**+	−0.51*+	0.97**	0.51**
BIS	0.33**	0.37**	0.51*	−0.06	0.50*+	−0.40*+	0.57*	0.45*
End. Thres.	0.63**+	0.35**+	0.76**+	−0.21+	0.67**+	−0.53*+	0.76**	0.37**
Proj.	0.79**+	0.41**+	0.77**+	−0.16+	0.77**+	−0.55*+	0.85**	0.41**
GC-Baseline	0.38**	0.27**	0.17	0.26*	−0.05	0.07	0.52**	0.34**
BIS	0.31**	0.21**	0.26	0.14	0.12	−0.15	0.37**	0.37**
End. Thres.	0.40**	0.24**	0.27*	0.17	0.06	−0.09	0.53**	0.33*
Proj.	0.43**	0.34**	0.53**	0.36*	0.04	0.13	0.56**	0.36*

Estimated cumulative fiscal multipliers in a downturn and an upturn of the financial cycle for two different types of government expenditure: government investment (GI) and consumption (GC). The displayed values are the multiplier estimates on impact, after 8 quarters, after 20 quarters and at the maximum. For each expenditure type four different model specifications are used: (*i*) the baseline model specification with an exogenous threshold at 0 (see Figures 1-2), (*ii*) a model in which the financial cycle of the BIS is used as the threshold variable (see Figure C.1), (*iii*) the baseline model with an endogenous threshold (see Figure C.2), where both models produced an estimated endogenous threshold of 0.15 with a standard error of 0.00, and (*iv*) a model where we detrend all non-stationary variables using the projection method by Hamilton (2018) (see Figure C.3). * and ** indicate significance at the 32% and 5% level, respectively, based on confidence bands constructed using 1,000 Monte Carlo replications. + indicates that the confidence bands of ±1 standard deviation do not overlap.

Figure 1: Cumulative fiscal multipliers for government investment



Cumulative multipliers are estimated using a TVAR panel model based on (1), where the financial cycle is the threshold variable. The cumulative multiplier is estimated in the downturn (red), $f_{it} \leq 0$, and in the upturn (black) of the financial cycle, $f_{it} > 0$. Confidence bands are one standard deviation wide and constructed using 1,000 Monte Carlo replications.

confidence bands to 95%. From summary statistics for the estimated multipliers in Table 1, we see that the multiplier in a downturn is significantly positive with a maximum value of 0.97, while in an upturn the multiplier is significantly negative reaching -0.51 after twenty quarters.

It is clear from Figure 1 that these results are robust to the three alternative model specifications. If we replace our financial cycle measure by that of the BIS, we find corresponding results. In Appendix C.1 we also show a plot of these cumulative multipliers in Figure C.1a. We note, however, that the difference in an upturn and a downturn is less pronounced. Our results are also robust when we allow for an endogenous threshold, see also Figure C.2a in Appendix C.1. In this case we find an endogenous threshold of 0.15, which is close but significantly different from the exogenous threshold value of zero with a standard error of 0.00.[11] However, only a limited amount of observations switches between regimes, explaining why the results remain robust.[12]

Finally, we can also see that our results are robust when instead of detrending all non-stationary variables by the HP-filter, we use the projection method as proposed by Hamilton (2018) (see Section 4.2 for further discussion). In Appendix C.1 we also show the relevant multipliers in Figure C.3a. These cumulative multipliers for GI are very comparable to our baseline results. Most importantly the multipliers still depend on the state of the financial cycle.

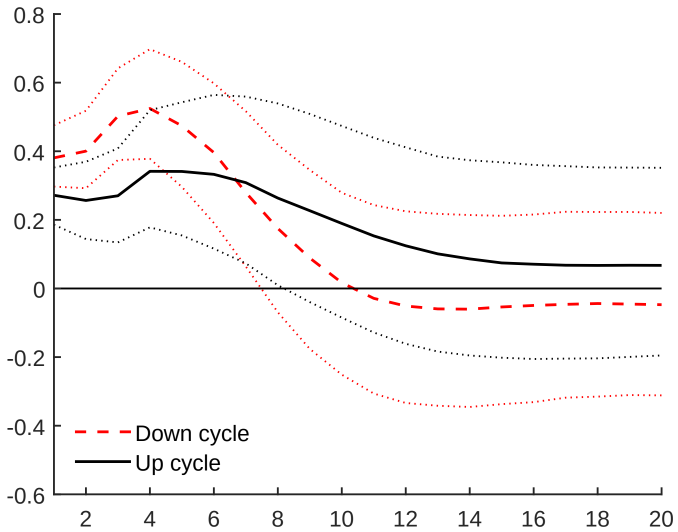
Our results concerning government investment are consistent with mechanisms suggested in the literature. Ferraresi *et al.* (2015) argue in their paper that additional government investment only drives up the cost of borrowing when credit is abundant, and that it competes with private agents for the limited number of investment opportunities. When the volume of credit is low, on the other hand, additional government investment can stimulate demand, with only limited crowding-out effects (Fernández-Villaverde (2010)). When financial frictions exist, it is even possible that an expansionary fiscal policy can lead to crowding-in of investment (e.g. Woodford (1990) and Holmström & Tirole (1998)), hence stimulating output. The intuition behind this is that there are both non-liquidity constraint and liquidity constraint private agents due to financial frictions. If the government borrows from the non-liquidity constraint agents to pay for their investment, it provides liquidity constraint agents indirectly with liquid assets in exchange for a claim on their illiquid future income. Those agents are now no longer liquidity constrained and can exploit existing investment opportunities.

[11] We use the Fisher information matrix to calculate the standard error. However, because the log-likelihood is highly non-linear it is not certain that this results in a reliable standard error.

[12] For the endogenous threshold 40% of the observations occur during an upturn of the financial cycle, while in the case of the exogenous threshold this percentage is 48%.

5.2 Government consumption

Figure 2: Cumulative fiscal multipliers for government consumption



See the note in Figure 1 for more information.

