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The Effects of Government Spending over the Business Cycle: A Disaggregated Approach

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Abstract

This thesis examines the effects of components of government spending over the business cycle (i.e. in expansion and in recession). We use two types of disaggregation, as proposed by the IMF: the economic and the functional classification. The economic classification categorizes government spending based on the type or economic characteristics of expenditure, while the functional classification organizes expenditures according to their purpose. Chapters 3 and 4 employ the economic classification, using alternative econometric specifications. Chapter 3 estimates a Smooth Transition Vector Autoregressive (STVAR) model using U.S. data, while in Chapter 4 government spending multipliers are estimated using local projections on panels of OECD and non-OECD countries. Finally, Chapter 5 uses local projections, in order to estimate multipliers based on the functional classification for a panel of OECD countries. The results confirm our intuition of heterogeneity among components of government spending, as well as state-dependence.

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Chapter 1

Introduction

Interest in the effects of fiscal policy has risen in recent years especially during and after the global financial crisis and ensuing recession, as changes in nominal interest rates provided limited ability to monetary authorities to stimulate the economy. In such cases, government spending packages are often used in order to generate higher aggregate demand. On the other hand, many countries with high public debt are usually forced to implement fiscal consolidation policies. Over the past few years, many countries have been faced with one of the above challenges, if not both.

The government spending multiplier is a metric used to summarize the effects of government spending on output, and is defined as the amount of extra output generated by an additional dollar of spending. The usual spending multiplier describes the effect of a shock in total government spending on the total output of the economy, as typically models do not distinguish between different types of spending. Total government spending expenditure, however, actually consists of a sum of separate expenditures, which differ considerably between them. Depending on the type of government spending changed each time, different types of effects are triggered in the overall output.

This heterogeneity is observed because each component interacts differently with private sector activity. For example, some components are growth-enhancing, in the sense that they amplify private sector productivity, while others distort incentives for private investment; some components work as complements to private consumption, but some others as substitutes, etc. Therefore, the same amount of government spending but with different composition, may produce different effects on the economy. For instance, one can imagine situations where the effect of different government spending components may be offsetting each other, leaving the false overall impression that government spending policy has been ineffective. The key to understand how these transmission mechanisms work, is to break down government spending into its components.

The importance of knowing the effects each government spending component induces on the economy, is, therefore, twofold. First, when it comes to designing effective stabilization policies or stimulus packages, policy makers can focus on components that have large and rapid effects on economic activity. Secondly, when designing fiscal consolidation policies that aim at reducing budget deficits, they must focus on the types of public expenditures to which economic activity is least sensitive, and are less likely to hurt economic growth.

In addition, after the Great Recession many researchers have started questioning whether the multiplier is linear in nature: it might well be that changes in governments spending affect the macroeconomy differently in times of economic strength and in times of economic weakness. Many recent studies who focus on the matter provide evidence that support this idea (Auerbach & Gorodnichenko, 2012b, 2013; Barro & Redlick, 2011; Biolsi, 2017; Fazzari *et al.*, 2015; Owyang *et al.*, 2013; Ramey & Zubairy, 2018). This distinction is crucial as in "bad" times, policy makers are more likely to use fiscal spending to stimulate the economy than in "good" times.

In this thesis I estimate disaggregated government spending multipliers over the business cycle. I use two different specifications and two different classifications of expenditures, as suggested by the IMF[1]: the economic classification and the functional classification. The economic classification of expenditure is based on the type or economic characteristics of expenditure (such as wages of public servants, purchases of goods and services, government investment etc.), and is the one used in Chapter 3 and Chapter 4. The functional classification, on the other hand, organizes government activities according to their purposes (such as defense, education, health, public order and safety, social security, housing, etc.). This type of classification is important in analyzing the allocation of resources among sectors. Estimating separate spending multipliers for each function offers a clearer view of the effectiveness of government spending within each sector. The functional classification is used in Chapter 5. In Chapter 3, I estimate a Smooth Transition Vector Autoregressive (STVAR) model in the manner of Auerbach & Gorodnichenko (2012b), using quarterly data from U.S.. In Chapters 4 and 5, I estimate again Smooth Transition models, but instead of an STVAR, I use the method of Local Projections, as proposed by Jordà (2005), while cumulative multipliers are estimated in the way proposed by Ramey & Zubairy (2018). In Chapter 4, I use annual data for both OECD and non-OECD countries, while in Chapter 5, I focus on OECD countries.

This thesis contributes to the voluminous literature on fiscal multipliers by providing state-dependent multipliers for different types of government spending. Even though Smooth Transition models have been used before in the estimation of government spending multipliers (Auerbach & Gorodnichenko, 2012a,b), I implement a finer level of disaggregation of government spending than what is usually used. In addition, the estimation of short-run multipliers using the functional classification is unprecedented in the literature. Finally, most of the existing studies focus on U.S. or a panel of OECD countries, while I report results for non-OECD countries, as well.

The main findings can be summarized as follows. First of all, the results verify the existence of heterogeneity among components of government spending. Multipliers based on the

[1] See IMF (2014).

economic classification suggest that compensation of public employees and government investment both have a positive effect on output, whereas purchases of goods and services seem to leave output unaffected. The effect of social benefits is not clear as we get a strong and positive multiplier for U.S. in Chapter 3, but an insignificant one in Chapter 4, for both OECD and non-OECD countries. When the functional classification is used, in Chapter 5, I find that some functional components are more effective than others, in the sense that they produce higher output multipliers. Defense, public order and safety, recreation, religion and culture, health and education give positive and strong multipliers, whereas multipliers for general public services and economic affairs are negative, and multipliers for housing, environmental protection and social protection are insignificant. My results agree with the existing literature in that some components are more efficient because they are productive (education, health, defense, public order and safety) or they are complements to private consumption (education, health and recreational, cultural and religious services). Finally, I find that multipliers for education, health, recreation, and social protection are higher in recession than in expansion.

The thesis is organized as follows. Chapter 2 provides a review of the related literature. Chapters 3 and 4 present the results using the economic classification but alternative specifications, while Chapter 5 presents the results of the functional classification analysis. Finally, Chapter 6 discusses and concludes.

Chapter 2

Related Literature

Measuring the effects of government spending and taxes on GDP and economic activity, in general, was an active research area for a number of decades. During the 1980s, 1990s and 2000s, however, interest was shifted towards monetary policy and only a few number of papers regarding the effects of fiscal policy were published. With the recent financial crisis and the interest rate reaching the zero lower bound, it was clear that more research on fiscal policy shocks was needed. The questions that most of the recent papers in this area try to answer are: (1) What are the effects of changes in government spending on economic activity?, and, (2) How are those effects transmitted?

So far the literature has not come to a consensus about the size of government spending multipliers, or the effects of government spending shocks on macroeconomic variables.[1] A main conclusion drawn is that there is no such thing as *the multiplier*. Instead, government spending multipliers are likely to depend on a number of factors, such as the type of government spending, its persistence, how it is financed and the state of the economy.

This chapter provides a review of the theoretical and empirical literature around government spending multipliers. It starts with a brief description of the main underlying theoretical frameworks, and continues with discussing the approaches on the identification of government spending shocks and the main results from the empirical literature on government spending multipliers. Finally, it reviews two small but growing branches of the literature, disaggregated multipliers and multipliers over the business cycle.

2.1 Theoretical Framework

In the traditional Keynesian analysis, the spending multiplier is given by 1/(1-mpc), where mpc is the marginal propensity to consume. mpc is usually around 0.5-0.9, implying a quite high Keynesian multiplier, around 2-5. In addition, in this framework, an increase in government spending leads to an increase in consumption. Neoclassical models (e.g Aiyagari *et al.*, 1992;

[1] A thorough survey of the theoretical and empirical literature on government spending multipliers is given in Ramey (2011a).

Baxter & King, 1993), on the other hand, predict that a rise in government spending (financed with lump-sum taxes or debt and spent on non-productive government spending, such as purchases of goods and services) should raise GDP and hours, but should decrease consumption and real wages. Whether investment initially rises or falls depends on the persistence of the increase in government spending. Baxter & King (1993) found that impact multipliers on output hardly ever exceed unity. If, however, government spending enhances the productive capacity of the economy, multipliers are much larger. On the contrary, output multipliers are negative if government spending is financed by distortionary taxes, because in that case, higher taxes will lead people to work less, reducing, in turn, labor supply. New-Keynesian models (e.g. Cogan *et al.*, 2010; Linnemann & Schabert, 2003; Smets & Wouters, 2007) introduce a sticky-price feature on a neoclassical foundation. Their results reveal a multiplier below unity, supporting the results of neoclassical models.

A notable difference between the traditional Keynesian and the neoclassical framework is the response of consumption. The reason for this divergence arises from the assumptions of how consumers behave in each case. The neoclassical model assumes infinitely-lived Ricardian households, whose consumption decisions at any point in time are based on an intertemporal budget constraint. Therefore, when an increase in government spending occurs, they acknowledge the fact that taxes will increase in the future, which leads them to reduce their consumption. On the contrary, consumption in the Keynesian framework is a function of consumers' current disposable income and not of their lifetime resources. This means that an increase in government will produce an increase in consumption, as well. Galí *et al.* (2007) introduced an additional type of households in a new-Keynesian model, the "rule-of-thumb" households. These are assumed to behave in a hand-to-mouth fashion, fully consuming their current labor income. Galí *et al.* (2007) showed that when the fraction of rule-of-thumb households is 50% of total consumers, and employment is demand-determined (so that workers are always willing to supply as many hours as firms demand), government spending generates a rise in consumption, and output multipliers can be as high as 2.

2.2 Identification of Government Spending Shocks

Most papers in the literature[2] estimate government spending multipliers using Structural Vector Autoregressive (SVAR) Models. Following the lead of Blanchard & Perotti (2002), they implement a Cholesky decomposition with government spending ordered first. This ordering implies that government spending does not respond within the period to the other endogenous variables and it is based on the idea that government spending is subject to certain decision and/or implementation lags, therefore, it cannot respond to current economic conditions. Blanchard & Perotti (2002) use external information (such as the elasticities of government spending and

[2] A full description of the identification approaches of government spending shocks is provided in Ramey (2016).

taxes on output), in order to achieve identification. Another way to achieve identification in an SVAR is imposing sign restrictions, which is what Mountford & Uhlig (2009), Caldara & Kamps (2008) and Canova & Pappa (2011) do.

Another widely used method of identification in the literature is the ”narrative” approach. Ramey & Shapiro (1998) were the first to implement this method, by creating a dummy capturing major military buildups. Military spending shocks, can be thought of as exogenous, since the decisions regarding military spending are not based on economic conditions. In a more recent work, Ramey (2011b) created a new measure of “news” about defense spending, a variable capturing the expected discounted value of government spending changes due to foreign political events. Moreover, using professional forecasters' surveys, Ramey (2011b) also concludes that the timing of the shock is of high importance and may also be the cause of the different results between the narrative approach of Ramey & Shapiro (1998) and standard VAR identification methods. The narrative approach is also followed by Ben Zeev & Pappa (2017), who identify defense spending news as a shock that is orthogonal to current defense spending, and, best explains future movements in defense spending over a horizon of five years. An important advantage of the narrative approach is that it does not require imposing identifying assumptions about the structure of the economy. However, with this approach one can estimate multipliers for only one component of government spending, the defense spending. In addition, this approach relies on subjective interpretations of announcements about future military spending in newspapers and government reports, which may lead to biased results. Finally, an alternative identification scheme is proposed by Fisher & Peters (2010), who identify government spending shocks with statistical innovations to the accumulated excess returns of large US military contractors.

A different identification approach is the one introduced by Perotti (1999), which is very useful when dealing with annual data, as we do for parts of our analysis. This strategy includes two stages of estimation. In the first stage a fiscal policy rule is estimated and the residuals of this estimation are used as shocks. Then, in the second stage, one is able to estimate the effects of these shocks on some variables of interest. This approach was also adopted by Tagkalakis (2008) and Corsetti *et al.* (2012).

2.3 Main Results from the Empirical Literature

Numerous empirical studies, conducted on a variety of countries, have tried to determine the size of the government spending multiplier. In a seminal study based on a SVAR using a long postwar U.S. sample, Blanchard & Perotti (2002) showed that government purchases shocks raise not only GDP, but also hours, consumption and real wages. They also find that increases in government spending have a strong negative effect on investment. Succeeding papers that adopted the same framework, such as Fatás & Mihov (2001), Perotti (2004a), and Pappa (2009), confirm these results[3].

Mountford & Uhlig (2009), as mentioned above, introduced a new identification strategy; they identified government spending shocks in an SVAR on U.S. data, using sign restrictions. Their results, though, agree with previous studies in this area. More precisely, they find that investment falls in response to government spending increases. However, they find only weak effects on GDP and no significant effect on consumption, and in addition that real wages do not rise in response to an increase in government spending and have a negative response on impact and at longer horizons. Therefore, the responses of investment, consumption and real wages to a government spending shock do not agree with either the standard Keynesian approach, or the benchmark real business cycle model. Canova & Pappa (2011) recover spending shocks using sign restrictions on the response of expenditure, deficits and output growth, and distinguish between normal situations and the current one by imposing additional constraints on the dynamics of tax receipts, inflation and the magnitude of the shocks. They show fiscal policy could be an effective countercyclical tool and that the output multipliers it generates may be significantly larger than 1, if certain conditions are satisfied: monetary policy should facilitate fiscal expansion; expectations about future output growth and inflation should not be affected; and structural relationships, such as the sensitivity of consumption to output or the real interest rate, should be invariant to the policy changes. Another paper that uses sign restrictions is that of Forni & Gambetti (2010), but they do it in the context of a dynamic factor model, using again U.S. data. Their results are closer to the typical Keynesian effects, as they find that government spending raises both consumption and investment, with no evidence of crowding out.

Caldara & Kamps (2008) try to compare all different identifications methods using U.S. data over the period 1955-2006. Controlling for differences in specification of the reduced-form model, they show that all identification approaches used in the literature produce qualitatively and quantitatively very similar results to government spending shocks. More specifically, real GDP, real private consumption and the real wage all significantly increase following a hump-shaped pattern, while private employment does not react.

Bilbiie *et al.* (2008) break U.S. time series into two periods: 1957-79 and 1983-2004. Estimating multipliers using VARs on each of these periods reveals different results; in the first period government spending shocks have stronger effects on output, consumption, and wages. Bilbiie *et al.* (2008) also construct a DSGE model with featuring price rigidities and limited asset market participation to help clarify this outcome. They conclude that most of the changes in fiscal policy transmission are created by increased asset market participation and more active monetary policy in the second period.

An important criticism of the SVAR approach is that the government spending shocks estimated by the econometrician are likely to have been anticipated by the public. In that case, the true shocks cannot be recovered from the estimated shocks. Ramey (2011b) argues that this can lead to an expansionary bias in the impulse responses from a SVAR, and it is mainly the cause

[3] Fatás & Mihov (2001) and Pappa (2009) use U.S. data, while Perotti (2004a) uses data on 5 OECD countries.

of the divergence between the results of SVARs and the narrative approach. The issue of anticipation was addressed by Tenhofen & Wolff (2010) and Mertens & Ravn (2010). Tenhofen & Wolff (2010) examine the effects of government expenditure on private consumption when the private sector anticipates the fiscal shocks. In order to capture anticipation of fiscal policy, they develop a new method based on a structural vector autoregression (SVAR). Using post-WWII US data, they show that when taking into account anticipation, private consumption decreases significantly in response to a defense expenditure shock, but increases significantly in response to a non-defense expenditure shock. Mertens & Ravn (2010) derive a fiscal SVAR estimator that is applicable when fiscal shocks are anticipated. Using U.S. data, they find no evidence that anticipation effects contradict the existing findings from the fiscal SVAR literature.

An important conclusion drawn from the existing empirical literature is that the size of government spending multiplier varies across studies. Ramey (2011a), in her survey on the topic, concluded that the multiplier for a temporary and deficit-financed increase in government purchases (that enter separately in the utility function and have no direct effect on private sector production functions) is probably between 0.8 and 1.5. Gechert (2015) conducted a meta-regression analysis on a unique dataset of 104 studies on multiplier effects. His findings suggest that general public spending multipliers are close to 1 and about 0.3 to 0.4 units larger than tax and transfer multipliers. In addition, public investment multipliers are even larger than those of spending, in general, by approximately 0.5 unit.

It should be noted, however, that in most of the cases described above, government spending is defined either as total spending or as government consumption. In the following section, we discuss the main results of papers that disaggregate government spending into its components.

2.4 Disaggregating Government Spending

The idea of examining the effects of different components of government spending on the economy is not new in the literature; however, only a handful of studies have addressed this issue. Table 2.1 provides a summary of the main studies that disaggregate government spending according to the economic classification. The first attempt to estimate partial multipliers is traced back to Fatás & Mihov (2001), who using a SVAR on U.S. data, estimated the effects of the three main government expenditure components: government investment, wage spending, and non-wage spending on macroeconomic variables. They showed that in all cases consumption goes up following a government spending shock, but the most prominent rise in private consumption occurs when government wage expenditures increase. In the same spirit, Perotti (2004c) using a SVAR and data from 5 OECD countries, estimated the macroeconomic effects of three government spending variables: government investment, consumption, and transfers to households. His findings indicate no evidence that government investment shocks are more effective than government consumption shocks in boosting GDP (this is true both in the short and in the long run). More recently, Zervas (2016, 2018) using U.S. data and an SVAR approach with

Blanchard-Perotti identification, estimated spending multipliers for total spending, government consumption, government wages and government investment, total or broken into the relevant civilian and military series. He found that government wages have the strongest effect on output, with a mean multiplier close to 2.5. Output multipliers to total spending and consumption are very similar and both around 0.8, while investment has a mean multiplier higher than 1, although insignificant. In addition, civilian and military spending appear to produce different effects on the economy.