In Figure 2 we plot the cumulative multiplier of government consumption (GC) for both a downturn and an upturn of the financial cycle. The corresponding summary statistics can be found in Table 1. The cumulative multipliers in the upturn and downturn have a close resemblance, with confidence bands that overlap. This suggests that the state of the financial cycle alone does not influence the fiscal multiplier for GC. Both multipliers are substantially smaller than one. They also decline over time and after around eight quarters are no longer significantly different from zero. This would seem to indicate that fiscal stimulus over the course of the business cycle may be effective, although only weakly so given the small size of the estimates. This is in line with neoclassical theory (see Leeper *et al.* (2017) for a more detailed discussion). According to the theory, when the government decides to consume more, private agents expect taxes to increase in the near future to finance this increase in government consumption. Agents therefore reduce their current consumption and work more. This wealth effect then reduces the effectiveness of government consumption.

Our estimates based on GC do not change appreciably for any of our three main alternative specifications as can be seen in Table 1. The plots of the multipliers for these three specifications can be found in Appendix C.1 in Figures C.1b, C.2b and C.3b, respectively. We note further that the estimated endogenous threshold of 0.15 for GC is almost identical to the estimated endogenous threshold for GI. As noted above, this value is close to but significantly different from the exogenous value of zero in our baseline specification.

We note that our results in this and the previous section based on the projection method of Hamilton (2018) demonstrate that detrending by the projection method does not alter our main conclusions. Although the literature shows that the HP-filter suffers from several drawbacks, the projection method leads to a loss of 198 observations. This would hamper the estimation of, for example, the model in the next section where we split the data into four different regimes based upon the states of the business and financial cycles. Therefore, we use the HP-filter detrended data in all of our remaining analyses.

Although the estimates for GC might seem to suggest that the financial cycle has no influence on the fiscal multiplier, our results in the next section indicate that this may not actually be the case: once we introduce the additional conditioning on the boom and bust states of the business cycle, we do find evidence that the state of the financial and business cycle jointly do influence the fiscal multiplier of GC. This seems to especially be the case during downturns of the financial cycle.

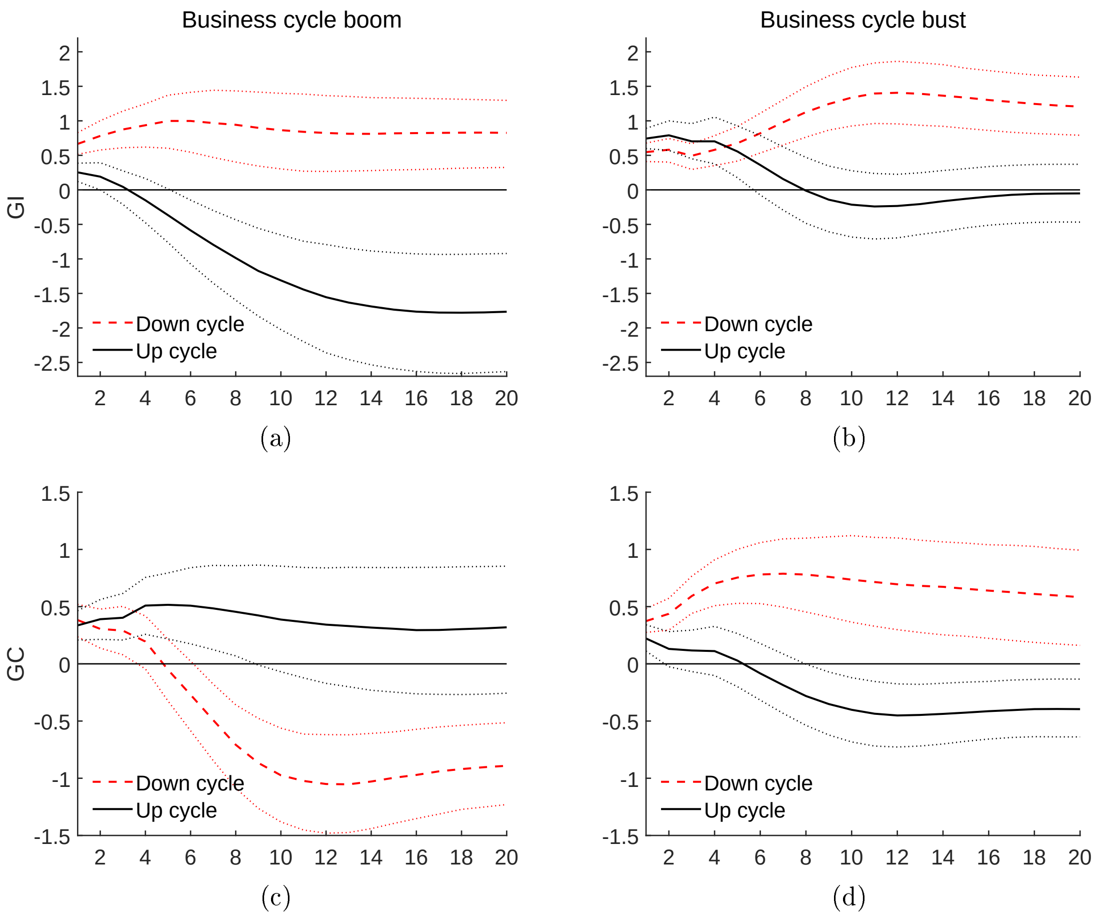
5.3 Accounting for the business cycle

One potential problem of our analysis is that our results might be (partly) driven by the business cycle. For example, Claessens *et al.* (2012) shows that the business and financial cycle are strongly linked. Ferraresi *et al.* (2015), on the other hand, show that the correlation between their credit availability variable and the business cycle is low. This latter result is more in line with our findings of a fairly low correlation between the estimated financial and business cycles in each country: the average correlation coefficient is only 0.13. See Table C.1 in Appendix C.2 for correlation coefficients on a country level. This makes it less likely that our results are driven by the business cycle.

Nonetheless, to ensure that our results are not driven by the business cycle, we split our sample in two. One sub-sample contains all observations for which the business cycle is larger than zero, a boom, and the second contains all observations for which the business cycle is smaller than zero, a bust. Our business cycle measure is based on the cycle from HP-filtered real GDP. For each sub-sample we perform our TVAR analysis with the financial cycle as threshold variable, effectively splitting the complete sample into four different regimes. These four regimes each have enough observations to result in reliable estimates because we have a panel.