Bouakez *et al.* (2018) introduce a higher level of disaggregation, which has not been previously explored in the empirical literature. They break U.S. public spending into various sub-categories, such as wages, durables, non-durables and services for public consumption and structures and equipment for public investment. Each of those sub-categories are measured at the levels of the federal (defense and non-defense), and state and local governments. Their results support the idea of heterogeneity in the effects of different components, both across sub-categories and government levels. At the federal level, output multipliers peak at 2.40 for wages, 3.19 for durables, 1.22 for non-durables and 1.70 for services. Sub-categories of government investment peak at 2.85 (structures) and 2.25 (equipment).

Bermperoglou *et al.* (2012) estimate the effects of government consumption (defined as government expenditures minus government wage expenditures), government investment and government employment (defined as government wage expenditure) separately using a SVAR, where shocks are identified using sign restrictions derived from a New-Keynesian DSGE model. They use data for US, Canada, Japan, UK and the Euro area. Their results suggest that all spending shocks stimulate output, but government employment shocks are those who produce the largest output multiplier. The output multipliers for US, on impact are: 2.24 for government consumption, 2.69 for government investment and 4.89 for government employment. In a more recent work, Bermperoglou *et al.* (2017) disaggregate the expense on government wages even further by distinguishing between shocks to public employment (number of public employees) and shocks to the public wage rate. They estimate the effects of these two shocks in US data, using sign restrictions derived again from a New-Keynesian DSGE model. They find public employment shocks to be expansionary, both in the federal and the state and local level, although public wages shocks increase output and consumption in the state and local level, but decrease them in the federal level.

Burgert & Gomes (2012) argue that differences in estimated multipliers are not due solely to different identification methods, as is usually suggested, but also to the fact that most empirical studies use aggregate government spending series. Some of the spending components (such as government wages) have a bigger share on total spending than others, while other spending components (such as the purchases of intermediate goods ans services) are more volatile. Since the composition of government spending changes over different samples, it is hard to identify spending shocks properly when one uses the aggregate government spending. To address this issue, they break government spending into five components: average wages, employment, purchases of intermediate goods and services, investment and transfers. Using U.S. data they estimate several SVAR models. First they test the identifications methods proposed by Blanchard & Perotti (2002), Perotti *et al.* (2007) and Ramey (2011a), and then they suggest a new identification approach that is based on the distinction between an idiosyncratic shock component and a global one. Their results show that the average wage and employment have bigger multipliers than purchases, investment and transfers. More precisely, the long-run present value multipliers are: wages:1.97, employment:2.93, consumption (purchases of goods and services):-0.12, investment: 0.2, and transfers: -1.66.

Marattin & Salotti (2014) on the other hand, focus on the effects of different types of public spending on private consumption in the UK. They estimate a structural VECM, and they find that wages reduce private consumption, while non-systematic components of social spending, as well as government purchases of goods and services increase private consumption.

Other papers who break government spending into consumption and investment components are: Tagkalakis (2006), Pappa (2009) and Bénétrix (2011) who study on the effects of government spending shocks on employment and real wage; and Beetsma *et al.* (2006, 2008), Bénétrix & Lane (2010); Bénétrix & Lane (2013a), and, Lane & Perotti (2003) who focus on the effects of government spending shocks on trade and real exchange rate. Pappa (2009), Bénétrix & Lane (2010); Bénétrix & Lane (2013a), Bénétrix (2011), Lane & Perotti (2003) and Tagkalakis (2006), in particular, disaggregate government consumption even further by distinguishing between its wage and non-wage components.

From a theoretical point of view, the paper of Baxter & King (1993), which has been an important contribution, is the first to examine the effects of government consumption and investment, separately. More recent papers who address this issue are those of Cortuk & Guler (2015) and Sims & Wolff (2018). Cortuk & Guler (2015) distinguish between government investment, government wage consumption and government non wage consumption. They show that government wage component of consumption has the largest effect on economic variables, affecting them through the government production function. Government investment also has a similar transmission mechanism. Sims & Wolff (2018) divide government spending into consumption and investment, and they test their effects not only on output but on aggregate welfare, as well. They find a government consumption multiplier for output equal to 1.07 and a government investment multiplier equal to 0.9.

In addition, there is another strand of the literature that estimates the effects of social benefits on output and economic activity. Social benefits are not a government spending component with the classical meaning, since they are transfers, but it is of interest to see what are the short-run effects of them on the economy and how they behave under different states of the business cycle. Furceri & Zdzienicka (2012) estimate the effects of social benefits on several macroeconomic variables for a panel of OECD countries. The output multiplier of social spending is found to be 0.6. In addition, they show that effect of social spending on output is larger in periods of severe downturns. Testing the effects of social benefits on private consumption and investment yields that social benefits have a positive and significant impact on private consumption, but insignificant effects on private investment. Romer & Romer (2016), using U.S. data, also show that permanent increases in social benefits produce a large, immediate, and significant positive response of consumption.

The functional classification of government spending is even less common in the literature, while the majority of papers who implement this type of disaggregation focus on the long-run effects of government spending on economic growth. A summary of these studies is given in Table 2.2. Devarajan *et al.* (1996) were the first to examine the long-run effect of defense, education, health and transportation and communication expenditure on growth. In a sample containing OECD countries with high income, they found a significant (and positive) result for transportation and communication expenditure only.

Kneller *et al.* (1999) examine the growth effects of fiscal policy for a panel of 22 OECD countries during 1970-95, and find considerable evidence in favor of the predictions of Barro (1990). They treat expenditures with a substantial (physical or human) capital component as ”productive” (general public services expenditure, defence expenditure, educational expenditure, health expenditure, housing expenditure, and, transport and communication expenditure) and the rest of them as ”non-productive” (social security and welfare expenditure, expenditure on recreation, expenditure on economic services). Their findings indicate that productive government expenditure enhances growth, while non-productive expenditure does not. In a succeeding paper, Bleaney *et al.* (2001), confirm the above results using the same framework but alternative specifications, that are more appropriate for estimating long-run effects.

Usually in the literature, studies that assess the aggregate short-run growth effects of fiscal policy use different methodologies than those who estimate the long-run effects. The former generally focus on temporary fiscal ’shocks’; the latter have no short-run dynamics or assume homogeneity. In order to investigate these cases simultaneously, Gemmell *et al.* (2011) use regression methods that treat heterogeneous short-run dynamics explicitly within a long-run model. Their results, for a panel of OECD countries, indicate that changes between different types of expenditure can affect GDP growth rates over the long-run, at a 30-35 year horizon. This ’long-run result’, however, appears to occur within a few years after the shock, implying relatively rapid short-run adjustment to a new long-run growth rate equilibrium. In a more recent work, Gemmell *et al.* (2016) extent the previous framework by disaggregating government expenditure into its functional components. They show that infrastructure and education creates positive long-run output levels, as opposed to social welfare, which may be associated with modest negative effects on output in the long run.

In a DSGE context, Agénor (2008) examines the optimal allocation of government spending resources between education and infrastructure. Using an endogenous growth framework, in which infrastructure services affect the schooling technology, he shows that the optimal share of spending on infrastructure depends on the quality of schooling and the degree to which infrastructure services affect the production of educated labor. Agénor & Neanidis (2011) extend the previous framework by also including health among the spending categories. In this case, infrastructure affects not only the production of goods and the quality of education but also the supply of health services. In addition, they support the idea that good health contributes not only to labor productivity but also to the quality of education, by improving the ability to attend school and learn. By focusing on the complementarity between these three categories, the authors show that the optimal allocation between infrastructure, health and education depends on the positive externalities that are created between them. Blankenau & Simpson (2004), on the contrary, focus on the relationship between government expenditure on education and growth. Using an endogenous growth model, they show that the response of growth on expenditure on education is subject to the level of government spending, the tax structure and the parameters of production technologies. In the same spirit, Dioikitopoulos (2014) examines the effect on growth of expenditures on both education and health. In a overlapping generations context, he suggests that dynamic complementarities of public expenditures lead to minimum threshold levels of public education and health expenditures that ensure sustainable growth. Finally, Economides *et al.* (2015), consider even more spending categories, such as spending on social protection (e.g. pensions), health, general public services (e.g. interest payments), education, economic affairs (e.g. public infrastructure) and defense and public-order safety. Using an overlapping generations general equilibrium model, they show that spending on education and health outperforms all other changes in fiscal policy.

Another important issue in analyzing functional government spending multipliers, is the response of consumption to changes in functional components. Fiorito & Kollintzas (2004) divide government spending into two categories: ”public goods”, which include defense, public order, and justice, and ”merit goods”, which include health, education, and other services that could have been provided privately. By estimating equations derived from a general permanent income model using data from 12 European countries, they show that public goods substitute while merit goods complement private consumption. This result has been confirmed by Bermperoglou *et al.* (2017), who find that wage shocks at the federal level have contractionary effects, but at the state and local levels they are expansionary. They argue that the public good provided at the federal level may exhibit a different degree of complementarity with private consumption than at the state and local level. This might be explained by the different nature of the public good provided in each case. For instance, federal government employees largely comprise military and defense employees, while state and local government employees provide mainly education, health care and transportation services. Perotti (2014) and Pieroni & Lorusso (2015) also support this idea by showing that, in U.S., civilian expenditure produces a positive and significant response on private consumption whereas military spending has a negative impact. In order to address this issue on a theoretical level, Bouakez & Rebei (2007) develop a simple real business cycle model where preferences depend on private and public spending, and households are habit forming. Estimating the model by maximum-likelihood using U.S. data, reveals a strong Edgeworth complementarity between the two types of consumption goods.

Finally, Fève *et al.* (2013) estimate a DSGE model using U.S. data and show that the combination of endogenous government expenditures and Edgeworth complementarity between private consumption and government expenditures, can create biases in the estimation of government spending multipliers.

Even though the functional classification of government spending is not commonly used in the literature, there are many studies that focus on one of the functional components, the expense on defense. This is because defense shocks, as we have already discussed in Section 2.2, constitute natural exogenous shocks, which makes identification a lot more straight-forward. Following Ramey (2011b), many succeeding papers have implemented the ”narrative” approach in identifying government spending shocks, in which a measure of news about defense spending is used, i.e. a variable capturing the expected discounted value of government spending changes due to foreign political events. Unfortunately, this is done mostly for the U.S.. Ramey (2011b)'s constructed news variables extends from 1939 to 2008. The implied government spending multipliers range from 0.6 to 1.2. Zervas (2016) confirms this result, as he finds the impact multiplier to be 1.24, although a lot smaller in the following periods. In a subsequent work, Owyang *et al.* (2013) find a 4-year-integral multiplier equal to 0.81 for U.S. and 0.79 for Canada; while in Ramey & Zubairy (2018) the 4-year-integral multiplier for the U.S. is 0.71. Ben Zeev & Pappa (2015), on the other hand, focus on unexpected changes in defense spending, identifying these shocks as innovations in defenses pending within a VAR that includes various real and nominal macroeconomic variables as well as the Ramey (2011b) news series. The unanticipated defense shock generates a median impact output multiplier of 0.94. In a more recent work, Ben Zeev & Pappa (2017) identify news shocks to U.S. defense spending as the shocks that best explain future movements in defense spending over a five-year horizon and are orthogonal to current defense spending, and find a cumulative output multiplier equal to 2.14. Finally, Perotti (2014) finds a cumulative output multiplier of defense spending equal to 0.31.

2.5 Government Spending Multipliers over the Business Cycle

Many studies assess whether the effects of government spending vary with the state of the business cycle or with other economic conditions that influence the economy. Tagkalakis (2008) examined the effects of fiscal policy in recessions and expansions when households face credit constraints, for a panel of OECD countries, and found that fiscal policy is more effective in boosting private consumption in recessions than in expansions. Corsetti *et al.* (2012) condition on the existence of a financial crisis, whether the exchange rate regime is pegged, and whether there is high public debt. In a similar framework, Ilzetzki *et al.* (2013) estimate panel VARs for groups of countries distinguished by the degree of development, the exchange rate flexibility, openness to trade, or high government debt.

Owyang *et al.* (2013) investigate whether multipliers are higher during periods of slack; slack is defined through a dummy that takes the value of one when the unemployment rate is above a threshold. They use historical data for the United States and Canada, and they find that even though multipliers are higher during slack in Canada, this is not the case in US. For Canadian data, the 4-year-integral output multiplier is: 0.79 in the linear model, 1.16 in recession (high unemployment) and 0.46 in expansion (low unemployment). In an more recent work, Ramey & Zubairy (2018) consider as an indicator of slack not only the unemployment rate, but also whether the interest rates are at the zero lower bound. They find multipliers that are below unity irrespective of the amount of slack in the economy.[4] In the same spirit, the results of Zervas (2018) and Fazzari *et al.* (2015) support the idea of state-dependence of multipliers, through the estimation of threshold VAR models.[5]

Another strand of the literature uses regime switching models, or Smooth Transition VARs (STVAR). In these types of models transitions across states (i.e., recession and expansion) are smooth, as opposed to what a simple dummy implies. Auerbach & Gorodnichenko (2012b) employ a such a model which is similar to smooth transition autoregressive (STAR) models developed in Granger & Teräsvirta (1993), and find that fiscal policy is significantly more effective in recessions than in expansions. This paper is very close to our work, as it also estimates separate multipliers for government consumption and investment, as well as for defense and non-defense spending. In the linear model the impact multiplier on output is 2 for investment and around 0.5 for consumption. Using a non-linear model they find larger positive multipliers in recession than in expansion. Defense spending in the linear case, triggers a rise in output by just over 1 on impact, which agrees with Ramey (2011b), and then gradually falls, becoming negative after several quarters. In expansion, output behaves in a similar way as in the linear case, whereas in recession there is a larger positive effect, that peaks at nearly 4 in the fifth quarter after the shock.

In their next papers, Auerbach & Gorodnichenko (2012a) and Auerbach & Gorodnichenko (2013) use again regime switching models, but instead of a Smooth Transition VAR they follow Jordà (2005) and estimate the multipliers through local projections. In particular, Auerbach & Gorodnichenko (2013) estimate the cross-country spillover effects of government purchases on output for a large number of OECD countries, allowing multipliers to vary across states of the business cycle. Riera-Crichton *et al.* (2015) use a similar framework with Auerbach & Gorodnichenko (2012a), but they bring into the picture a new dimension: whether government spending is going up or down. Finally, the STVAR model has also been adopted by Caggiano *et al.* (2015) and Fotiou (2017), who follow Auerbach & Gorodnichenko (2012b) closely, but estimate responses using the Generalized IRF framework.[6]

[4] Biolsi (2017) using the same framework, shows that raising the threshold unemployment rate produces a higher spending multiplier under recession, although not significantly greater than unity.

[5] A similar work is also that of Candelon & Lieb (2013) who use a threshold vector error-correction model (VECM).

[6] Fotiou (2017), in particular, allows responses to vary not only with the state of the cycle, but also with the

In a DSGE context, state-dependence of government spending multipliers is addressed by Canzoneri *et al.* (2016) and Sims & Wolff (2018). Canzoneri *et al.* (2016), using a banking model as described by Cúrdia & Woodford (2010, 2016) show that in the presence of cyclical variation in bank intermediation costs, fiscal multipliers can be state-dependent. In particular, they find multipliers in recessions that exceed two, and multipliers in expansions that are below unity. Sims & Wolff (2018), on the other hand, compute state-dependent multipliers, while at the same time they disaggregate government spending into government consumption and investment. Their findings, though, do not provide evidence of state-dependence.

composition of the fiscal adjustment and the degree of indebtedness.

Table 2.1: Literature Review Summary Table: Economic Classification

Study	**Government Spending Component**	**Method**	**Data**	**Output Multipliers**	**State-Dependence**
Auerbach & Gorodnichenko (2012b)	Consumption, Investment	STVAR, Identification: Cholesky with G ordered first	US: Quarterly, 1947:I−2008:IV	(cumulative, 20 quarters) Consumption:1.2, Investment:2.39	Expansion: Consumption:-0.25, Investment:2.27 , Recession: Consumption:1.47, Investment:3.42
Bermperoglou *et al.* (2012)	Consumption (expenditure minus wages), Investment, Employment (wages)	SVAR, Identification: sign restrictions extracted from a DSGE model	US: Quarterly, 1960-2007	(cumulative,12 quarters) Cons:7.39, Inv:8.29, Empl:13.2	No
Bouakez *et al.* (2018)	Consumption (wages, durables, non-durables, services), Investment (structures, equipment)	SVAR, Identification: based on the conditional heteroscedasticity of the structural disturbances	US: Quarterly, 1979-2010	(peak) wages:2.4, durables:3.19, non-durables:1.22, services:1.7, structures:2.85, equipment:2.25	No
Burgert & Gomes (2012)	Wages, Employment, Purchases of intermediate goods and services, Investment, Transfers	SVAR, Identification: Generalization of Blanchard & Perotti (2002)	US: Quarterly, 1960:1−2006:4	(present value long-run multipliers) Wages:1.97, Employment:2.93, Purchases:-0.12, Investment:0.20, Transfers:-1.66	No

Continued on next page

Table 2.1 – continued

Study	**Government Spending Component**	**Method**	**Data**	**Output Multipliers**	**State-Dependence**
Corsetti *et al.* (2012)	Consumption	Shocks are identified as residuals from a fiscal policy rule	Panel of 17 OECD countries: Annual, 1975–2008	(impact) 0.7	Financial Crisis: (impact) 2.3 , (cumulative, 6 years) 2.6
Furceri & Zdzienicka (2012)	Social Benefits	Estimation of a dynamic growth equation	Panel of OECD countries: Annual, 1980–2005	0.6	No
Perotti (2004b)	Consumption, Investment	SVAR, Identification: a variant of Blanchard & Perotti (2002)	US: Quarterly, 1960:1 - 2001:4	(cumulative, 20 quarters) Consumption: 7.30, Investment: 1.44 (insignificant)	No
Sims & Wolff (2018)	Consumption, Investment	Estimated medium scale New Keynesian DSGE model	US: Quarterly, 1984q1-2008q3	(steady-state multipliers) Consumption:1.07, Investment:0.90	Recession: about equal to the unconditional case
Zervas (2018)	Total, Consumption, Investment, Wages	SVAR, Identification: Blanchard & Perotti (2002)	U.S., Quarterly: 1960q1-2006q4	(mean) Total:0.66, Consumption:0.79, Investment:1.04, Wages:2.59	No

Table 2.2: Literature Review Summary Table: Functional Classification

Study	Government Spending Component	Method	Data	Output Multipliers	State-Dependence
Ben Zeev & Pappa (2017)	Defense	VAR, Shock that (i) is orthogonal to current defense spending; and (ii) best explains future movements in defense spending over a horizon of five years	US: Quarterly, 1947–2007	(cumulative, 6 quarters) 2.14	No
Gemmell *et al.* (2016)	Transport & Communication (T&C), Education, Health, Housing, Social Welfare, Defense, Economic Services, General Public Services, Recreation	Pooled Mean Group (PMG) estimator	Panel of 17 OECD countries, Annual, 1972–2008	T&C:0.022**, Educ:0.020**, Health:0.001, Housing:0.009, Soc.Welfare:-0.001, Defense:-0.001, Econ.Serv.:-0.005, Gen.Pub.Serv.:-0.005**, Recreation:-0.005 [7]	No
Perotti (2014)	Defense	EVAR, Ramey (2011b) defense news narrative	US: Quarterly, 1947–2008	(cumulative, 8 quarters) 0.18	No

Continued on next page

Table 2.2 – continued

Study	Government Spending Component	Method	Data	Output Multipliers	State-Dependence
Ramey (2011b)	Defense	VAR using shocks to the expected present discounted value of government spending caused by military events, based on narrative evidence	US: Quarterly, 1939–2008 and subsamples	(cumulative, 20 quarters) 0.6 to 1.2, depending on sample	No
Ramey & Zubairy (2018)	Defense	Local Projections, Ramey & Zubairy (2018) military news narrative	US:, Quarterly, 1889q12015q4	(cumulative, 4 years) 0.71	High Unemployment: 0.68, Low Unemployment:0.67
Zervas (2018)	Defence	SVAR, Identification: Blanchard & Perotti (2002)	US: Quarterly, 1960q1–2006q4	(mean) 0.18	No

[7]* (**) Significant at the 5% (1%) respectively.

Chapter 3

The Effects of Different Components of Government Spending: Evidence from the U.S.

3.1 Introduction

The recent financial crisis and ensuing recession have highlighted a crucial question about government spending: is government spending more effective under recessive states? Many recent papers try to answer this (Auerbach & Gorodnichenko, 2012b,b; Ramey & Zubairy, 2018; Riera-Crichton *et al.*, 2015), with most of them providing strong evidence that multipliers are stronger in recessions than in expansions.

In this chapter we estimate government spending multipliers that vary with the business cycle, for different components of spending. As we have already mentioned in Chapter 1, estimating such multipliers is very important and has many applications in the forming of fiscal policies. Indeed, government spending is often used as a stabilization tool in times of slack; especially when the interest rate is at the zero lower bound and monetary policy is ineffective. On the other hand, governments who want to put their fiscal in order are often forced to implement reductions in government spending. Under these circumstances, knowing how each part of government spending affects output would be extremely useful. When planning the stabilization policy, if one has to increase/decrease government spending, he can focus on the component which produces the maximum/minimum effect on growth, respectively. Therefore, the need to estimate separate multipliers for each government spending component is substantial.

We use the economic classification of government as suggested by IMF[1], in which government spending is classified according to its economic nature. More specifically, we use government expense on compensation of employees, government purchases of goods and services, government investment and government expense on social benefits. The dataset consists

[1]See IMF (2014) for a detailed discussion.

of quarterly data on U.S. for the period 1949:I-2017:III. We follow Auerbach & Gorodnichenko (2012b) and employ a Smooth Transition Vector Autoregressive Model (STVAR). This framework is based on the Smooth Transition Autoregressive (STAR) model, introduced by Granger & Teräsvirta (1993). These types of models assume two regimes, recession and expansion, while at the same time they allow for smooth transition between them. Typical two-regimes threshold autoregressive models use a dummy that takes on the value of one when a variable that works as a state indicator exceeds a certain threshold, and zero otherwise. However, the episodes of recession are usually few, which leads to limited realizations of recession, and in turn, biased results. Smooth transition models, on the other hand, instead of a dummy, incorporate the probability of being in a regime, given the state-indicator of the economy. This way we obtain a switching variable, who's job is weighing between the two regimes. Our specification assumes in addition, that the variance-covariance matrix of the disturbances is allowed to differ depending on the state of the economy. Such a framework is highly non-linear, therefore, we estimate the model using Monte Carlo Markov Chain methods, as suggested by Chernozhukov & Hong (2003).

Our work is mostly related to Auerbach & Gorodnichenko (2012b), who not only examine state-dependence, but also disaggregate government spending to consumption and investment. Apart from Auerbach & Gorodnichenko (2012b), our work is also closely related to Bermperoglou *et al.* (2012), Bermperoglou *et al.* (2017), Zervas (2018), Bouakez *et al.* (2018), Burgert & Gomes (2012), who break down government spending to wages, consumption (purchases of goods and services) and investment. In a DSGE context, this issue is addressed by Cortuk & Guler (2015). The effects of social benefits have also been examined by Furceri & Zdzienicka (2012) on a panel of OECD countries and Romer & Romer (2016) on U.S..

This chapter contributes to the existing literature by extending the work of Auerbach & Gorodnichenko (2012b). We do so in three ways: first of all, we adopt a finer level of disaggregation for government consumption, as we break it into expense on compensation of employees and purchase of goods and services. Secondly, we also provide estimates of the effects of social benefits on output, in recession and in expansion. Finally, Auerbach & Gorodnichenko (2012b)'s sample reaches up to 2008, but we use a larger sample which reaches up to 2017. Therefore, our sample includes the years of the recent recession. Our results are indeed different, as we find a higher multiplier for government investment.

Our results indicate a high level of heterogeneity among the components of government spending. More specifically, the multiplier of compensation of employees is higher than the rest of them (2.42); multiplier on goods and services is negative; multiplier on government investment is insignificant. Compensation of employees and government investment multipliers are higher in recessions than in expansions; however this is not the case for the expense on goods and services. Our results confirm the existence of state-dependence as in Auerbach & Gorodnichenko (2012b), even though we find a higher multiplier for investment in recession than them. Our results are also in accordance with other similar studies, (such as Bermperoglou *et al.* (2012), Bermperoglou *et al.* (2017), Zervas (2018), Cortuk & Guler (2015)).

The chapter is organized as follows. Section 3.2 describes the data and the methodology. Results are reported in Section 3.3, while Section 3.4 concludes.

3.2 Data and Methodology

3.2.1 Data

We have collected quarterly data for U.S., on total government spending (consumption plus investment), total government consumption, government expense on goods and services, government expense on compensation of employees, government investment, real Gross Domestic Product (GDP) and government current tax receipts. The time period we consider is 1949:I-2017:III. Note that we expand the dataset of Auerbach & Gorodnichenko (2012b), which covers the period 1947:I-2008:IV, by including the years of the recent recession. Our data source is the U.S. Bureau of Economic Analysis. A full list of our variables and their definitions can be found in Appendix 3.A.

3.2.2 Econometric specification

The specification is the following:

$$\mathbf{X}_t = (1 - F(z_{t-1}))\mathbf{\Pi}_E(L)\mathbf{X}_{t-1} + F(z_{t-1})\mathbf{\Pi}_R(L)\mathbf{X}_{t-1} + \mathbf{u}_t \tag{3.1}$$

$$\mathbf{u}_t \sim N(0, \mathbf{\Omega}_t) \tag{3.2}$$

$$\mathbf{\Omega}_t = \mathbf{\Omega}_E(1 - F(z_{t-1})) + \mathbf{\Omega}_R F(z_{t-1}) \tag{3.3}$$

$$F(z_t) = \frac{exp(-\gamma z_t)}{1 + exp(-\gamma z_t)} \tag{3.4}$$

$$var(z_t) = 1, E(z_t) = 0 \tag{3.5}$$

$\mathbf{X}_t$ is defined as $\mathbf{X}_t = [G_t\ T_t\ Y_t]'$, where G_t denotes log real government spending, T_t log real taxes, and Y_t is log real GDP in chained 2012 dollars. The choice of ordering agrees with Blanchard & Perotti (2002), who assume that shocks in tax revenues and output have no contemporaneous effect on government spending. G_t in our case is one of the components of government spending. This assumption is based on the idea that government spending is subject to certain decision and implementation lags, therefore it is affected by past information only. Unlike Auerbach & Gorodnichenko (2012b), who break government spending into consumption and investment only, we use a finer level of disaggregation for consumption; we break government consumption into two of its main components: compensation of government employees and government purchases of goods and services. We also estimate multipliers for government investment and social benefits. In order to make our results comparable to Auerbach & Gorodnichenko (2012b), we also report results on total government spending and total government consumption in Appendix 3.C.

The model allows for two regimes: expansion (E) and recession (R). $\mathbf{\Pi}_E(L)$ and $\mathbf{\Pi}_R(L)$ are lag polynomials for expansion and recession, respectively. The transition function, $F(z_t)$, is given by the logistic function and describes the probability of being in a recession, while z_t is an indicator of the state of the economy. Note that z_t enters the transition function with a lag, in order to avoid contemporaneous feedbacks from policy actions into the definition of the regime. We choose z_t to be the normalized 7-quarter moving average of output growth rate. With this choice we are allowed to use our full sample for estimation, which improves our estimates. In addition, setting z_t equal to the moving average of growth rate, allows the indicator of state to be affected by policy changes. In other words, we take into consideration that changes in government spending policy can alter the regime. In Appendix 3.D we report results from a robustness test in which the state variable z_t is defined as the 7-quarter moving average of the detrended GDP growth rate, where trend was computed with the Hodrick-Prescott filter. We find that the results do not change significantly. Finally, stability tests in Appendix 3.E, indicate that the model under recession is unstable, for some of the components.

The parameter γ shows the smoothness of the transition between regimes. For $\gamma = 0$ the model becomes linear, i.e. STVAR nests the linear case. When $\gamma \to \infty$ the model approaches the switching regression model with two regimes that have equal variances. As in Auerbach & Gorodnichenko (2012b), we set parameter $\gamma = 1.5$, which means that the economy spends about 20 percent of time in a recessionary regime.[2] Equation 3.3 implies that the variance-covariance matrix of the disturbances, $\mathbf{\Omega}$, is also state-dependent, with $\mathbf{\Omega}_E$ and $\mathbf{\Omega}_R$ denoting the respective matrices in recession and expansion. Although omitting this assumption would make the specification a lot simpler, we keep it as we believe that in reality it is far more possible that the behavior of the disturbances differs among regimes.

3.2.3 Estimation Procedure

The problem is defined as follows. The Log-likelihood is:

$$log\mathcal{L} = const - \frac{1}{2}\sum_{t=1}^{T} log|\mathbf{\Omega}_t| - \frac{1}{2}\sum_{t=1}^{T} \mathbf{u}_t'\mathbf{\Omega}_t^{-1}\mathbf{u}_t \tag{3.6}$$

where:

$$\mathbf{u}_t = \mathbf{X}_t - (1 - F(z_{t-1}))\mathbf{\Pi}_E(L)\mathbf{X}_{t-1} - F(z_{t-1})\mathbf{\Pi}_R(L)\mathbf{X}_{t-1}$$

The model is highly non-linear and it has a lot of parameters, $\Psi = \{\gamma, \mathbf{\Omega}_E, \mathbf{\Omega}_R, \mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)\}$, therefore, standard optimization techniques cannot be implemented. For that matter we follow the following estimation procedure.

[2] Auerbach & Gorodnichenko (2012b) find this value after calibrating γ to U.S. data. They define the economy to be in a recession if $F(z_t) > 0.8$, and they set γ so that the economy spends about 20% in recession.

First, it should be noted that, for given $\{\gamma, \mathbf{\Omega}_E, \mathbf{\Omega}_R\}$, the model is linear in lag polynomials $\{\mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)\}$. Therefore, if we make a guess on $\{\gamma, \mathbf{\Omega}_E, \mathbf{\Omega}_R\}$, we can estimate $\{\mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)\}$ using weighted least squares, where weights are given by $\mathbf{\Omega}_t^{-1}$, and estimates of $\{\mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)\}$ must minimize $\frac{1}{2}\sum_{t=1}^{T} \mathbf{u}_t'\mathbf{\Omega}_t^{-1}\mathbf{u}_t$.

The extended vector of regressors is:

$$\mathbf{W}_t = [(1 - F(z_{t-1}))\mathbf{X}_{t-1} \quad F(z_{t-1})\mathbf{X}_{t-1} \ \ldots \ (1 - F(z_{t-p}))\mathbf{X}_{t-1} \quad F(z_{t-1})\mathbf{X}_{t-p}]$$

and $\mathbf{\Pi} = [\mathbf{\Pi}_E \quad \mathbf{\Pi}_R]$, so that $\mathbf{u}_t = \mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t'$ and the objective function is given by:

$$\frac{1}{2}\sum_{t=1}^{T}(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t')'\mathbf{\Omega}_t(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t') \tag{3.7}$$

Equation 3.7 can be rewritten as:

$$\begin{aligned}
&\frac{1}{2}\sum_{t=1}^{T}(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t')'\mathbf{\Omega}_t(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t') \\
&= trace[\frac{1}{2}\sum_{t=1}^{T}(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t')'\mathbf{\Omega}_t(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t')] \\
&= \frac{1}{2}\sum_{t=1}^{T} trace[(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t')'(\mathbf{X}_t - \mathbf{\Pi}\mathbf{W}_t')\mathbf{\Omega}_t]
\end{aligned}$$

The first order condition with respect to $\mathbf{\Pi}$ is:

$$\frac{1}{2}\sum_{t=1}^{T}(\mathbf{W}_t'\mathbf{X}_t\mathbf{\Omega}_t^{-1} - \mathbf{W}_t'\mathbf{W}_t\mathbf{\Pi}'\mathbf{\Omega}_\mathbf{t}^{-\mathbf{1}}) = 0$$

Using the vec operator, yields:

$$\begin{aligned}
vec(\frac{1}{2}\sum_{t=1}^{T}\mathbf{W}_t'\mathbf{X}_t\mathbf{\Omega}_t^{-1}) &= vec(\frac{1}{2}\sum_{t=1}^{T}\mathbf{W}_t'\mathbf{W}_t\mathbf{\Pi}'\mathbf{\Omega}_\mathbf{t}^{-\mathbf{1}}) \\
&= \frac{1}{2}\sum_{t=1}^{T} vec(\mathbf{W}_t'\mathbf{W}_t\mathbf{\Pi}'\mathbf{\Omega}_\mathbf{t}^{-\mathbf{1}}) \\
&= \frac{1}{2}\sum_{t=1}^{T}[vec\mathbf{\Pi}'][\mathbf{\Omega}_t^{-1} \otimes \mathbf{W}_t\mathbf{W}_t'] \\
&= [vec\mathbf{\Pi}']\frac{1}{2}\sum_{t=1}^{T}[\mathbf{\Omega}_t^{-1} \otimes \mathbf{W}_t\mathbf{W}_t']
\end{aligned}$$

and, finally:

$$vec\mathbf{\Pi}' = (\frac{1}{2}\sum_{t=1}^{T}[\mathbf{\Omega}_t^{-1} \otimes \mathbf{W}_t\mathbf{W}_t'])^{-1}vec(\frac{1}{2}\sum_{t=1}^{T}\mathbf{W}_t'\mathbf{X}_t\mathbf{\Omega}_t^{-1}) \tag{3.8}$$

Then, we perform an iteration on $\{\gamma, \mathbf{\Omega}_E, \mathbf{\Omega}_R\}$ (which yields Π and the likelihood) until we find an optimum. Note that if the error term was homoskedastic ($\mathbf{\Omega}_t = const$), i.e. Ω_t was not state-dependent, then the estimates we would get, would be the standard VAR estimates.

However, the model is highly non-linear in parameters and there could be more than one local optima. Therefore, we must try different starting values for $\gamma, \mathbf{\Omega}_E, \mathbf{\Omega}_R$. In order to ensure that $\mathbf{\Omega}_E$ and, $\mathbf{\Omega}_R$ are positive definite, we use $\Psi = \{\gamma, chol(\mathbf{\Omega}_E), chol(\mathbf{\Omega}_R), \mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)\}$, where chol denotes Cholesky decomposition. Another issue that arises due to the non-linearity of the problem is the difficulty to construct confidence intervals for parameter estimates and impulse responses. For that matter, we follow Auerbach & Gorodnichenko (2012b) and employ the Monte Carlo Markov Chain method suggested by Chernozhukov & Hong (2003). This way we obtain a global optimum, as well as distributions of parameter estimates. This procedure is described in detail in Appendix 3.B.

Finally, it should be noted that during the construction of impulse responses to government spending shocks in a given regime, we initially ignore any feedback from changes in z into the dynamics of output. Essentially, we assume that the system can stay for a long time in a regime. The advantage of this approach is that, once a regime is fixed, the model is linear and hence impulse responses are not functions of history (see Koop *et al.* (1996)).

3.3 Results

Figures 3.1-3.3 and Table 3.1 present our main results. Figure 3.1 suggests that the response of taxes and output to a shock to government expense on compensation of employees, in the linear specification, is zero on impact, but becomes positive as time goes by. Output multiplier reaches up to 5.21 (Table 3.1). Taxes' response is negative in expansion, whereas in recession, their response is negative at first, but becomes positive after a few quarters. Output's reaction in recession, is zero at first, but then becomes positive and reaches up to 4.94, 20 quarters after the shock (Table 3.1). Cumulative multipliers in Table 3.1 also suggest that in the linear model and in recession the results are very close (2.42 and 2.41, respectively), although the multiplier is insignificant in expansion. These results agree with previous studies on government wage multipliers (Bermperoglou *et al.*, 2012, 2017; Bouakez *et al.*, 2018; Burgert & Gomes, 2012; Zervas, 2018), and with Auerbach & Gorodnichenko (2012b), who show that government consumption multiplier is higher in recessions[3]. The latter is not a surprising result, though, since compensation of employees is the biggest part of government consumption.