Figure 3 shows the cumulative multipliers for GC and GI in the four different regimes. If our results were driven solely by the business cycle via the business cycle's correlation with the financial cycle, then we would see no additional effect of the state of the financial cycle on the fiscal multiplier once we control for the business cycle. As the figure makes clear, our results indicate a continued large influence of the financial cycle on the size of the fiscal multiplier even

Figure 3: Cumulative fiscal multipliers for government investment and consumption in different phases of the business and financial cycle



The full sample is split in two: (i) when the business cycle is in a boom, above zero, and (ii) when it is in a bust, below zero. We use HP-filtered GDP as a proxy for the business cycle. Within each sample split we estimate the cumulative multiplier using a TVAR analysis for two regimes: (i) in a downturn (red), $f_{it} \leq 0$, and (ii) in an upturn (black) of the financial cycle, $f_{it} > 0$. See the note in Figure 1 for more information.

after we control for the business cycle.

Figures 3a and 3b show the cumulative multipliers for GI in the four different regimes. The cumulative multipliers for GI in a boom and bust of the business cycle are relatively consistent with our main results: the multiplier in a downturn of the financial cycle is still significantly positive and in a financial upturn it is (in)significantly negative. In a business cycle boom the multipliers do appear to be smaller than in a bust, but the financial cycle is still largely responsible for the difference in the cumulative multipliers for GI.

Figures 3c and 3d show the cumulative multipliers for GC in the four different regimes. During downturns of the financial cycle, the business cycle has an additional effect on the multiplier: becoming significantly negative in a boom, while remaining significantly positive in a bust of the business cycle. This leads to the conclusion that GC is more effective in stimulating output during a bust and a downturn in the financial cycle, making it apparent that if we control for both cycles then we do obtain a significant difference in the cumulative multiplier for GC. During upturns of the financial cycle, the interpretation of the business cycle results is less clear. In particular, we would expect, in line with Auerbach & Gorodnichenko (2012), that the effect of government consumption would be significantly negative during a business cycle boom and a financial cycle upturn. Instead, we find that the financial cycle, during an upturn, has no additional effect and the multiplier quickly drops back to around zero.

We conclude that fiscal multipliers are higher during a bust of the business cycle. This is in line with both theoretical and empirical literature, which finds that government expenditure has considerably larger multipliers during an economic bust than during booms, see for example Auerbach & Gorodnichenko (2012) and Baum *et al.* (2012). GI is most effective when a financial cycle downturn coincides with a business cycle bust because the government does not have to compete for the scarce capacity, which is the case when a financial cycle downturn coincides with a business cycle boom. In general, however, we still find that the most significant impact on the size of the fiscal multiplier for GI is caused by the state of the financial cycle even after we control for the business cycle. For GC we find evidence that the state of the business cycle does significantly influence the size of the fiscal multiplier, particularly when the financial cycle is in a downturn.

6 Robustness checks

Our baseline results are in general very robust with respect to different model specifications. We show in this section that our identification assumptions do not drive the results, and that the results are robust for different sample splits and periods. Most underlying results in this section will not be presented, but are available on request.

6.1 Investigating the identification strategy

In this section we investigate our identifying assumptions and show that they are robust to a number of alternatives. First, we use yearly data instead of quarterly data and find similar results (see also Figure D.1). As explained in Section 3 the use of quarterly data might have a number of drawbacks: the fiscal budget is decided on an annual basis making the identifying shocks on a yearly level closer to the true shocks than on a quarterly level and a potential endogeneity problem caused by a shock in government expenditure possibly being foreseen on a quarterly basis, as well as due to possible measurement errors introduced by the interpolation of the data. On the other hand the identification assumption is less plausible with yearly data and we have fewer observations. To be able to compare the results based on yearly data with the quarterly ones we specify only one lag in the yearly model. This is consistent with the 4 lags we include when using quarterly data.[13]

The ordering of the endogenous variables is essential for our identification scheme because we use a Cholesky decomposition. Therefore, we investigate different variations on the order of our variables to investigate whether this influences the results. First, we place gdp_{it} at the end of all endogenous variables. Next, we interchange π_{it} and i_{it}. We then drop the monetary policy channel, i_{it}, from the model entirely, and also estimate a model with only gi_{it}, dropping gc_{it} from the model. Finally, we reverse the order of gi_{it} and gc_{it}. In all cases the results are robust.

Finally, we follow Beetsma *et al.* (2008) and replace GDP with "private GDP", that is, GDP minus government expenditure. This might be important because it is possible that government expenditure is affected by GDP within one quarter, which would violate the identifying assumption of no contemporaneous influence. The results are almost identical to our baseline results. It is also possible to place private GDP before government expenditure because there is no longer a direct link from the latter to the former (which is the case with government expenditure and GDP). Note that this results in the cumulative multipliers being equal to one on impact by construction. Again our results are similar to the main results, see Figure D.2. These results lead us to conclude that our identifying assumptions do not significantly influence our estimates.

6.2 Sample split

In this section we investigate whether our selection of countries might be responsible for our results. Here we re-estimate our model using several sample splits.[14] Corsetti *et al.* (2012) argue that countries' economies can differ considerably, and it is therefore possible that results for

[13] The results are also robust for the use of 2 lags, corresponding to 8 lags when using quarterly data. Since, the information criteria only support the use of 5 lags when using quarterly data, there is no point in adding more lags to the model.

[14] We also ensure that our results are not driven by one single country, by removing one country at the time. This does not affect the results.

specific groups of countries differ from those based on the full-sample. We perform three sample splits: (1) open versus closed economies, (2) highly versus modestly indebted countries and (3) all EMU countries. Important descriptive statistics of the estimated cumulative multipliers are displayed in Table 2.