[3] Auerbach & Gorodnichenko (2012b)'s cumulative multipliers for consumption are: linear:1.20, expansion: -0.25, recession: 1.47.

When government spending is defined as government purchases of goods and services, results are somewhat different. In the linear model (Figure 3.2), taxes response is negative but very close to zero, while output multiplier is zero at first and becomes negative after 5 quarters. Table 3.1 suggests that the overall change (in 20 quarters) is negative and equal to -2.02. This outcome contradicts Bouakez *et al.* (2018) and Bermperoglou *et al.* (2012), who find a positive multiplier for government purchases of goods and services. Burgert & Gomes (2012), however, do find a negative result equal to -0.12 in the long-run. In the non-linear model, taxes are negative in expansion and positive in recession, in the beginning, but they both become insignificant after a few quarters. Output multipliers in expansion are positive, but small, reaching 0.30, while the cumulative multiplier is 0.43. On the contrary, in recession, output multiplier is only significant on impact, and equal to 0.72. The overall effect as described by the cumulative multiplier, is insignificant. These results disagree with Auerbach & Gorodnichenko (2012b)'s non-linear multipliers for government consumption, but as we said before, government consumption consists mainly of compensation of government employees, and government purchases on goods and services is only a small part of it.

A shock that increases government investment, on the other hand, decreases taxes in the linear specification during the first quarters, but the effect diminishes as we move in time. Output's response is positive at first, but becomes negative after 5 quarters.[4] Its maximum value is 1.33 and it occurs on impact, while the overall effect is insignificant (Table 3.1). Bermperoglou *et al.* (2012), Burgert & Gomes (2012), and Zervas (2018) also find a government investment multiplier between 1-2. Taxes increase in recession and decrease in expansion, but the response of output is positive in both cases. In expansion, the output multiplier reaches up to 1.32, while the cumulative multiplier is 0.87. In recession, though, the multiplier is significantly higher; it reaches up to 5.01, while the overall effect reaches up to 7.68. In both regimes, the positive effect on output seems to be increasing over time, implying that the benefits of government investment accrue in the future, as it takes time for the stock of government capital to accumulate. Comparing our results to those of Auerbach & Gorodnichenko (2012b), we see that they do not match; our multiplier is smaller than theirs in the linear case and in expansion, but higher in recession[5]. These differences probably occur because our sample includes the Great Recession period, while Auerbach & Gorodnichenko (2012b)'s sample stops at 2008.

Distinguishing between tax-financed and deficit-financed shocks is beyond the scope of this study. We are only able to see the response of taxes to a 1% government spending shock. In all of the cases, the increase in government spending is smaller than the increase in government spending, which means that the increase in government spending is partially deficit-financed. In addition, changes in taxes may also be caused by changes in output. We notice that, in most of the cases, taxes move in the same way as output; a behavior that is consistent with the automatic

[4]Note that this pattern is similar to the pattern observed in the outcome of the OECD sample in Figure 4.3.

[5]Auerbach & Gorodnichenko (2012b)'s cumulative multipliers for investment are: linear:2.39, expansion: 2.27, recession: 3.42.

responses of tax collections to changes in output.

To sum up, we have seen that compensation of employees has the biggest cumulative linear output multiplier of all spending components. Government investment has a positive multiplier on impact but an insignificant overall effect, and the overall effect of the expense on goods and services seems to be negative. This outcome was also reported by Bermperoglou *et al.* (2012), Zervas (2018), Burgert & Gomes (2012), as well as, Perotti (2004c) who was the first to show that shocks to government consumption have larger cumulative effects on output than shocks to government investment.

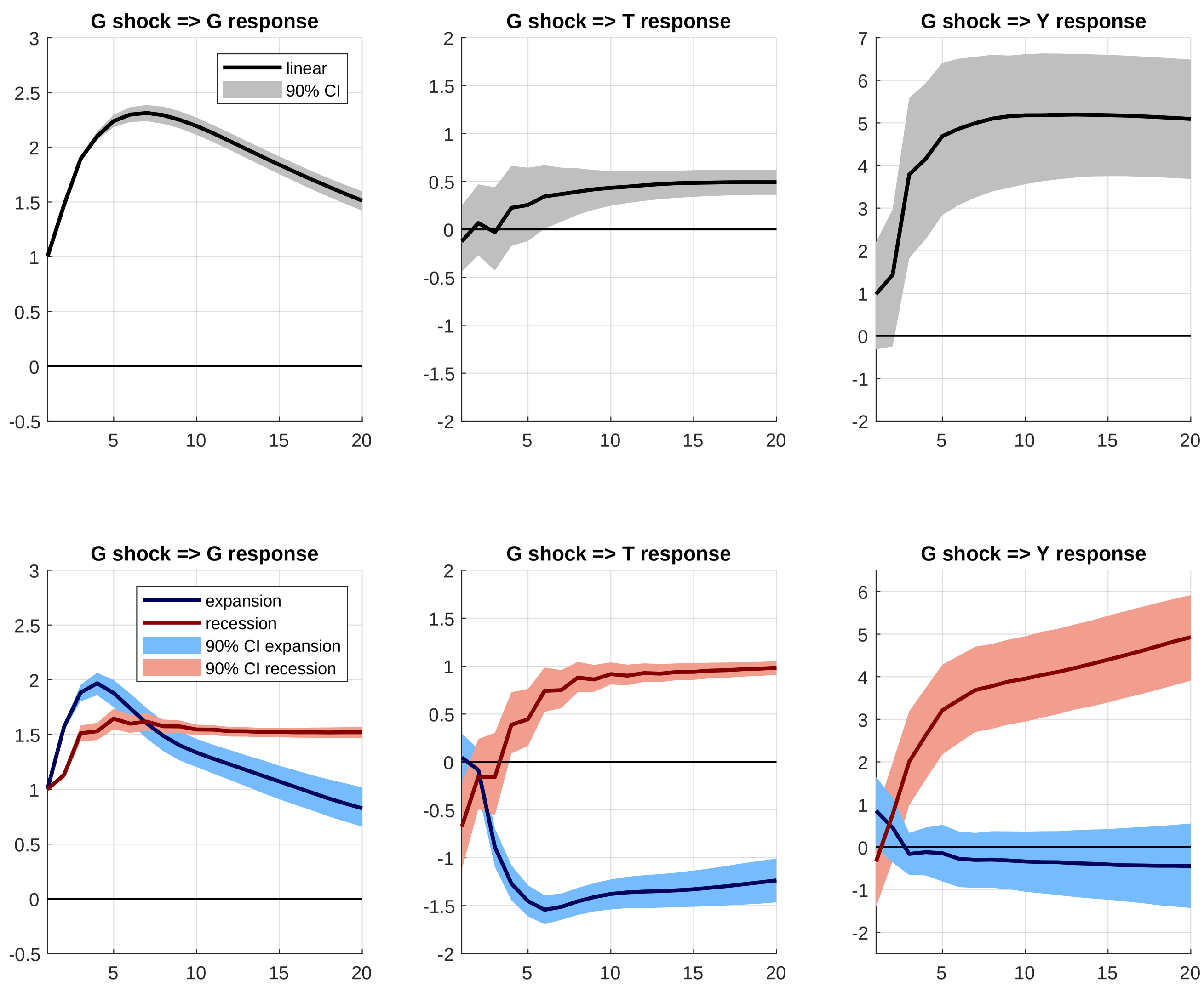
An explanation to these results is provided by theoretical models, such as Bermperoglou *et al.* (2012, 2017) and Cortuk & Guler (2015). First of all, purchases of goods and services is the type of spending that is only meant for consumption purposes and is neither utility-enhancing, nor productive. Therefore, the fact that the compensation of employees multiplier and the government investment multiplier are higher than the expense on goods and services multiplier is not surprising. However, the fact that the compensation of employees multiplier is higher than government investment is rather counterintuitive, as we would expect that the "productive" component of government spending, i.e. government investment, would be the one producing the biggest effect on output. The truth is that both compensation of employees and government investment, participate in the productive operations of the government. Government production increases the productivity of private sector, leading to higher growth. However, government expense on compensation of employees has a higher multiplier than government investment, because it increases output through an additional channel. Increasing the government expense on compensation of employees creates a positive wealth effect for households, who spend their extra income on both consumption and investment, enhancing the positive effect on output even more. It should be noted however, that this result occurs only in the linear case. In recession, government investment has a higher cumulative effect than compensation of employees, implying that in a recessive state, the "productive" channel is stronger than the "wealth" channel.

Finally, in Figure 3.4 and Table 3.1 we report output multipliers for social benefits. Although we know that social benefits contain a cyclical component and are essentially automatic stabilizers, we believe that estimating these multipliers will provide an answer to the question of how changes in social benefits affect output. In Table 3.1 we can see that the linear multiplier peaks at 0.99. This result is very close to Furceri & Zdzienicka (2012) who find social benefits multiplier equal to 0.6. We also document a higher multiplier in recession than in expansion (1.22 and 0.39, respectively), again in accordance with Furceri & Zdzienicka (2012). Cumulative multipliers are consistent with the above estimates (linear:2.04, expansion:0.33, and recession: 1.94).

3.4 Conclusions

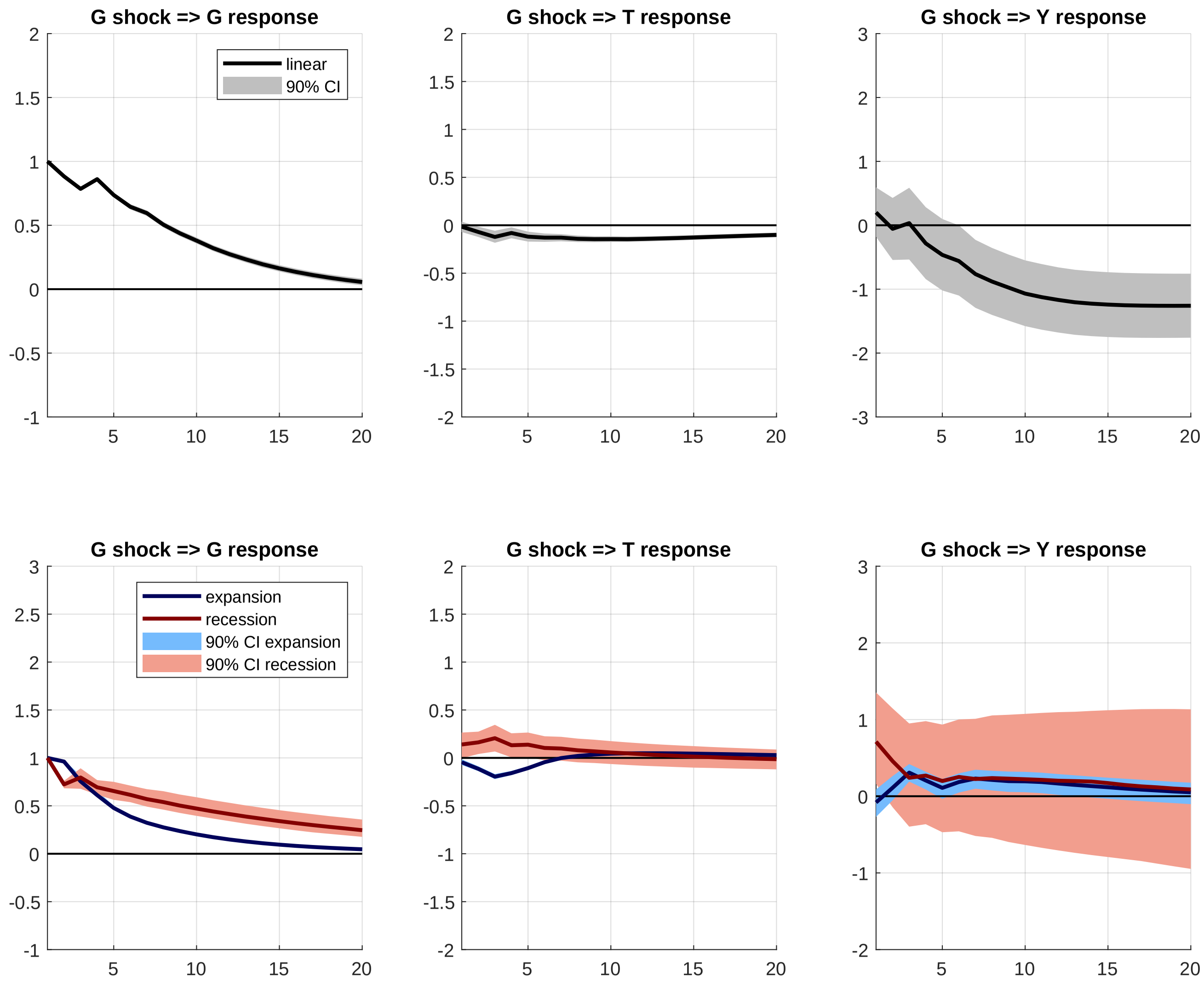
In this chapter, we have examined the effect of components of government spending on output over the business cycle, using the STVAR model as proposed by Auerbach & Gorodnichenko (2012b). We contribute to the literature by expanding their dataset up to 2017, in order to include the recent financial crisis. More specifically, we used U.S. quarterly data, on the period 1949:I-2017:III. The horizon we use is 20 quarters after the shock. We also used a finer disaggregation level than Auerbach & Gorodnichenko (2012b), that is we consider three different components of spending: government expense on compensation of employees, government expense on goods and services and government investment. Our results show that different components produce indeed different multipliers. In particular, cumulative multiplier on expense on compensation of employees is higher than the rest of them and around 2.42; cumulative multiplier on goods and services is negative; multiplier on government investment is around 1.32 in the early years and zero afterwards, while the overall effect of government investment is insignificant. Compensation of employees and government investment multipliers are higher in recession than in expansions; however this is not the case for the expense on goods and services. Finally, we also estimate the effects of social benefits on output. We find a multiplier that peaks at 0.99 and a cumulative multiplier equal to 2.04. Our results are in accordance with the literature in the majority of the cases.

Figure 3.1: Responses to a shock to Compensation of Government Employees for the U.S.



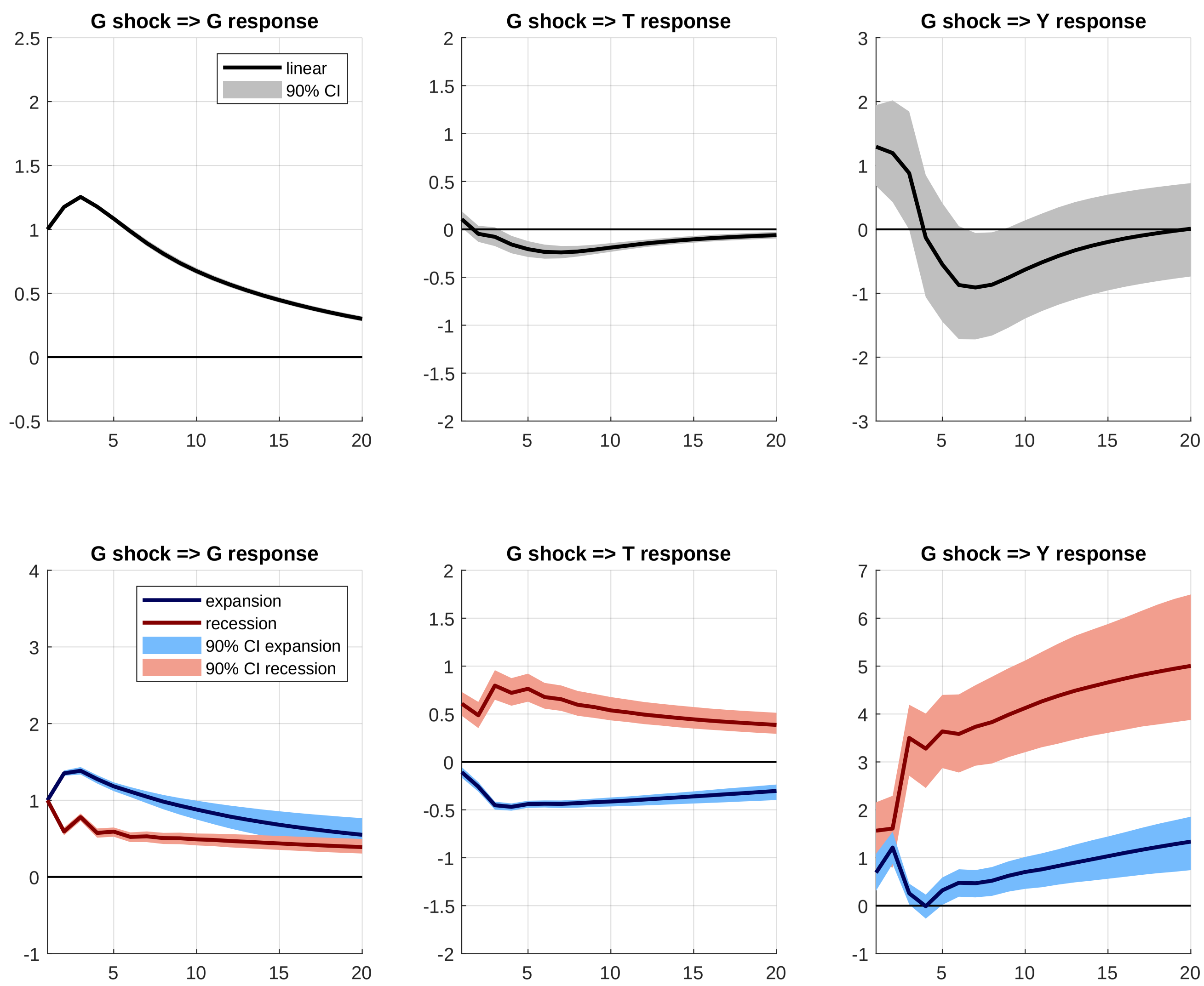
Notes: Figure 3.1 reports the effects of a shock which raises the compensation of government employees by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending).

Figure 3.2: Responses to a shock to Government Purchases of Goods and Services for the U.S.