Table 2: Summary of cumulative fiscal multipliers for different sample splits

Multiplier at	Impact		8Q		End (20Q)		Max	
Fin. Cycle	Down	Up	Down	Up	Down	Up	Down	Up
GI-Baseline	0.55**	0.49**	0.94**+	−0.27+	0.89**+	−0.51*+	0.97**	0.51**
Open	0.78**	0.90**	1.78**+	−0.21+	1.38**+	−0.77*+	1.80**	0.97**
Closed	0.44**	0.31**	0.54*	−0.22	0.58*+	−0.41+	0.60*	0.33*
High debt	0.90**	1.04**	1.42**	0.43	1.10**	0.34	1.42**	1.04**
Low debt	0.50**+	0.14+	0.79*+	−0.92*+	0.81*+	−1.39**+	0.86*+	0.14+
EMU	1.44**	1.19**	2.24**+	0.37+	2.12**+	−0.19+	2.41**+	1.25**+
GC-Baseline	0.38**	0.27**	0.17	0.26*	−0.05	0.07	0.52**	0.34**
Open	0.59**+	0.21*+	−0.10	0.18	−0.50*	0.12	0.59**	0.30
Closed	0.32**	0.32**	0.36*	0.32*	0.26	0.06	0.66**	0.42**
High debt	0.30**	0.13*	0.20	−0.10	0.00	−0.23	0.50**+	0.13*+
Low debt	0.45**	0.31**	0.12	0.30	−0.16	−0.05	0.59**	0.48*
EMU	0.21*	0.31**	0.01	0.31	−0.15	0.09	0.22*	0.53**

GI and GC multipliers for five different sample selections: (*i*) all open countries with respect to trade (Open), (*ii*) all closed countries with respect to trade (Closed), (*iii*) all high indebted countries (High debt), (*iv*) all low indebted countries (Low debt) and (*v*) all EMU countries (EMU). For ease of comparison we also display the baseline results. For more information, see also the table note of Table 1.

6.2.1 Openness

It is possible that in an open economy more government expenditure leaks abroad, see for example Beetsma *et al.* (2008). Similar to Ilzetzki *et al.* (2013), we consider a country to be open if the average and median of the country's trade as a percentage of GDP[15] are both above 60% over the entire sample period.[16]

In the case of the open economies, the cumulative multiplier estimate for GI and GC are comparable to that of the entire sample, although perhaps somewhat more pronounced in the case of GI. This implies that government investment does not leak abroad in an open economy, but makes it actually more effective.

The results for the closed economies are very similar to that of the full sample. There are two differences. First, the cumulative multiplier of GI in a downturn is not as high as in the full

[15]Data obtained from the World Bank over the period 1960-2016.

[16]Open economies: Belgium, Denmark, Ireland, the Netherlands, Norway, Sweden and Switzerland. The remaining eleven countries are closed economies.

sample, reaching a maximum value of 0.60. Second, in a downturn the cumulative multiplier of GC first sharply increases for four quarters, rising to 0.66, before it quickly decreases. Overall however the results are qualitatively the same as those from our baseline specification.

We also perform a sample split based on whether trade as percentage of GDP in 2016 is larger than 60%(not shown).[17] The results for both open and closed economies are close to our baseline results. The only exception is that for closed economies the cumulative multiplier for GI in a downturn is no longer significantly different from zero and hoovers between 0.27 and 0.49. It nonetheless remains significantly different from the multiplier in an upturn.

6.2.2 Indebtedness

The response of the economy to government spending might differ for countries with high public debt, see for example Corsetti *et al.* (2012), and this might also lead to a different multiplier response to the state of the financial cycle. We follow Ilzetzki *et al.* (2013) and classify a country as being highly indebted if their average and median debt-to-GDP ratios[18] are both higher than 60% over the period 1980-2017.[19]

In a downturn of the financial cycle the cumulative multipliers for GC and GI for highly indebted countries are similar to the baseline results. However, the multiplier for GI in an upturn differs substantially. The impact multiplier is much higher, 1.04, and it does not become negative, although it does almost immediately start declining and becomes insignificant after eight quarters. Consequently, the confidence bands of the multipliers in an upturn and downturn overlap constantly. This might suggests that even in an upturn, highly indebted countries benefit from an impulse in investment. A possible explanation might be that these countries structurally underinvest. The results for modestly indebted countries are similar to that of our benchmark results.

We also investigate a sample split based on whether debt as percentage of GDP in 2017 is larger than 60% (not shown).[20] The results for both open and closed economies are similar to our baseline results.

Finally, other papers, such as Corsetti *et al.* (2012), suggest a debt-to-GDP ratio cut-off of 100%. Since, only three countries exceed this cut-off for the full sample on average, we only consider whether countries exceed it in 2017 (not shown).[21] The results of these highly indebted

[17]Open economies: Belgium, Canada, Denmark, Finland, France, Germany, Ireland, South-Korea, the Netherlands, Norway, Spain, Sweden and Switzerland. The remaining five countries are closed economies.

[18]Data obtained from Oxford Economics over the period 1980-2018.

[19]Highly indebted countries: Belgium, Canada, Denmark, France, Italy, Japan, the Netherlands and the US. The remaining ten countries are all lowly indebted countries.

[20]Highly indebted countries: Belgium, Canada, Finland, France, Italy, Japan, the Netherlands, Spain, the UK and the US. The remaining eight countries are all lowly indebted countries.

[21]Highly indebted countries: Belgium, France, Italy, Japan, Spain and the US. The remaining twelve countries

countries deviate from the main results. In a downturn the cumulative multipliers for GC quickly rise, while the multiplier in an upturn decreases towards zero in the long-run. The multiplier for GI in a downturn looks qualitatively the same, but in an upturn it increases towards 0.5 and becomes only narrowly insignificant after twenty quarters. If these results are to be believed, then it would seem that in a downturn both GC and GI are effective ways to stimulate output for highly indebted countries. Given the small size of this panel, however, we regard these results as being less convincing. Results for the group of less indebted countries are similar to the baseline results.

6.2.3 EMU countries

Finally, we obtain estimates based on all eight EMU countries.[22] These countries all introduced the euro in 1999. In the years before the introduction of the euro, the EMU member countries' currencies were pegged either within the European Exchange Rate Mechanism (1979-1999) or in the Bretton Woods system (1944-1973). It is possible that having a peg or single currency might lead to different multipliers because they have less or no control over their own monetary policy and exchange rate.

The results show that our conclusions are not different for this selection of countries. If anything, the cumulative multiplier for GI in a downturn is much higher, even exceeding 2 after twenty quarters. It might be that a fixed exchange rate and later on a common currency magnifies the impact of the financial cycle in a downturn.