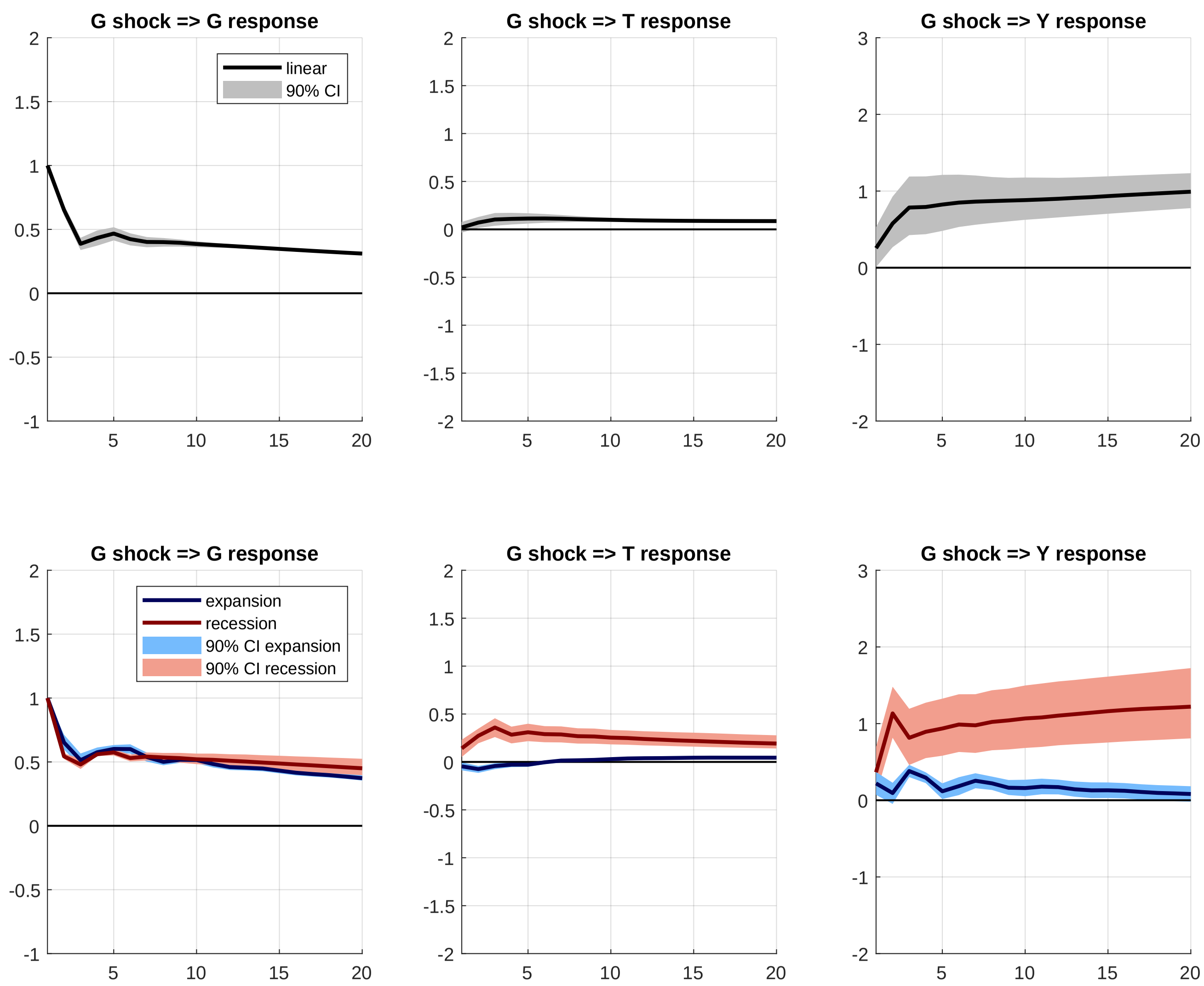
Notes: Figure 3.2 reports the effects of a shock which raises the government spending on gooda and services by 1%. The horizon is in quarters after the shock. (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending).

Figure 3.3: Responses to a shock to Government Investment for the U.S.



Notes: Figure 3.3 reports the effects of a shock which raises government investment by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending).

Figure 3.4: Responses to a shock to Social Benefits for the U.S.



Notes: Figure 3.4 reports the effects of a shock which raises social benefits by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending).

Table 3.1: Output Multipliers for the U.S.

	Max	Cumulative
Compensation of Employees		
Linear	5.21***	2.42***
	(0.92)	(0.81)
Expansion	0.81	-0.19
	(0.50)	(0.45)
Recession	4.94***	2.41***
	(0.63)	(0.59)
Goods and Services		
Linear	0.20	-2.02***
	(0.23)	(0.26)
Expansion	0.30***	0.43***
	(0.08)	(0.09)
Recession	0.72*	0.42
	(0.38)	(0.53)
Investment		
Linear	1.33***	-0.20
	(0.40)	(0.48)
Expansion	1.32***	0.87***
	(0.28)	(0.22)
Recession	5.01***	7.68***
	(0.81)	(0.57)
Social Benefits		
Linear	0.99***	2.04***
	(0.15)	(0.17)
Expansion	0.39***	0.33***
	(0.05)	(0.06)
Recession	1.22***	1.94***
	(0.28)	(0.26)

Notes: Table 3.1 presents output multipliers, i.e. estimates that have been multiplied ex-post by the mean of Y/G. They describe the effect on output of an $1 increase in the respective component of government spending. The first column presents the maximum response of output to a shock, $max_{h=1,...,20}Y_h$, while the second column presents cumulative multipliers, calculated as: $\sum_{h=20}^{h} Y_h / \sum_{h=20}^{h} G_h$. Standard errors are reported in parentheses, while asterisks *, ** and ***, denote significance at the 10%, 5% and 1% level, respectively.

Appendix 3.A Data Description

Table 3A.1: Data Description

Variable	Definition	Source
Total Government Spending	Government Consumption Expenditures and Gross Investment	U.S. Bureau of Economic Analysis (NIPA Table 3.9.5)
Government Consumption	Government consumption expenditures	U.S. Bureau of Economic Analysis (NIPA Table 3.9.5)
Government Investment	Gross government investment	U.S. Bureau of Economic Analysis (NIPA Table 3.9.5)
Government Expense on Compensation of Employees	Government consumption expenditures: Gross output of general government: Value added: Compensation of general government employees	U.S. Bureau of Economic Analysis (NIPA Table 3.10.5)
Government Expense on Goods and Services	Government consumption expenditures: Gross output of general government: Intermediate goods and services purchased	U.S. Bureau of Economic Analysis (NIPA Table 3.10.5)
Government Expense on Social Benefits	Personal current transfer receipts: Government social benefits to persons	U.S. Bureau of Economic Analysis (NIPA Table 3.1)
GDP	Real Gross Domestic Product in Chained 2012 Dollars	U.S. Bureau of Economic Analysis (NIPA Table 1.1.6)
Deflator	Gross Domestic Product: Chain-type Price Index (Index 2012=100)	U.S. Bureau of Economic Analysis (NIPA Table 1.1.4)
Taxes	Government current tax receipts	U.S. Bureau of Economic Analysis (NIPA Table 3.1)

Appendix 3.B Estimation Procedure

In order to follow Chernozhukov & Hong (2003)'s estimation method we use the Hastings-Metropolis algorithm. Chains of length N are constructed according to the following procedure:

Step 1: Draw $\mathbf{\Theta}^{(n)}$, a candidate vector of parameter values for the chains $n+1$ state, as $\mathbf{\Theta}^{(n)} = \mathbf{\Psi}^{(n)} + \psi^{(n)}$ where $\mathbf{\Psi}^{(n)}$ is the current n state of the vector of parameter values in the chain, $\psi^{(n)}$ is a vector of i.i.d. shocks taken from $N(\mathbf{0}, \mathbf{\Omega_\Psi})$, and $\mathbf{\Omega_\Psi}$ is a diagonal matrix.

Step 2: Take the $n+1$ state of chain as:

$$\mathbf{\Psi}^{(n+1)} = \begin{cases} \mathbf{\Theta}^{(n)} \texttt{ with probability min } \{1, exp[log\mathcal{L}(\mathbf{\Theta}^{(n)}) - log\mathcal{L}(\mathbf{\Psi}^{(n)})]\} \\ \mathbf{\Psi}^{(n)} \texttt{ otherwise} \end{cases}$$

where $log\mathcal{L}(\mathbf{\Theta}^{(n)})$ is the value of the objective function at the current state of the chain and $log\mathcal{L}(\mathbf{\Psi}^{(n)})$ is the value of the objective function using the candidate vector of parameter values.

The starting value of $\mathbf{\Psi}^{(0)}$ is computed according to the following procedure. First, the model described in equations 3.1-3.5 can be written as regressing $\mathbf{X}_t$ on lags of $\mathbf{X}_t, \mathbf{X}_t Z_t, \mathbf{X}_t Z_t^2$. Using the residuals from this equation we fit Equation 3.3 using MLE in order to estimate $\mathbf{\Omega}_E$ and $\mathbf{\Omega}_R$. These estimates are the starting values. Starting values for lag polynomials $\mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)$ are also computed using the starting values of $\mathbf{\Omega}_E$ and $\mathbf{\Omega}_R$ and Equation 3.8, exploiting the fact that the model is linear in $\mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)$. The starting value of $\mathbf{\Omega_\Psi}$ is set to about one percent of the parameter value and then adjusted on the fly for the first 20,000 draws to generate 0.3 acceptance rates of candidate draws. We use 100,000 draws for our baseline and robustness estimates, and drop the first 20,000 draws (burn-in period).

According to Chernozhukov & Hong (2003) $\bar{\mathbf{\Psi}} = (\frac{1}{N}) \sum_{n=1}^{N} \mathbf{\Psi}^{(n)}$ is a consistent estimate of $\mathbf{\Psi}$ under standard regularity assumptions of maximum likelihood estimators. In addition, the covariance matrix of the estimate of $\mathbf{\Psi}$ is given by $\mathbf{V} = (\frac{1}{N}) \sum_{n=1}^{N} (\mathbf{\Psi}^{(n)} - \bar{\mathbf{\Psi}})^2$ that is the variance of the estimates in the generated chain.

Finally, impulse responses are also computed using the generated chain of parameter values $\{\mathbf{\Psi}^{(n)}\}_{n+1}^{N}$. More precisely, we make 1,000 draws (with replacement) from $\{\mathbf{\Psi}^{(n)}\}_{n+1}^{N}$ and for each draw we calculate an impulse response. Since columns of $chol(\mathbf{\Omega}_E)$ and $chol(\mathbf{\Omega}_R)$ in $\{\mathbf{\Psi}^{(n)}\}_{n+1}^{N}$ are identified up to sign, the generated chains for $chol(\mathbf{\Omega}_E)$ and $chol(\mathbf{\Omega}_R)$ can change signs. This change of signs may not a problem for estimation, but it can sometimes create a problem for the analysis of impulse responses. For instance, when there is a change of signs for the entries of $chol(\mathbf{\Omega}_E)$ and $chol(\mathbf{\Omega}_R)$ that correspond to the variance of government spending shocks, these entries can be very close to zero. Since we compute responses to a unit shock in government spending, we have to divide entries of $chol(\mathbf{\Omega}_E)$ and $chol(\mathbf{\Omega}_R)$ that correspond to the government spending shock by the standard deviation of the government spending shock. This, however, may produce wide confidence intervals. To overcome this, when constructing impulse responses, we draw $\mathbf{\Pi}_E(L), \mathbf{\Pi}_R(L)$ directly from $\{\mathbf{\Psi}^{(n)}\}_{n+1}^N$ while the covariance matrix of residuals in regime s is drawn from $N(\,vec(\,\mathbf{\Omega}_s)\,, \mathbf{\Sigma}_s)$ where:

$$\mathbf{\Sigma}_s = 2[\,(\,\mathbf{D}_n'\mathbf{D}_n)^{-1}\mathbf{D}_n]\{var(\,vec(\,\mathbf{\Omega}_s)\,)\otimes var(\,vec(\,\mathbf{\Omega}_s)\,)\,\}$$

$\mathbf{D}_n$ is the duplication matrix, and $var(\,vec(\,\mathbf{\Omega}_s)\,)$ is computed from $\{\mathbf{\Psi}^{(n)}\}_{n+1}^N$. The 90 percent confidence bands are computed as the fifth and 95th percentiles of the generated impulse responses.

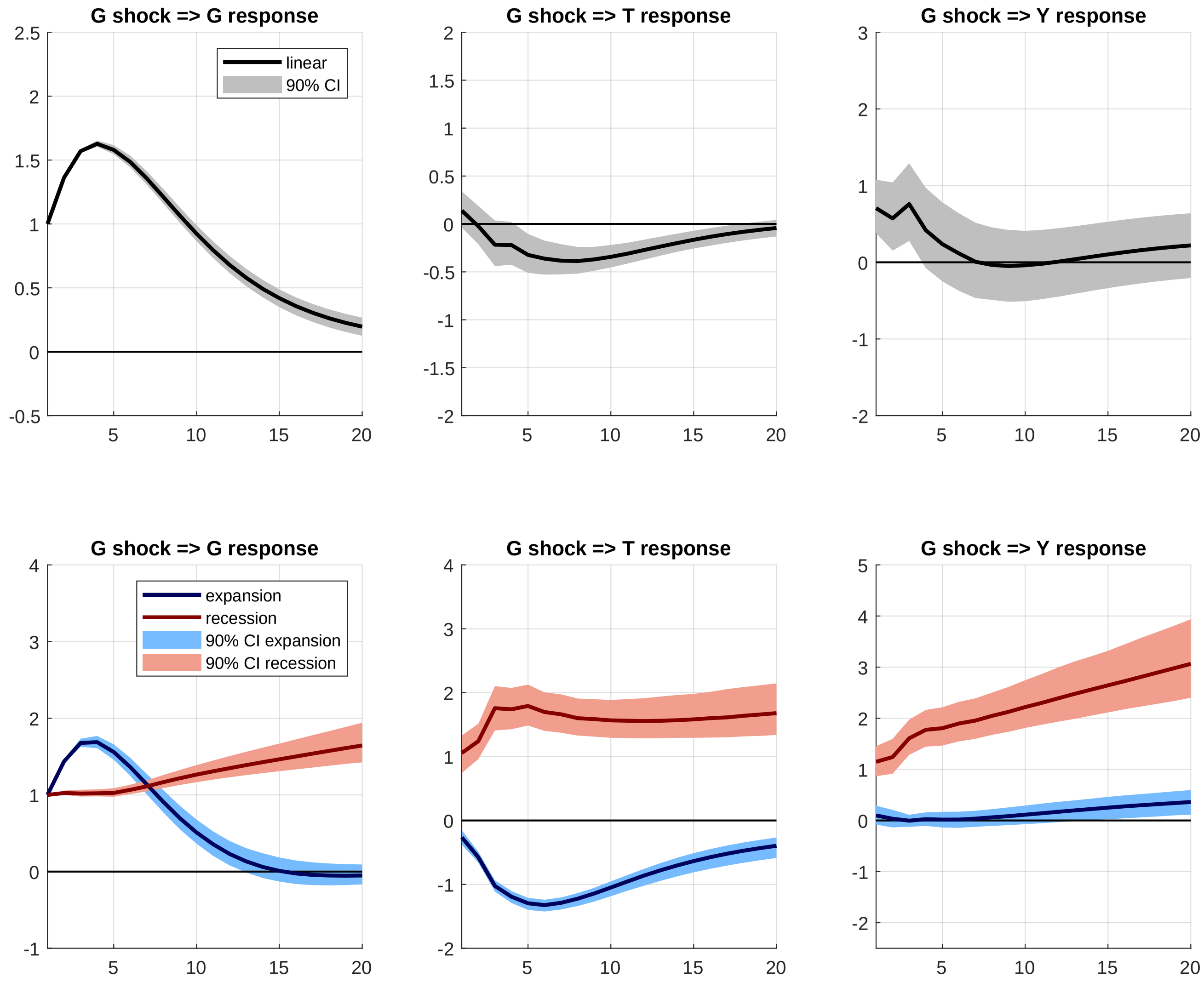
Appendix 3.C Additional Results

Table 3C.1: Output Multipliers for the U.S.