6.3 Different sample periods

It is possible that there are structural breaks in our long sample period causing the fiscal multiplier to shift over time. To control for this possibility, we investigate two different shorter sample periods. The first new sample period starts in 1985q1. We drop the earlier years from our sample period because government expenditure as share of GDP in most countries was substantially higher in this period than in the later years. Starting from the second half of the eighties, a new view on government spending arose: governments ought to be smaller with public firms privatized. This can also be seen in the data for most countries where there appears to be a trend break in government spending around this time. Furthermore, it is possible that appending data from earlier years to our main series might lead to measurement error (see Section 4.2). However, omitting observations before 1985 does not change our results. The only notable difference is that the confidence bands of the GC multipliers in the upturn and the downturn do no longer constantly overlap, although the gap between both bands is small.

are all modestly indebted countries.

[22]Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands and Spain

We truncate the second sample period at the end of 2006. The Great Recession and the zero lower bound period that followed represent an unusual economic event which can have an impact on our results. On the other side, it does lead to a substantial loss of observations (792), during which financial markets have become increasingly integrated and thus the financial cycle has become more important. For GC, we find that the cumulative multipliers are similar but now they do significantly differ from each other. For GI, the point estimates are similar to our main results: the multiplier in the downturn of the financial cycle is significantly positive yet somewhat lower. However, due to the loss of observations the error bands become wider and the two regimes are no longer significantly different from each other.[23]

6.4 Other robustness check

Finally, we perform three other robustness checks. First, we include the financial cycle as an additional endogenous variable to our baseline model and obtain similar results. We follow Afonso *et al.* (2018) and include the financial cycle as the last endogenous variable after the real interest rate i_{it}. Our main results are robust for this specification. Allowing for an endogenous instead of exogenous threshold, we find a threshold value of -0.18 and 0.14 for GI and GC, respectively. Both are not far from the exogenous value, and the results are very robust.

Second, we estimate the cumulative multipliers for total government expenditure (TGE), that is, government investment plus consumption (see also Figure D.3). The multipliers in the downturn and the upturn of the financial cycle both go to zero and are not significantly different from each other, resembling the multipliers of GC. GI is in all countries substantially smaller than GC. This might explain why TGE has a closer resemblance to GC than to GI.

Third, we allow for three regimes instead of two and allow the two threshold values to be determined endogenously (see also Figure D.4). For a model with GI as endogenous variable we find 0.13 and 0.33 as threshold values, and for the model with GC we estimate threshold values 0.12 and 0.33. In both models the number of observations in the middle regime is considerably smaller, containing only 15% of the observations in both models. The cumulative multipliers in an upturn and downturn for GI and GC are very similar to our baseline results. The cumulative multiplier for GI in the middle regime quickly goes to zero, while that of GC stays positive but insignificant. In both cases the confidence bands for the multiplier in the middle regime are wide, likely due to the limited number of observations.

[23] We have also estimated this truncated sample using an endogenous threshold. In this case the results are very similar to our baseline results.

7 Conclusion

In this paper we contribute in three ways to the existing literature. First, we show the importance of taking the state of the financial cycle into account when estimating cumulative fiscal multipliers. Second, we are the first to extend the TVAR method to a panel setting. Third, we perform our analysis for different types of government spending, that is, government investment and government consumption.

The results show that the cumulative multiplier of government investment differs according to the state of the financial cycle. In the down cycle, the multiplier almost exceeds one, while in the up cycle, the multiplier goes to zero and even becomes negative. These results suggest that in an upturn the government crowds-out investment by competing with private agents for scarce investment opportunities thereby driving up borrowing costs. In a downturn, government investment stimulates demand even leading to crowding-in of investment. This effect is amplified during a business cycle bust and mitigated during a boom.

The cumulative multiplier of government consumption does not seem to differ over the state of the financial cycle. Its impact is also more modest and lasting no longer than two years. This is in any case potentially sufficiently long lived to still be able to influence the business cycle. Interestingly, however, we also find a substantial difference in the multiplier for government consumption over the business cycle when we also condition our estimates on the economy also being in a downturn of the financial cycle.

These results imply that governments should invest more during downturns of the financial cycle to stimulate the economy. In practice, however, timing the government expenditure such that the actual implementation of government investment coincides with a downturn of the financial cycle is difficult. In any event governments should not reduce investment during a downturn. However, in a business cycle boom it might be more expensive for governments to invest because of capacity scarcity, even though the financial cycle is in a downturn. Our results suggest that the most effective moment for government investment is when a business cycle bust coincides with a financial cycle downturn.

Future research should attempt to determine the mechanisms that drive the observed differences in the fiscal multipliers for GI and GC. More research is also needed to further explore how our results are influenced by the business cycle. The panel TVAR model we develop in this paper would also be suitable for researching whether the cumulative multiplier of monetary policy depends on the different states of the financial cycle.

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A State space model of CPB financial cycle

We denote the credit data for country i by y_{it}^1 and the housing price index by y_{it}^2 and define the data column vector $\vec{y}_{it} = \left(y_{it}^1, y_{it}^2\right)'$. Similarly we denote the vector of the financial cycles for credit and the housing price index of country i as $\vec{f}_{it}$. We use the same notion for the vector of the business cycle components, $\vec{b}_{it}$. The state space model also includes two local linear trend components, one for credit and one for the housing price index, giving rise to the vector $\vec{\mu}_{it}$ to capture the growth dynamics in the data. Each trend component is itself affected by a random walk growth component, which for both series we also denote by a vector: $\vec{\beta}_{it}$. Using this notation we can express the model in Luginbuhl *et al.* (2019) as follows:[24]

$$\begin{aligned}
\vec{y}_{it} &= \vec{\mu}_{it} + \vec{f}_{it} + \vec{b}_{it} + \vec{\varepsilon}_{it}, \quad \vec{\varepsilon}_{it} \sim N\left(0, \Omega_{\varepsilon,it}\right), \\
\vec{\mu}_{it} &= \vec{\mu}_{i,t-1} + \vec{\beta}_{i,t-1} + \vec{\eta}_{it}, \quad \vec{\eta}_{it} \sim N\left(0, \Omega_{\eta,i}\right), \\
\vec{\beta}_{it} &= \vec{\beta}_{i.t-1} + \vec{\zeta}_{it}, \quad \vec{\zeta}_{it} \sim N\left(0, \Omega_{\zeta,i}\right),
\end{aligned}$$

where the financial cycle component is given by

$$\begin{pmatrix} \vec{f}_{it} \\ \vec{f}^*_{it} \end{pmatrix} = \rho_i^f \begin{pmatrix} \cos\frac{2\pi}{\lambda_i^f} & \sin\frac{2\pi}{\lambda_i^f} \\ -\sin\frac{2\pi}{\lambda_i^f} & \cos\frac{2\pi}{\lambda_i^f} \end{pmatrix} \otimes I_2 \begin{pmatrix} \vec{f}_{i,t-1} \\ \vec{f}^*_{i,t-1} \end{pmatrix} + \begin{pmatrix} \vec{\kappa}^f_{it} \\ \vec{\kappa}^{f*}_{it} \end{pmatrix},$$

and the business cycle component by

$$\begin{pmatrix} \vec{b}_{it} \\ \vec{b}^*_{it} \end{pmatrix} = \rho_i^b \begin{pmatrix} \cos\frac{2\pi}{\lambda_i^b} & \sin\frac{2\pi}{\lambda_i^b} \\ -\sin\frac{2\pi}{\lambda_i^b} & \cos\frac{2\pi}{\lambda_i^b} \end{pmatrix} \otimes I_2 \begin{pmatrix} \vec{b}_{i,t-1} \\ \vec{b}^*_{i,t-1} \end{pmatrix} + \begin{pmatrix} \vec{\kappa}^b_{it} \\ \vec{\kappa}^{b*}_{it} \end{pmatrix}.$$

Note that the components $\vec{b}^*_{it}$ and $\vec{f}^*_{it}$ are only required for the construction of the cycle components $\vec{b}_{it}$ and $\vec{f}_{it}$. Also note that the model contains the vector disturbance terms $\vec{\varepsilon}_{it}$, $\vec{\eta}_{it}$, $\vec{\zeta}_{it}$, as

[24]Their model also includes seasonal components to correct for any seasonality in the data. We omit this aspect of the model here for simplicity.

well as $\vec{\kappa}_{it}^{C} \sim N\left(0, \Omega_{\kappa,i}^{C}\right)$ and $\vec{\kappa}_{it}^{C*} \sim N\left(0, \Omega_{\kappa,i}^{C}\right)$ for $C = b$ or f.[25]

The state space model Luginbuhl *et al.* (2019) use in the estimation of the financial cycle is closely related to work of Rünstler & Vlekke (2018) and Winter *et al.* (2017), which are also based on unobserved cycle components to model financical cycles. The main difference here being that the estimation method by Luginbuhl *et al.* (2019) imposes the restriction of there being only one shared stochastic process driving both financial cycle components in their bi-variate model. This restriction is necessary to help identify one financial cycle for each country. In fact the financial cycle estimate f_{it} is the cycle component for the credit data. Although the housing price index shares the same stochastic disturbance driving the cycle, the housing price index has its own starting value. As a result the housing price index financial cycle can deviate from the credit cycle in the initial part of the sample period.[26]

The bi-variate state space models distinguish between the business cycle and the financial cycle by assuming that the financial cycle has a longer period cycle than the business cycle. The estimates of the financial cycle are obtained using Bayesian Markov Chain Monte Carlo, or MCMC methods.

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[25]Note that the covariance matrices of both disturbance vectors $\vec{\kappa}_{it}^{C}$ and $\vec{\kappa}_{it}^{C*}$ are restricted to be equal. This restriction is standard, see Harvey (1991) for details.

[26]Asymptotically however the two financial cycles will be qualitatively the same, only differing in their amplitude.

B Data series

Table B.1: Data for benchmark specification

	gc, rgdp, ngdp		inf	prate
Country	Start	Base rgdp	start	start
Austrialia	1959q3	2014-2015	1950q3	1969q3
Belgium	1995q1	2015	1955q1	1968q1
Canada	1961q1	2007	1950q3	1950q3
Denmark	1995q1	2010	1955q1	1950q3
Finland	1990q1	2010	1955q1	1980q1
France	1980q1	2010	1955q1	1974q1
Germany	1991q1	2010	1955q1	1950q3
Ireland	1995q1	2015	1955q1	1957q1
Italy	1995q1	2010	1955q1	1960q1
Japan	1994q1	2011	1955q1	1950q3
Netherlands*	1995q1	2010	1959q1	1950q3
Norway	1978q1	2015	1955q1	1983q3
South-korea	1960q1	2010	1951q4	1980q1
Spain	1995q1	2010	1954q2	1964q1
Sweden	1993q1	2016	1955q1	1974q3
Switzerland	1980q1	2010	1955q1	1957q1
United Kingdom	1955q1	2015	1955q1	1950q3
United States	1950q3	2009	1955q1	1954q2

Source: Quarterly National Accounts, OECD. Note: We splice quarterly series to the earlier available quarterly series of annual stock levels. All of these growth rates start in 1960q1, except for Canada (no data available) and France (GC starts in 1950q3, and nominal GDP in 1951q4). Furthermore, for the UK, US, AU the series in quarterly levels start prior to 1960, so no link had to be made. *The data of real GDP for the Netherlands starts at 1996q1.

Table B.2: Government investment, Oxford Economics series linked to data described below