	Max	Cumulative
Total Spending		
Linear	0.75***	0.22
	(0.26)	(0.25)
Expansion	0.36**	0.25**
	(0.14)	(0.11)
Recession	3.06***	1.74***
	(0.50)	(0.31)
Government Consumption		
Linear	0.53*	0.11
	(0.32)	(0.32)
Expansion	0.25*	0.25**
	(0.13)	(0.11)
Recession	1.09***	0.83***
	(0.35)	(0.31)

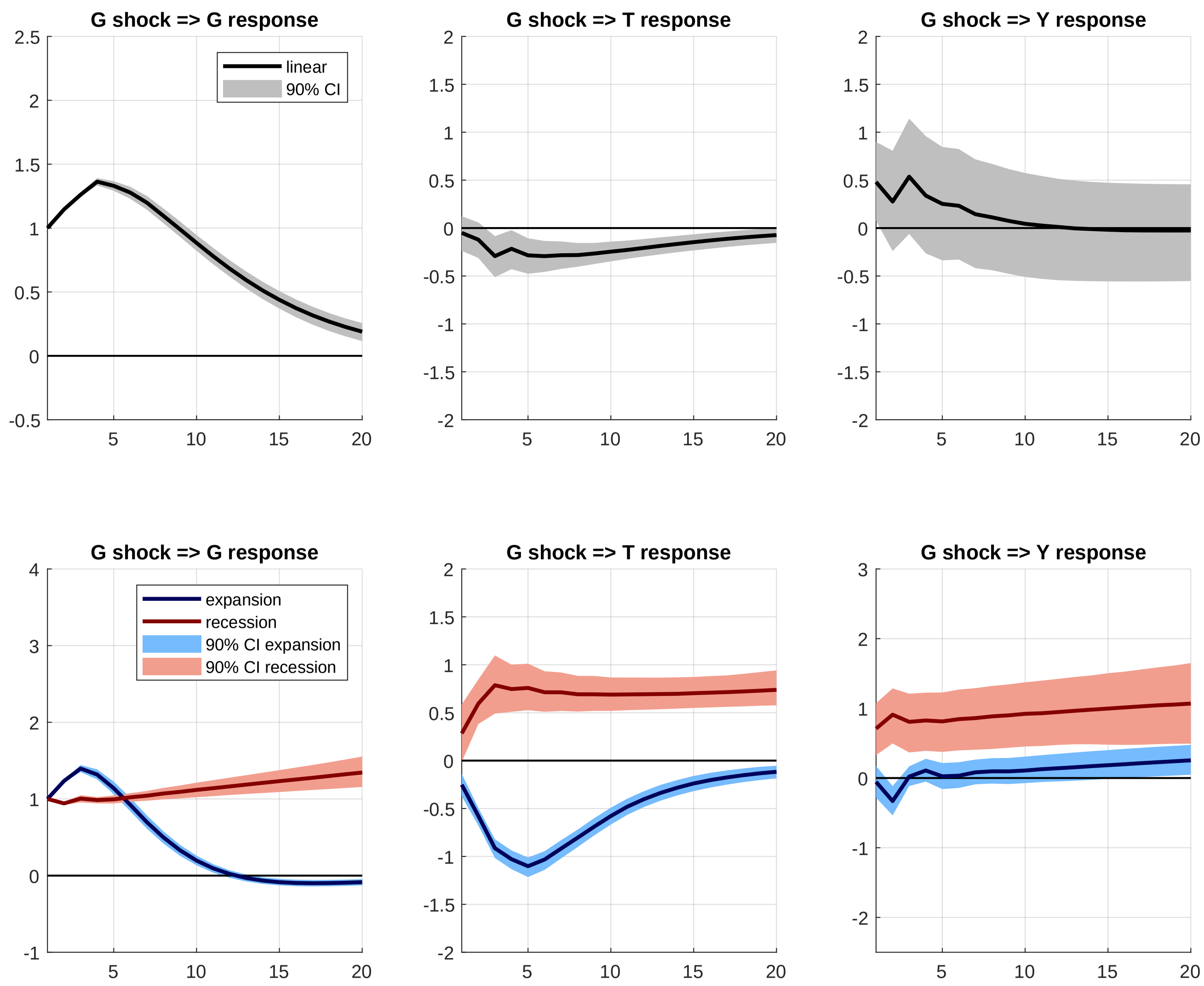
Notes: Table 3C.1 presents output multipliers, i.e. estimates that have been multiplied ex-post by the mean of Y/G. They describe the effect on output of an $1 increase in government spending. The first column presents the maximum response of output to a shock to the relevant government spending component, $max_{h=1,...,20}Y_h$, while the second column presents cumulative multipliers, calculated as: $\sum_{h=20}^{h} Y_h / \sum_{h=20}^{h} G_h$. Standard errors are reported in parentheses, while asterisks *, ** and ***, denote significance at the 10%, 5% and 1% level, respectively.

Figure 3C.1: Responses to a shock to Total Government Spending for the U.S.



Notes: Figure 3C.1 reports the effects of a shock which raises the total government spending by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G).

Figure 3C.2: Responses to a shock to Government Consumption for the U.S.



Notes: Figure 3C.2 reports the effects of a shock which raises the government consumption by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G).

Appendix 3.D Robustness Analysis

Table 3D.1: Output Multipliers for the U.S. (Robustness)

	Max	Cumulative
Compensation of Employees		
Linear	5.28***	2.44***
	(0.9)	(0.49)
Expansion	1.17**	-3.2***
	(0.49)	(0.49)
Recession	7.01***	4.37***
	(0.47)	(0.56)
Goods and Services		
Linear	0.20	-1.98***
	(0.23)	(0.28)
Expansion	0.17*	-2.04***
	(0.09)	(0.1)
Recession	0.26	-1.51***
	(0.27)	(0.39)
Investment		
Linear	1.32***	-0.23
	(0.4)	(0.5)
Expansion	1.66***	0.78***
	(0.23)	(0.27)
Recession	5.26***	9.28***
	(0.6)	(0.53)
Social Benefits		
Linear	1.00***	2.03***
	(0.15)	(0.17)
Expansion	0.37***	-0.06
	(0.06)	(0.07)
Recession	1.56***	2.40***
	(0.28)	(0.23)

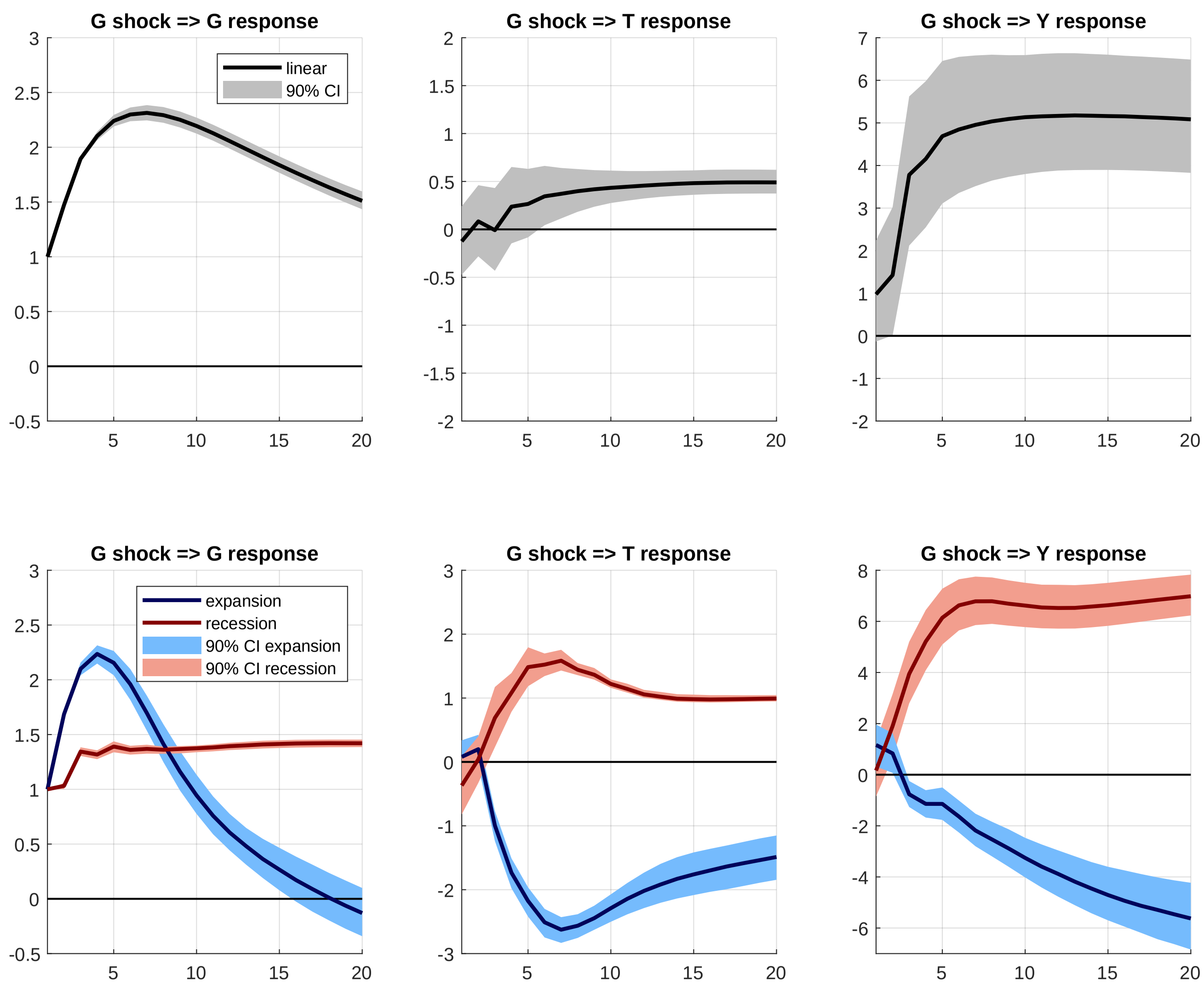
Notes: Table 3D.1 presents output multipliers, i.e. estimates that have been multiplied ex-post by the mean of Y/G. They describe the effect on output of an $1 increase in the respective component of government spending. The first column presents the maximum response of output to a shock, $max_{h=1,...,20}Y_h$, while the second column presents cumulative multipliers, calculated as: $\sum_{h=20}^{h} Y_h / \sum_{h=20}^{h} G_h$. Standard errors are reported in parentheses, while asterisks *, ** and ***, denote significance at the 10%, 5% and 1% level, respectively. Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Table 3D.3: Output Multipliers for the U.S. (Robustness)

	Max	Cumulative
Total Spending		
Linear	0.75***	0.19
	(0.25)	(0.24)
Expansion	0.18	-1.01***
	(0.14)	(0.19)
Recession	2.70***	2.19***
	(0.25)	(0.26)
Government Consumption		
Linear	0.53*	0.11
	(0.32)	(0.33)
Expansion	-0.11	-5.99***
	(0.14)	(0.22)
Recession	1.53***	1.15***
	(0.31)	(0.24)

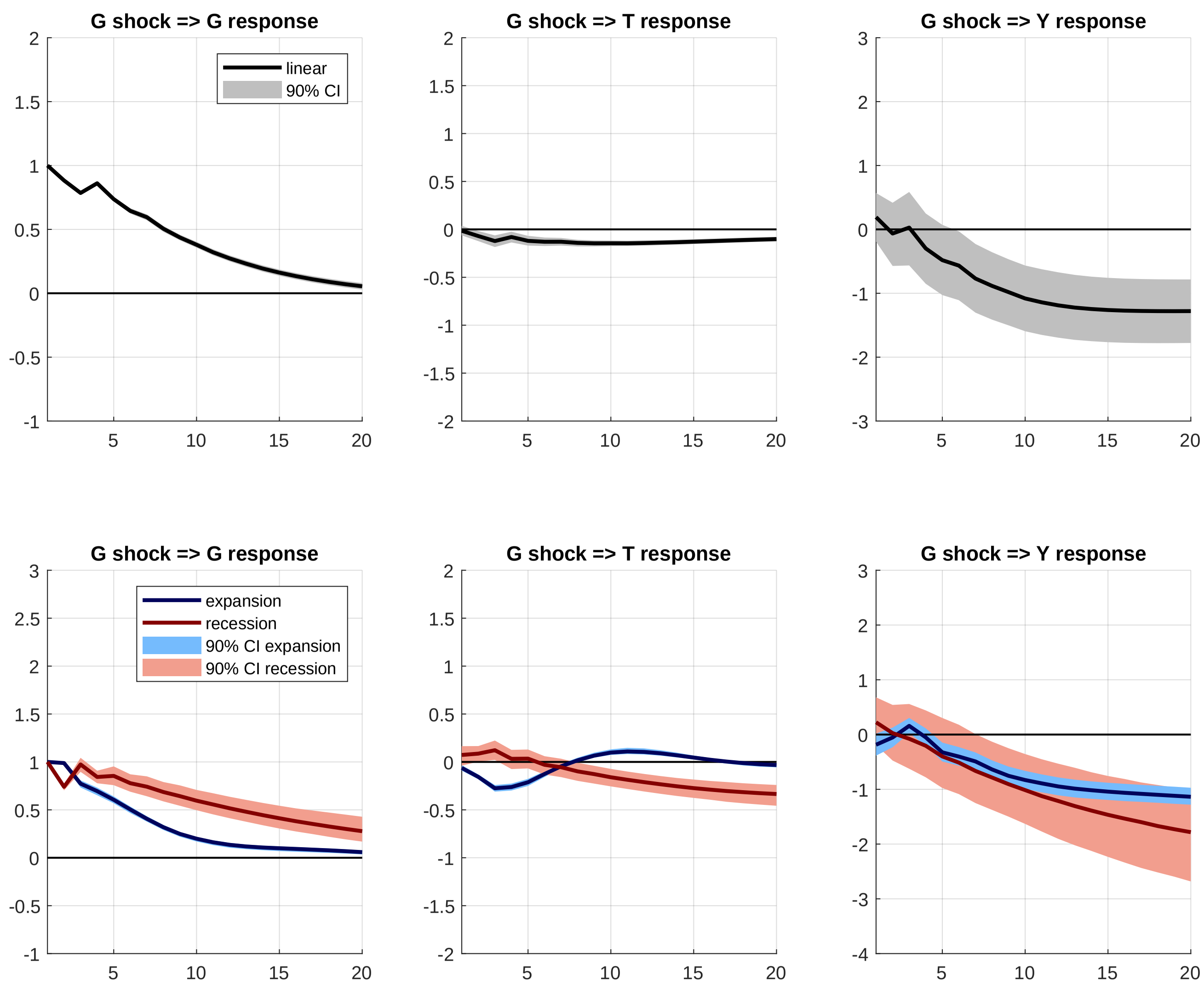
Notes: Table 3D.3 presents output multipliers, i.e. estimates that have been multiplied ex-post by the mean of Y/G. They describe the effect on output of an $1 increase in government spending. The first column presents the maximum response of output to a shock to the relevant government spending component, $max_{h=1,...,20}Y_h$, while the second column presents cumulative multipliers, calculated as: $\sum_{h=20}^{h} Y_h / \sum_{h=20}^{h} G_h$. Standard errors are reported in parentheses, while asterisks *, ** and ***, denote significance at the 10%, 5% and 1% level, respectively. Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Figure 3D.1: Responses to a shock to Compensation of Government Employees for U.S. (Robustness)



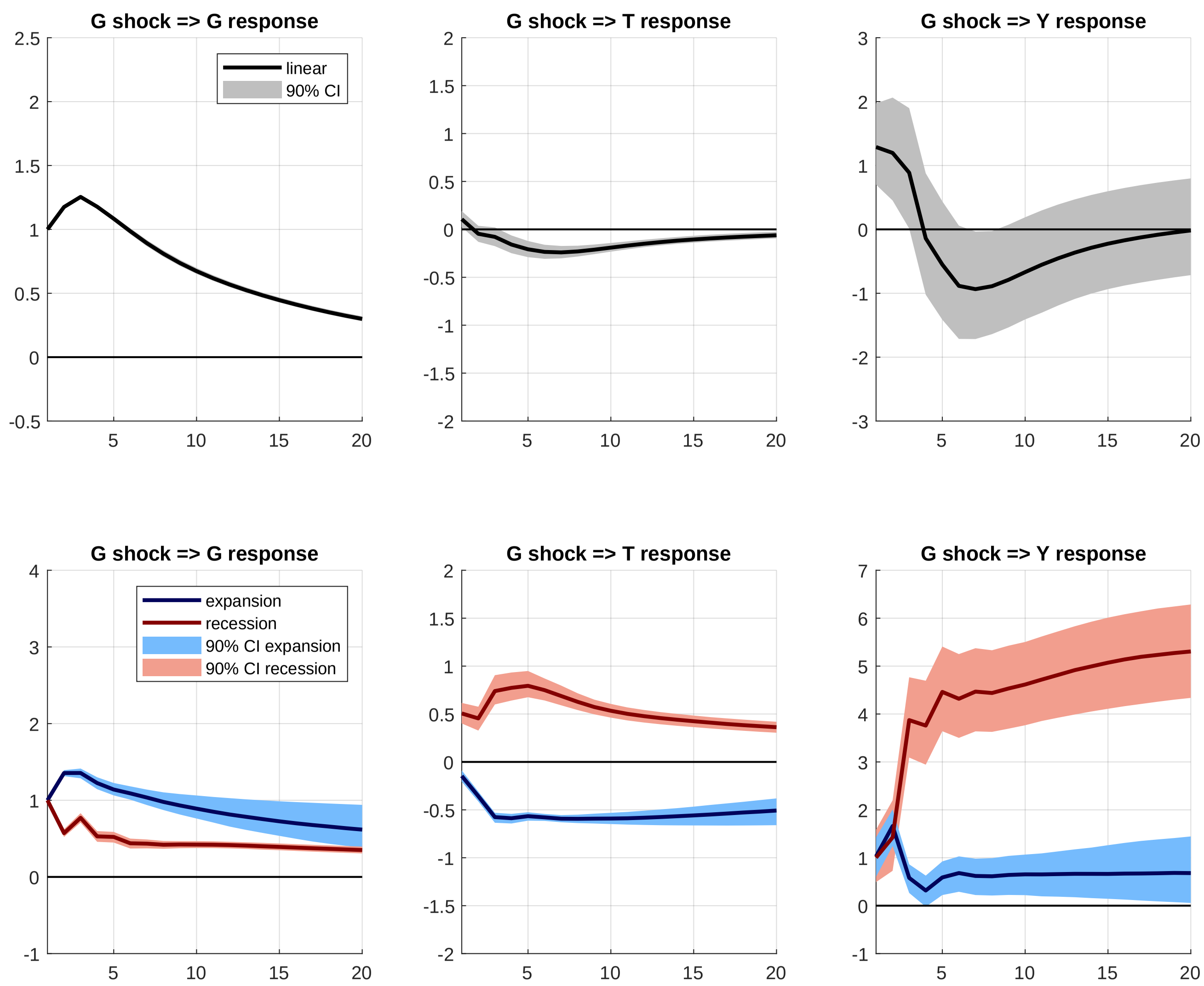
Notes: Figure 3.1 reports the effects of a shock which raises the compensation of government employees by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending). Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Figure 3D.2: Responses to a shock to Government Purchases of Goods and Services for U.S. (Robustness)