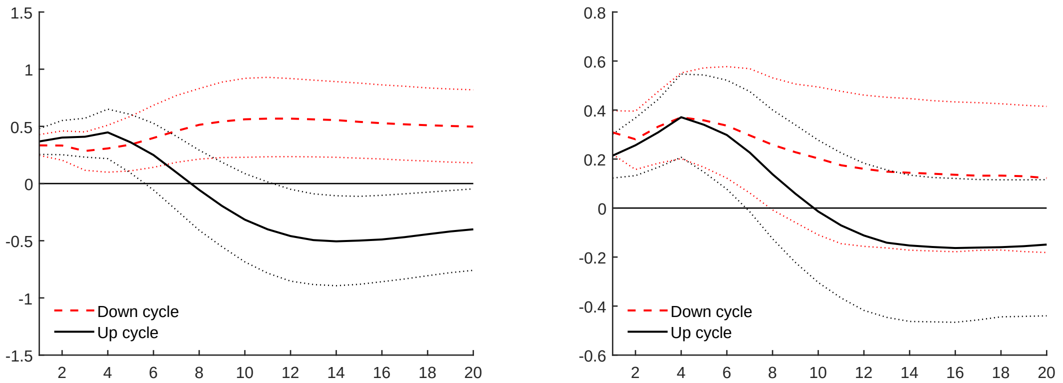
Country	Start	Source	Comments
Austrialia	1959q3	Australian Bureau of Statistics	Gross Fixed Capital Formation, General Government, Calendar and Seasonally Adjusted, 2015-2016 Chained Prices
Belgium	1960q1	OECD Economic Outlook	Government Investment, Constant Prices, 2000 Prices
Canada	1951q1	CANSIM - Statistics Canada	Government Investment: Fixed Capital (Use CND14849), 1986 Prices
Denmark	1971q1	OECD Economic Outlook	Government Investment, Constant Prices, 2000 Prices
Finland	1960q1	OECD Economic Outlook	Government Investment, Constant Prices, 2000 Prices
France	1950q4	INSEE	Gross Fixed Capital Formation, General Government, Calendar and Seasonally Adjusted, 2014 Chained Prices
Germany	1960q1	OECD Economic Outlook	Government Investment, Constant Prices, 1995 Prices
Ireland	1960q1	OECD Economic Outlook	Government Investment, Constant Prices, 2003 Prices
Italy	1960q2	OECD Economic Outlook	Government Gross Fixed Capital Formation, Volume, Constant Prices, 1995 Prices
Japan	1955q2	Cabinet Office, Japan	Gross Fixed Capital Formation, Public, Constant Prices, 1990 Prices
Netherlands	1960q1	OECD Economic Outlook	Government Investment, Constant Prices, 2001 Prices
Norway	1962q1	OECD Economic Outlook	Government Investment, Constant Prices, 2002 Prices
South-korea	1975q1	OECD Economic Outlook	Government Investment, Constant Prices, 2000 Prices
Spain	1964q1	OECD Economic Outlook	Gross Government Fixed Capital Formation, Current Prices
Sweden	1960q1	OECD Economic Outlook	Government Investment, Constant Prices, 2000 Prices
Switzerland	-	-	-
United Kingdom	1962q1	OECD Economic Outlook	Government Investment, Constant Prices 2002 Prices
United States	1950q1	Quarterly national accounts OECD	Gross Fixed Capital Formation, General Government, Current Prices

Note: All series are seasonally adjusted and in constant prices, or indicated where the series deviate. The data on General Government Investment from Oxford economics starts at 1980q1, is seasonally adjusted, and in chained prices. For Switzerland there is no series prior to 1980 available.

C Baseline results in alternative specifications

C.1 Figures for baseline results in alternative specifications

Figure C.1: Cummulative fiscal multipliers using the BIS-cycle as financial cycle

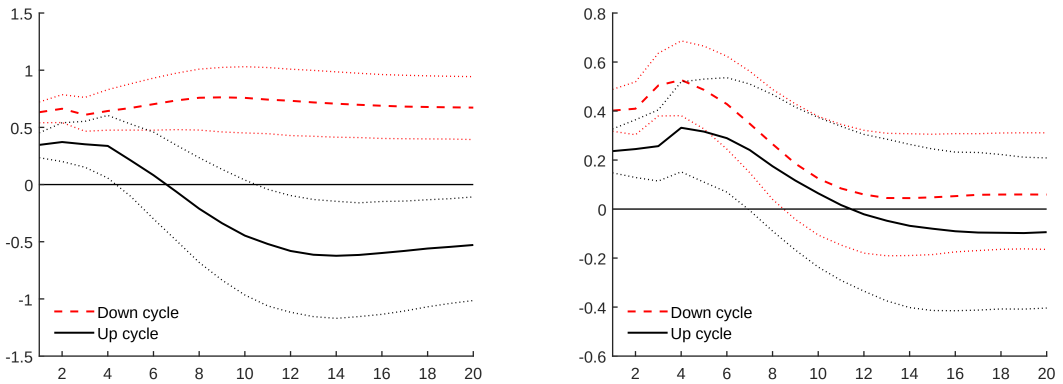


(a) Government investment (GI)

(b) Government consumption (GC)

See the note in Figure 1 for more information.

Figure C.2: Cumulative fiscal multipliers with an endogenous threshold

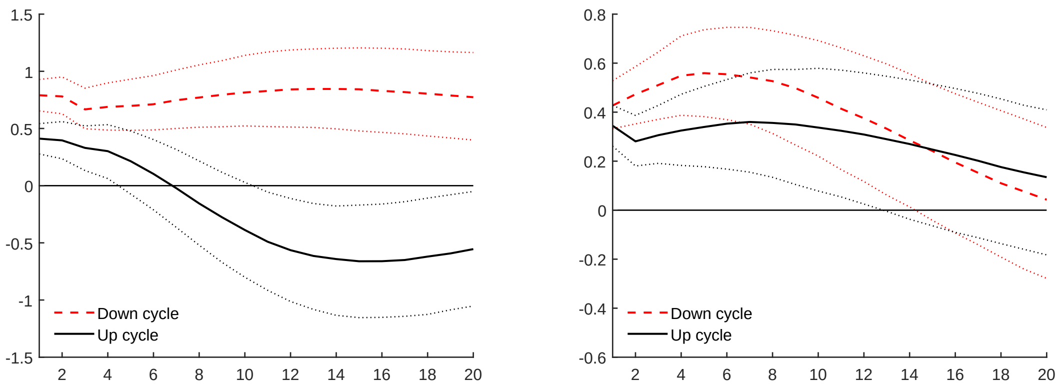


(a) Government investment (GI)

(b) Government consumption (GC)

See the note in Figure 1 for more information.

Figure C.3: Detrending with the projection method



(a) Government investment (GI) (b) Government consumption (GC)

We detrend all non-stationary variables using the projection method, where we follow Hamilton (2018) and project the variable at time $t+8$ onto the four most recent values $t-3, \ldots, t$. See the note in Figure 1 for more information.