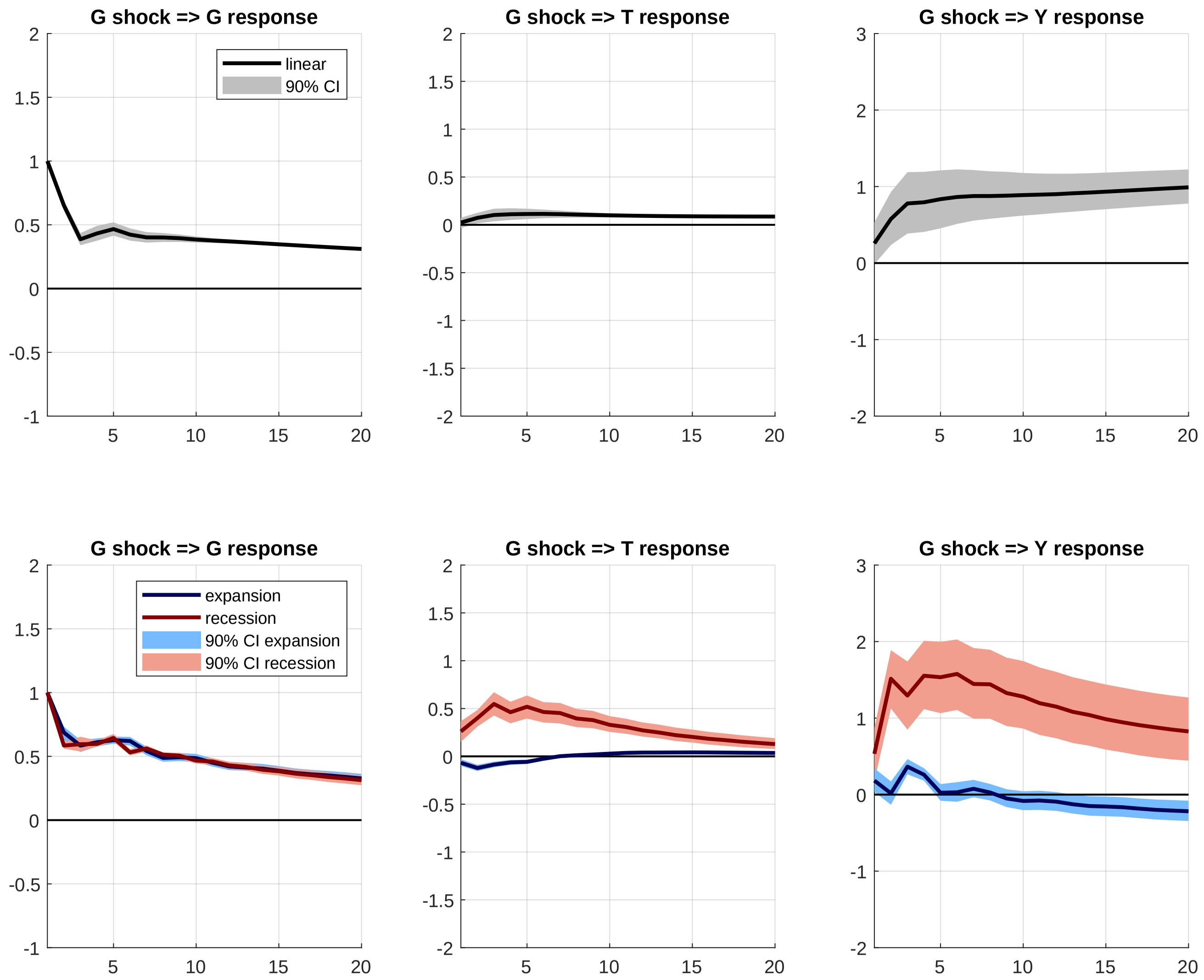
Notes: Figure 3D.2 reports the effects of a shock which raises the government spending on gooda and services by 1%. The horizon is in quarters after the shock. (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending). Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Figure 3D.3: Responses to a shock to Government Investment for U.S. (Robustness)



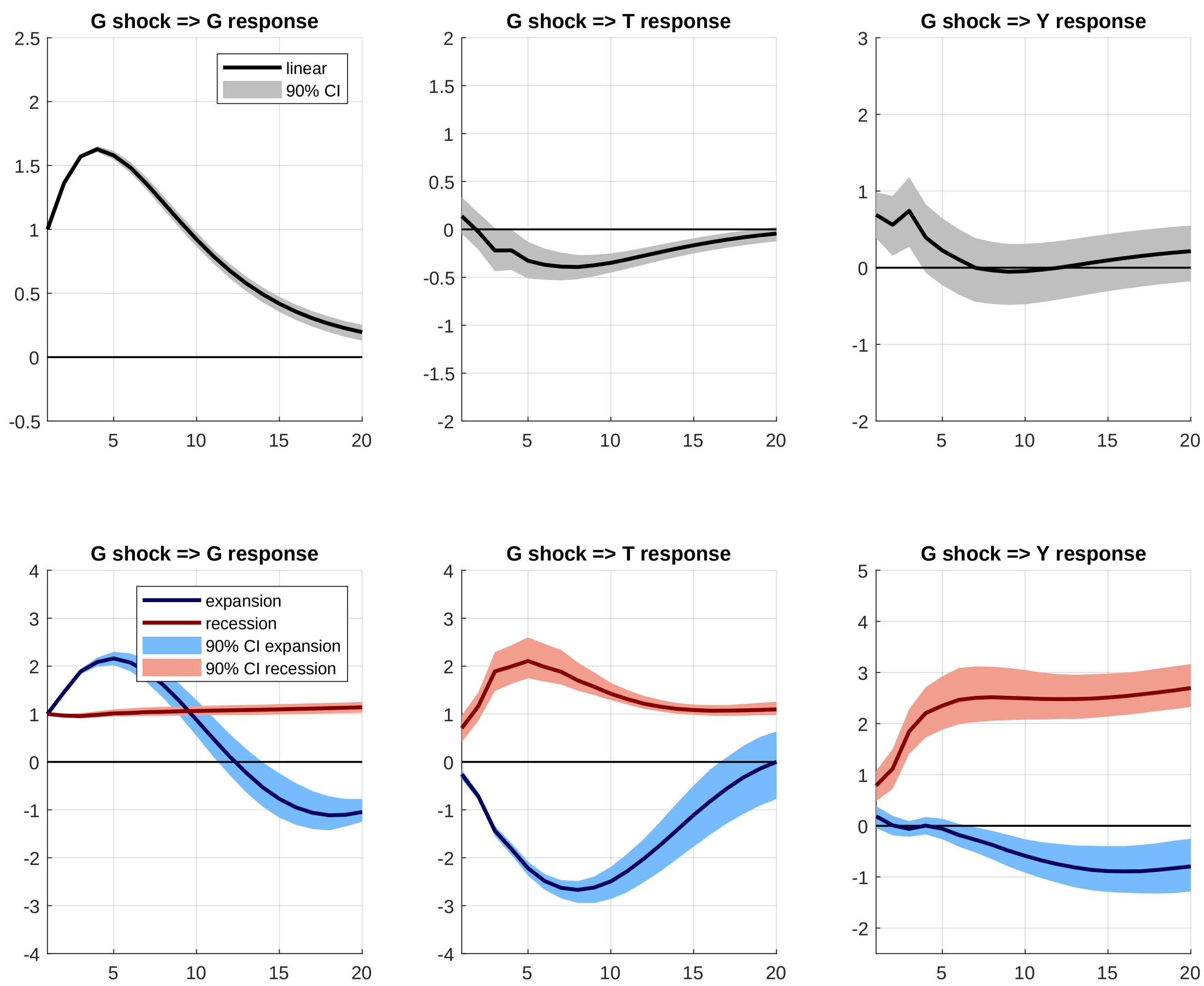
Notes: Figure 3D.3 reports the effects of a shock which raises government investment by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending). Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Figure 3D.4: Responses to a shock to Social Benefits for U.S. (Robustness)



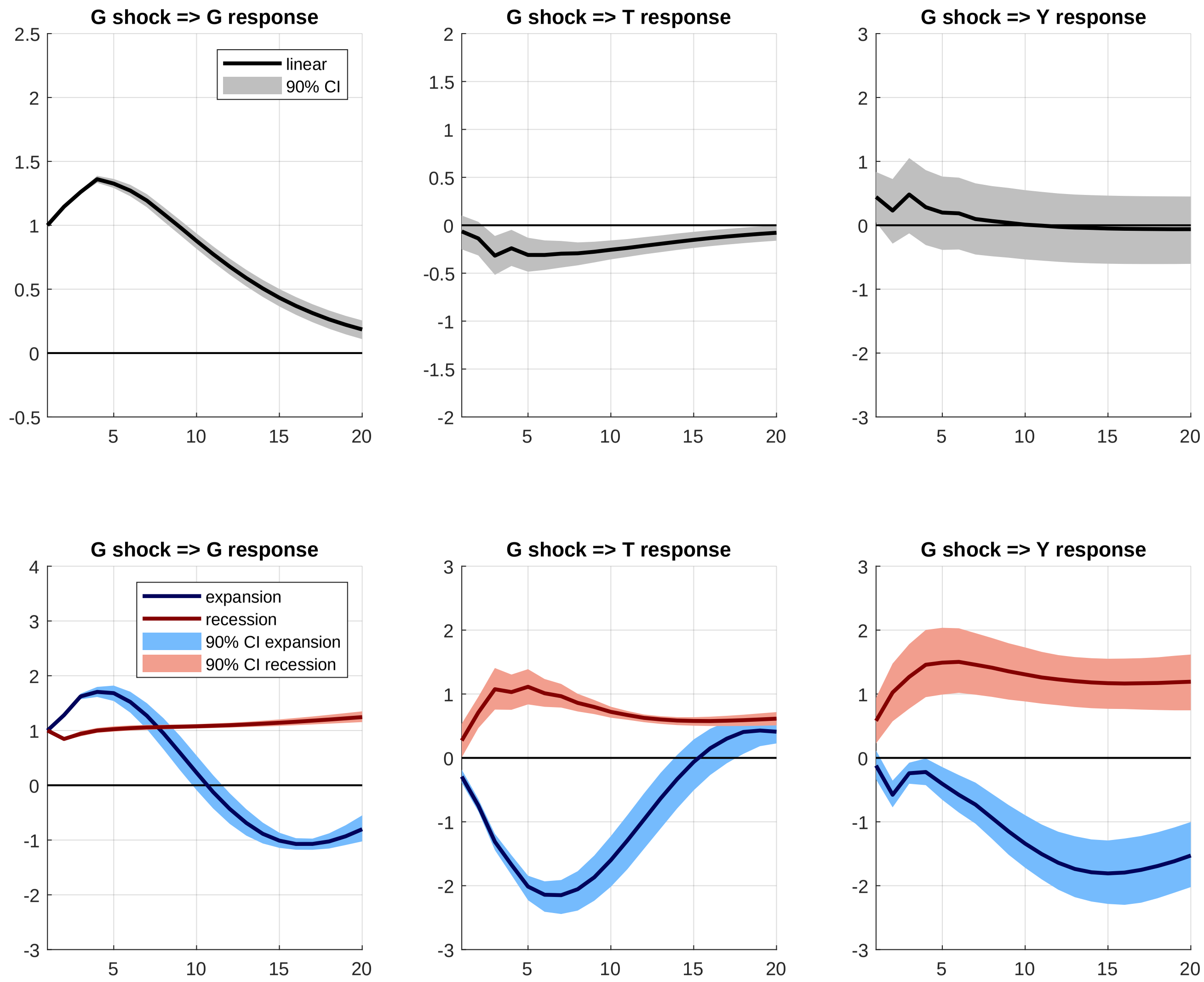
Notes: Figure 3D.4 reports the effects of a shock which raises social benefits by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G and they describe the effect on output of an $1 increase in the respective component of government spending). Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Figure 3D.5: Responses to a shock to Total Government Spending for U.S. (Robustness)



Notes: Figure 3D.5 reports the effects of a shock which raises the total government spending by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G). Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Figure 3D.6: Responses to a shock to Government Consumption for U.S. (Robustness)



Notes: Figure 3D.6 reports the effects of a shock which raises the government consumption by 1%. The horizon is in quarters after the shock. Output (Y) graphs report multipliers (i.e. estimates have been multiplied the by mean of Y/G). Robustness test: state variable z is defined as the 7-quarter moving average of the HP detrended GDP growth rate.

Appendix 3.E Stability Tests

Table 3E.1: Stability Tests

	Linear	**Expansion**	**Recession**
Comp. of Employees	Stable	Stable	Unstable
Goods and Services	Stable	Stable	Stable
Government Investment	Stable	Stable	Stable
Social Benefits	Stable	Stable	Unstable
Government Consumption	Stable	Stable	Unstable
Total Spending	Stable	Stable	Unstable

Chapter 4

Analyzing the Effects of Government Spending: Evidence from OECD and Non-OECD Countries

4.1 Introduction

This chapter contributes to the empirical literature by providing estimates of multipliers for different components of government spending: compensation of government employees, government use of goods and services and government investment. In a linear setting, we show that these multipliers are far from homogeneous for different spending components, and we also assess the effects of these spending components on household consumption and private investment – two key ingredients of GDP that are thought to be affected by changes in government spending (see e.g. Baxter & King, 1993; Galí *et al.*, 2007). Moreover, we demonstrate that these multipliers also differ across different groups of countries, namely OECD and non-OECD economies. For instance, we document that the multipliers of government use of goods and services are very small and in most cases insignificant for both groups of countries. Instead, we find that the multiplier of compensation of government employees and government investment is much larger of OECD economies.

We also extend a small but growing literature that analyzes the role of state dependence of government spending multipliers, by providing a comparative analysis for different components of spending for OECD countries, but we also provide evidence for non-OECD economies.[1] We provide evidence that in periods of *slack*, multipliers tend to be higher: this holds for the compensation of employees when we study OECD economies, and for government investment for their non-OECD counterparts. Nonetheless, the difference does not persist for long horizons: it vanishes for horizons beyond two years.

[1] Corsetti *et al.* (2012) and Auerbach & Gorodnichenko (2013) have estimated multipliers for a subset of the OECD economies we consider here.

Finally, we contribute to the empirical literature by studying the effects of variations in social benefits (Furceri & Zdzienicka, 2012; Romer & Romer, 2016). Whereas the evidence we provide should be interpreted as suggestive rather than conclusive, we find that social benefits increase only moderately output at short horizons. However, we provide evidence that consumption responds significantly in linear settings. When we condition on the state of the economy we find that consumption increases both in recessions and in expansions in OECD economies, but only in recessions in non-OECD countries.

We should highlight here a caveat of the estimates we provide. These are based on averages for the groups of countries we study over a particular period. As controlled, randomized trials which would allow us to estimate *average treatment effects* of increases in government spending are not possible, our estimates of multipliers are history-dependent. Theoretical models highlight that factors such as the persistence of spending changes, how they are financed, the openness of the economy, etc., do matter for the magnitude of the multipliers. The data at hand, however, do not provide us with (quasi) natural experiments that would allow us to answer such questions more formally.

The rest of the chapter is organized as follows. In Section 4.2 we describe the data and our empirical methodology, while our results are presented in Section 4.3. The final section (Section 4.5) concludes.

4.2 Data and Empirical Methodology

4.2.1 Data

We have collected annual data for the period covering 1991 to 2016 on 35 OECD and 49 non-OECD economies – the list of countries in our dataset is shown in Table 4A.1 in the Appendix. In some detail, as we would like to evaluate the effects of different economic components of government expenditure, we chose to employ data on government expenditure on compensation of employees, the government use of goods and services and government investment. Our fiscal spending variables come entirely from IMF's Government Financial Statistics (see IMF, 2014). The response variables of interest to us are output (to estimate fiscal spending multipliers), household consumption and private investment which we obtained data from World Bank and the OECD. A full account of our variables and data sources is provided in Table 4A.2 in the Appendix.

To get an overall feeling of the fiscal variable we employ here, Table 4A.4 presents the average shares of each government spending component in GDP and in total government expenditure. A key feature to note is that the overall size of the public sector is about 15 percentage points of GDP larger in OECD economies, but if one looks at specific components of public spending, these seem closely aligned for OECD and Non-OECD economies.

4.2.2 Identification of Fiscal Spending Shocks

In order to identify the effects of different components of government spending we employ a variant of the methodology discussed in Corsetti *et al.* (2012), which follows the strategy of Perotti (1999) and Tagkalakis (2008). We do so for two reasons. First, standard VARs are unsuitable for our purposes as the time span of the data available is relatively short (we have a maximum of 25 observations per country), and the estimated effects would be imprecisely estimated – let alone the fact that our panel is unbalanced. Second, as we would also like to assess the effects of fiscal spending shocks in different economic environments (e.g. in periods of recessions and expansions of the economy), the two-step approach adopted here allows for considerable flexibility in estimating such effects.[2]

The first step in our work consists of obtaining series of fiscal policy innovations for each country i in the sample, for different components of fiscal spending.[3] The usual practice in the literature has been to use the log variables (for example GDP and government spending) and transform the estimated elasticities into impulse responses ex post, using the sample average of the ratio of GDP to government spending (see e.g. Auerbach & Gorodnichenko, 2012b). Ramey & Zubairy (2018) explain that such practice might cause biases due to variations of the sample average – which applies to our case as well, with sample averages varying considerably across countries. To avoid such bias, we follow the suggestion of Ramey & Zubairy (2018) and employ the Gordon & Krenn (2010) transformation: we divide government spending, GDP, consumption, and investment, by an estimate of potential, or trend GDP.[4] This puts all variables in the same units, which means that there is no need for an ex-post transformation, also making the interpretation of impulse responses easier.

With this transformation at hand, following Corsetti *et al.* (2012) we postulate a fiscal policy rule of the form:

$$g_{i,t} = \alpha_i + \lambda_1 g_{i,t-1} + \lambda_2 g_{i,t-2} + \gamma_1 gdp_{i,t-1} + \gamma_2 gdp_{i,t-2} + \delta debt_{i,t-1} + \tau tax_{i,t-1} + \theta trend_t + \varepsilon_{i,t} \tag{4.1}$$

where $g_{i,t}$ denotes government spending, $gdp_{i,t-1}$ is real output, $trend_t$ denotes a deterministic time trend and $\varepsilon_{i,t}$ captures discretionary policy changes. In order to account for the role of financing as well as the level of outstanding liabilities of the government, we control for taxes by adding one lag of the average tax rate (revenues as a ratio of GDP) $tax_{i,t}$,and one lag of

[2]Using linear panel VARs it would be possible to examine differences of the effects of government spending across subsets of the data, using sample splits, but it would be difficult to account for time-varying regimes, such as presence of a recession.