C.2 Correlation between financial and business cycles

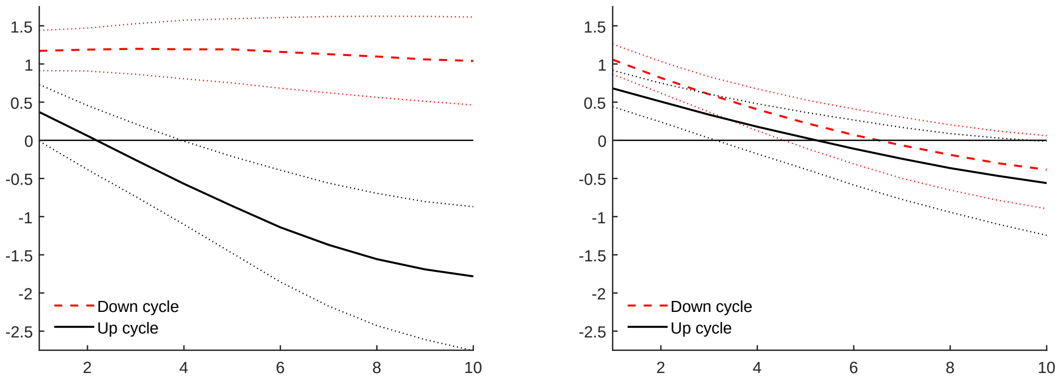
Table C.1: Correlation coefficient between the financial, the BIS and the business cycle

Country	BIS fin cyc	Bus cyc	Country	BIS fin cyc	Bus cyc
Australia	0.79	0.05	Italy	0.76	0.08
Belgium	0.83	0.07	Japan	0.68	0.21
Germany	0.53	0.11	South-Korea	0.48	0.06
Canada	0.69	0.21	Netherlands	0.87	0.07
Denmark	0.74	0.08	Norway	0.60	0.01
Spain	0.90	0.32	Sweden	0.63	0.11
Finland	0.58	0.08	Switzerland	0.87	0.13
France	0.72	0.19	UK	0.88	0.16
Ireland	0.67	0.21	US	0.93	0.13
Average	0.73	0.13			

Correlation coefficients between the estimated financial cycle and the financial cycle estimated by the BIS and the business cycle. The business cycle is constructed by HP-filtering quarterly real GDP, using a λ of 1600.

D Additional figures of robustness checks

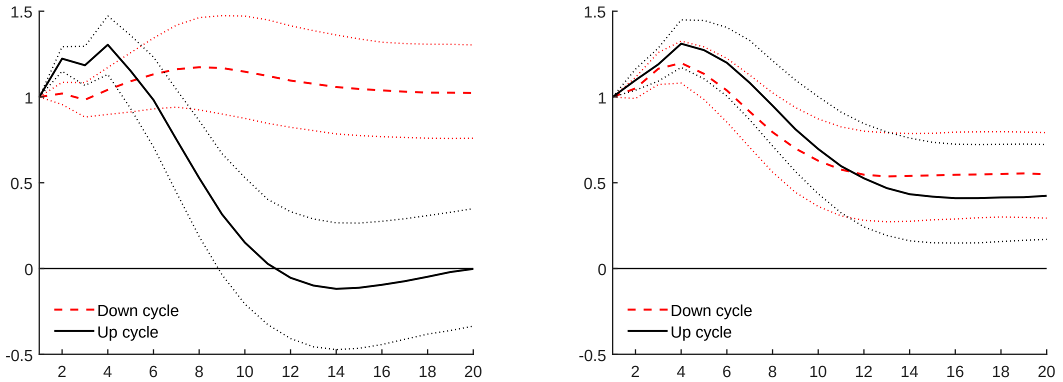
Figure D.1: Cumulative fiscal multipliers with yearly data



(a) Government investment (GI) (b) Government consumption (GC)

The model is estimated with year data and include $L = 1$ lags. See the note in Figure 1 for more information.

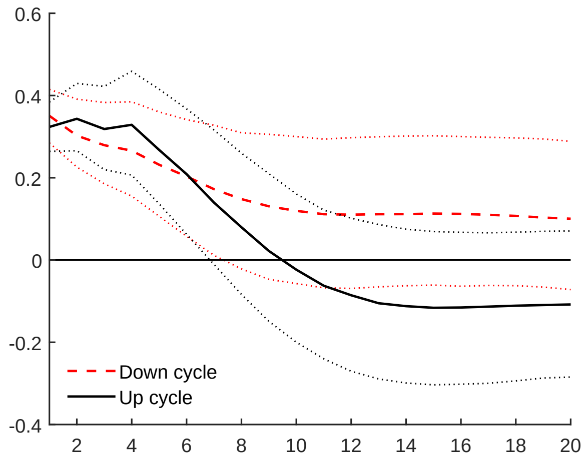
Figure D.2: Cumulative fiscal multipliers with private GDP as first endogenous variable



(a) Government investment (GI) (b) Government consumption (GC)

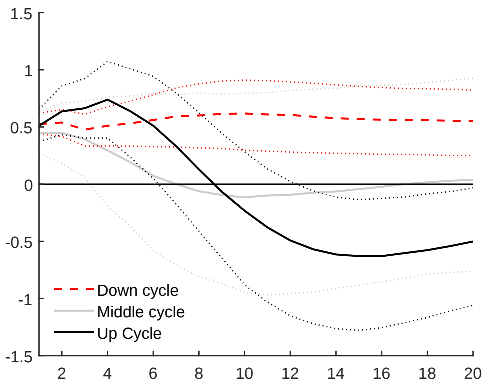
Private GDP is ordered as the first endogenous variable. Therefore, the cumulative multipliers are equal to one by construction in the first period. See the note in Figure 1 for more information.

Figure D.3: Cumulative fiscal multipliers for total government expenditure

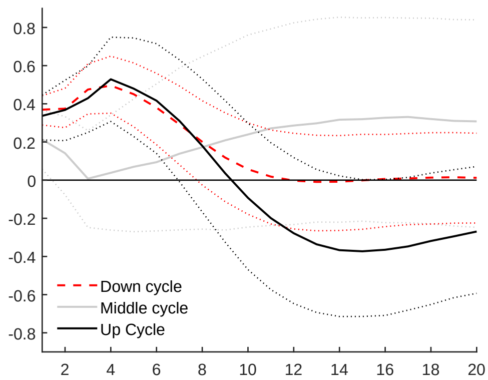


See the note in Figure 1 for more information.

Figure D.4: Cumulative fiscal multipliers with three regimes and two endogenous thresholds



(a) Government investment (GI)



(b) Government consumption (GC)

See the note in Figure 1 for more information.