[3]Many papers in the literature (e.g. Bermperoglou *et al.*, 2017; Corsetti *et al.*, 2012; Ilzetzki *et al.*, 2013) focus only on government consumption, as there seems to be no direct link between the government wage bill and private sector productivity. We depart from the existing literature in accommodating other types of government spending (use of goods and services and government investment) in search of a richer set of empirical regularities. We do assume however that all types of government expenditure we consider do not affect potential output.

[4]In order to estimate (log) trend real output, we fit log real GDP to a third-degree polynomial in time, on a country-by-country basis. Then "potential GDP" is estimated as an exponential trend.

the debt-to-GDP ratio, $debt_{i,t-1}$. Because of the unbalanced nature of our panel dataset, we do not allow for country-specific coefficients in the policy rule, but rather we pool the coefficients across countries. It is important to highlight that by estimating Equation 4.1 we posit a fiscal policy rule in the spirit of the rule adopted in Blanchard & Perotti (2002): identification is achieved by assuming that spending cannot respond simultaneous output changes, but only to past growth developments.

4.2.3 Model Estimation Using Local Projections

Having obtained our fiscal policy innovations ($\hat{\varepsilon}_{i,t}$) from (4.2), in a second step we trace the dynamic effects of these innovations on key macroeconomic variables of interest.[5] To this end we use the method of local projections proposed by Jordà (2005).[6] In particular, in the linear case (where we abstract from any variations in the state of the economy), we estimate a model of the form:

$$y_{i,t+h} = \eta_{i,h} + \beta_h \hat{\varepsilon}_{i,t} + \boldsymbol{\psi}_h (L) \mathbf{x}_{i,t-1} + \kappa_h trend_t + v_{i,t+h} \tag{4.2}$$

where $y_{i,t+h}$ denotes a variable of interest (such as government spending itself, GDP, private consumption, or private investment) h periods after the shock, $\mathbf{x}_{i,t-1}$ is a vector of control variables, $\boldsymbol{\psi}_h (L)$ is a polynomial in the lag operator and $trend_t$ is a time trend. The vector $\mathbf{x}_{i,t-1}$ includes two lags of government spending, two lags of GDP, one lag of debt and one lag of tax rate – similar to (4.1) above. Whenever (Equation 4.2) is estimated for consumption and private investment, $\mathbf{x}_{i,t-1}$ also includes two lags of the relevant left-hand side variable. We estimate this model with fixed effects panel regressions for an horizon of 5 years after the shock, i.e. we estimate the above equation for $h = 0, ..., 5$. In this context the parameter β_h defines the response of y to a shock in period t, h periods after the shock. Gathering up all the β_h's, provides us with the Impulse Response Function (IRF) of the specific variable y.

The local projection approach can easily be adopted to estimating non-linear models. In particular, when we wish to estimate a state-dependent model, this is easily done by estimating:

$$\begin{aligned} y_{i,t+h} \;\; = \;\; & \eta_{i,h} + (1 - F(z_{i,t-1})) \left[\; \beta_{E,h} \hat{\varepsilon}_{i,t} + \boldsymbol{\psi}_{E,h}(L) \mathbf{x}_{i,t-1} \; \right] \\ & + F(z_{i,t-1}) \left[\; \beta_{R,h} \hat{\varepsilon}_{i,t} + \boldsymbol{\psi}_{R,h}(L) \mathbf{x}_{i,t-1} \; \right] + \kappa_h trend_t + v_{i,t+h} \end{aligned} \tag{4.3}$$

where $F(.)$ is the transition function, which is given by the logistic function:

$$F(z_{i,t}) = \frac{exp(-\gamma z_{i,t})}{1 + exp(-\gamma z_{i,t})}, \text{ with } \gamma > 0. \tag{4.4}$$

Here $F(z_{i,t})$ can be interpreted as the probability of being in a recession, given the state of

[5] We use the normalized shock, i.e. the shock is divided by its standard deviation.

[6] See also Auerbach & Gorodnichenko (2012a), Auerbach & Gorodnichenko (2013), Jordà & Taylor (2016), Owyang *et al.* (2013) and Ramey & Zubairy (2018) inter alia for applications employing local projections methods.

the economy $z_{i,t}$. The parameter γ shows the smoothness of the transition between regimes: when $\gamma = 0$, we get the linear case, while when γ takes on very high values, the state indicator resembles a usual dummy. We choose $z_{i,t}$ to be the 2-year moving average of GDP growth rate (normalized). When $F(z_{i,t}) = 1$ the economy is in extreme recession, while when $F(z_{i,t}) = 0$ the economy is in extreme expansion. We follow Auerbach & Gorodnichenko (2012a) and set $\gamma = 1.5$.[7] The vector $\mathbf{x}_{i,t-1}$ is the same set of control variables as in Equation 4.2, $\boldsymbol{\psi}_{E,h}(L)$ and $\boldsymbol{\psi}_{R,h}(L)$ are polynomials in the lag operator in expansions and recessions, and $\{\beta_{E,h}\}_{h=0}^{H}$ and $\{\beta_{R,h}\}_{h=0}^{H}$ are the responses of y in a state of expansion and recession respectively, to a shock in period t, h periods after the shock. In our work we employ clustered standard errors at the country level.

4.2.4 Cumulative Multipliers

In order to capture the dynamic effects of government spending on output and compare our findings with those of the existing literature, it is possible to compute multipliers that measure the effect of an increase in government expenditure on output some h periods after the shock, or to compute cumulative multipliers. The latter answer the policy question of interest, as they measure the cumulative change in GDP relative to the cumulative change in government spending for horizons of up to h years-ahead – we compute multipliers for up to five-year-ahead in our work.[8]

It is be possible to estimate cumulative multipliers (in linear models) using the following three steps: (1) estimate equation Equation 4.2 for output and government spending, for each horizon up to h; (2) sum β_h's for output and government spending, respectively; and, (3) compute the cumulative multipliers as the ratio of the sum of β_h's for output to the sum of β_h's for government spending. Ramey & Zubairy (2018) suggest an alternative method which is equivalent to above procedure but produces multiplier estimates in one step. In particular, the 1-step procedure consists of an instrumental variable estimation of the sum of GDP on the sum of government spending, using the estimated shock as an instrument.[9] The clear benefit of the 1-step procedure is that while being similar to the 3-step estimation strategy, it provides us with a point estimate of the multiplier but also with a standard error, making inference on multipliers easier.

[7] Auerbach & Gorodnichenko (2012a) calibrate γ, so that the economy spends about 20% of time in recession, where they define an economy to be in a recession if $F(z_{i,t}) > 0.8$. This is consistent with the duration of recessions in the US.

[8] Since we employ the Gordon & Krenn (2010) transformation — i.e. we divide all variables with an estimate of potential GDP – all variables are expressed in the same units, hence we avoid the need for an ex-post transformation.

[9] Ramey & Zubairy (2018) explain that the multipliers from the two procedures should be equal if one uses the exact same sample for all of the regressions and also drops the last h observations.

Lets us first consider the model in the linear case, which reads:

$$\sum_{j=0}^{h} y_{i,t+j} = \chi_{i,h} + m_h \sum_{j=0}^{h} g_{i,t+j} + \boldsymbol{\psi}_h(L)\mathbf{x}_{i,t-1} + \phi_h trend_t + \omega_{i,t+h}, \quad h = 0, 1, \cdots, 5 \quad (4.5)$$

where $\sum_{j=0}^{h} y_{i,t+h}$ is the sum of GDP from t to $t+h$, $\sum_{j=0}^{h} g_{i,t+h}$ is the sum of the government spending component from t to $t+h$. The idea is to use the estimated shock $\hat{\varepsilon}_{i,t}$, as an instrument for $\sum_{j=0}^{h} g_{i,t+h}$. Then, m_h is the h-period cumulative output multiplier.

In the state-dependent case, we estimate an equation of the form:

$$\begin{aligned} \sum_{j=0}^{h} y_{i,t+j} &= \chi_{i,h} + (1 - F(z_{i,t-1})) \left[m_{E,h} \sum_{j=0}^{h} g_{i,t+j} + \boldsymbol{\psi}_{E,h}(L)\,\mathbf{x}_{i,t-1} \right] + \\ & F(z_{i,t-1}) \left[m_{R,h} \sum_{j=0}^{h} g_{i,t+j} + \boldsymbol{\psi}_{R,h}(L)\,\mathbf{x}_{i,t-1} \right] + \phi_h trend_t + \omega_{i,t+h}, h = 0, 1, \cdots, 5 \end{aligned} \quad (4.6)$$

where we use $F(z_{i,t-1}) \cdot \hat{\varepsilon}_{i,t}$ and $(1 - F(z_{i,t-1})) \cdot \hat{\varepsilon}_{i,t}$ as instruments for $F(z_{i,t-1}) \cdot \sum_{j=0}^{h} g_{i,t+j}$ and $(1 - F(z_{i,t-1})) \cdot \sum_{j=0}^{h} g_{i,t+j}$, respectively. This procedure provides us with state-dependent multipliers $m_{E,h}$ and $m_{R,h}$ and their associated standard errors – we also employ clustered standard errors when estimating multipliers.

4.3 Empirical Results

In this section we discuss our main empirical findings. We first discuss our findings for the OECD countries in our sample and then compare these to our results for non-OECD countries.

4.3.1 Main Findings for OECD Countries

Our main findings for OECD economies are summarized in Figure 4.1 – Figure 4.3 and Table 4.1 – Table 4.3. The figures present the IRFs of output, household consumption and private investment estimated using equations (4.2) and (4.3). In particular, they show the response of each variable when a shock to the respective component of government spending increases government spending by 1% of GDP. Changes in output, consumption, and investment are also expressed in percent of GDP.

Starting with our results using a linear specification, in Figure 4.1a we note that a 1% (of GDP) increase in the compensation of government employees increases output by 0.61 % on impact, with the response peaking at 0.93% two years after the shock and becoming insignificant at a horizon of four years after the shock. Similarly, consumption increases on impact (by 0.77% of GDP), displaying a hump-shaped pattern: its response peaks one year after the shock and declines smoothly – becoming insignificant at a horizon of four years after the shock. On the other hand, there seems to be no significant effect on private investment for horizons up to three years after the shock (i.e. no evidence of crowding out), with the investment response being positive at horizons of four years and beyond. When we employ a state-dependent specification we note in Figure 4.1b that the there seems to be no effect of government spending on all three variables considered when the economy is expanding. Instead, while the response of investment is insignificant, the responses of output and consumption when the economy is in a recessionary environment are similar to the linear case: the response of output peaks at 2.08% one year after the shock, becoming insignificant at horizons beyond two years; and the response of consumption also peaks one year after the shock at 2.12%. The findings in a recessionary environment are in line with models which feature rule-of-thumb consumers (Galí *et al.*, 2007) and/or liquidity-constrained households (Kara & Sin, 2018).

When we use the expense on goods and services as government spending variables, the results are slightly different in the linear case (Figure 4.2a). We find that the response of consumption is always insignificant, while output responds positively with the response peaking at 0.82% two years after the shock. Moreover, we find evidence that investment is crowded-out: investment falls by 0.38% of GDP after both one and five years after the shock. When we employ the state-dependent specification (Figure 4.2b) we note that in expansions only investment responds significantly, falling by 0.70% and 0.34% three and four years after the shock, while the response of output and consumption is indistinguishable from zero. Instead, when the economy is in a recession, the situation is reversed: the response of investment is essentially zero, while output and consumption increase significantly at horizons of one to three years after the shock. Again these findings are broadly in line with models that feature some type of liquidity frictions or hand-to-mouth individuals.

On the other hand, shocks to government investment produce effects that are in between those generated by shocks to government purchases of goods and services and shocks to compensation of government employees (Figure 4.3). In the linear specification, output and consumption increase – GDP rises significantly on impact and responds significantly for two more years, while household consumption responds significantly only one year after the shock – and private investment is crowded out, but only on impact. When we turn to the state-dependent specification, we find that in expansions a government investment shock leaves output and consumption virtually unaffected at all horizons, but private investment is crowded out significantly only two years after the shock (the drop being 1.18% of GDP). When the economy instead is in a state of recession, we note a significant increase in both GDP (between 0.91% and 1.62%) and household consumption (between 1.24% and 1.30%) for horizons between one to three years after the shock. As far as investment is concerned, with the exception of its response at a horizon of three years after the shock (at which it rises by 0.83% of output), it does not move significantly in response of a government investment shock during recessions.

The above results regarding the effects of government spending on output also carry the interpretation of a multiplier: they trace the effect of a government spending increase in period t

by 1% of GDP on output for horizons of up to five years after the shock. These results, however, do not account for the fact that the government spending increase persists over time. As we have already discussed in Subsection 4.2.4 the quantity of interest to the policy maker is the *integral* of the output response divided by the *integral* government spending response.[10] The estimated multipliers are reported in Table 4.1 for the compensation of government employees, Table 4.2 for the government purchase of goods and services and in Table 4.3 for government investment. The overall pattern we note is that when these multipliers are estimated using linear model they take values well below unity, whereas when they are estimated using a state-dependent model they are below one in expansions but, in general, larger than one during recessions.

For instance, in Table 4.1 the estimated multiplier of compensation of government employees in linear environments ranges between 0.58 and 0.78, being significant at all horizons considered. Our results agree with previous studies on government wage multipliers (Bermperoglou *et al.*, 2012, 2017; Bouakez *et al.*, 2018; Burgert & Gomes, 2012; Zervas, 2018), in the sense that they also find a positive and significant multiplier. However, our estimates are smaller, since their multipliers are around 2-2.5. In expansions, this multiplier is found to be significant only on impact and equal to 0.73. Instead, the estimated multipliers are above unity during recessions: they vary between 0.99 (4 years after the shock) and 1.48 (at horizons of five years) being significant at all horizons. In order to assess more formally the difference of multipliers in different states of the economy, we perform a simple test of equality at each horizon considered. Our results show that multipliers differ significantly for horizons up to two years, but not at longer horizons when testing at conventional significance levels. Note that this outcome agrees with Auerbach & Gorodnichenko (2012b), who show that government consumption multiplier is higher in recessions than expansions. The fact that compensation of government employees behaves the same way with government consumption is not surprising, though, since compensation of employees is the biggest part of government consumption.

The multipliers estimated in Table 4.2 indicate that variations of the government expense on goods and services do not produce a significant effect on the economy. In particular, we find that in a linear environment the multiplier estimate ranges between 0.14 and 0.55, being significant only on impact and one year after the shock, when it attains a value of 0.55 and 0.56,respectively. This outcome is in line with Bouakez *et al.* (2018) and Bermperoglou *et al.* (2012), who find a positive multiplier for government purchases of goods and services, although their estimates are higher in magnitude. In expansionary and recessionary states, we note a similar picture. During expansions, the multiplier estimate ranges from 0.00189 (five years after the shock) and 0.608 on impact, which is the only significant value; and during recessions the multiplier varies between 0.06014 (five years after the shock) and 1.045 (one year after the shock), with the latter being the only significant estimate.[11] These results disagree with

[10] See Mountford & Uhlig (2009), Fisher & Peters (2010) and Uhlig (2010) for a discussion.

[11] Formal testing reveals that the multiplier estimates do not differ significantly at all horizons considered in this case.

Auerbach & Gorodnichenko (2012b)'s non-linear multipliers for government consumption, but as we said before, government consumption consists mainly of compensation of government employees, and government purchases on goods and services is only a small part of it.

Finally, in Table 4.3 where we report output multipliers of government investment we note a picture similar to that in Table 4.1. In the linear specification, the multiplier estimates varies between 0.299 (on impact) and 0.82 (two years after the shock), being significant at all horizons considered. Bermperoglou *et al.* (2012), Burgert & Gomes (2012), and Zervas (2018), however, find a government investment multiplier between 1-2. In expansions, we find that this multiplier varies between 0.68 and 0.815, with values reported for horizons one and two years ahead being significant. In states of recession, the impact multiplier is insignificant but then it is found to be significant for all horizons considered, varying between 1.29 (two years after the shock) and 1.78 (fiver years ahead). Testing for differences in multipliers in different states of the economy, again we find no such evidence for horizons up to four years: we are unable to reject the null that the multiplier estimates are equal in recessions and in expansions. We do uncover significant differences in cumulative multipliers only at horizons of five years. Comparing our results to those of Auerbach & Gorodnichenko (2012b), we see that they do not match. Their multipliers for government investment are bigger than ours (1.5-2 in the linear case, around 1 in expansion and above 2 in recession), while they also find a bigger multiplier in recession than expansion.

To sum up, when we examine OECD economies we find that the multiplier estimates for government purchases of goods and services tend to be insignificant both in recessions and in expansions. Instead, the multipliers of the compensation of government employees and government investment are found to be significant. They are found to be less than one in the linear specification. They are also found to be less than one in states of expansion, but to be larger than one in states of recession. However, formal testing does provide some evidence in favor of hypothesis that the multipliers differ in expansions and in recessions: this holds at relatively short horizons for government compensation of employees and at long horizons for government investment. The fact that compensation of government employees and government investment have a significant effect on output, while government purchases of goods and services do not, is not surprising. An explanation to this is provided by theoretical models, such as Bermperoglou *et al.* (2012, 2017) and Cortuk & Guler (2015). As opposed to the expense on goods and services which is only meant for consumption purposes, government expense on compensation of employees and government investment both participate in the productive operations of the government. Government production increases the productivity of private sector, leading this way to higher output growth. This is confirmed in Figures 4.1-4.3. The response of private investment to government purchases of goods and services is negative at all times. Its response to compensation of employees and government investment, however, tends to become positive in the final years, implying that these two types of spending have a "productive" nature, which takes some years to implement. In the same Figures, we also notice that the response of private consumption and private investment to compensation of employees is higher than the other two.

This happens because, in addition to the ”productive” effect, an increase in compensation of employees creates a positive wealth effect for them, which allows them to consume and invest more.

4.3.2 Empirical Findings for Non-OECD Countries

In order to assess how different government spending components affect the economy in Non-OECD countries, we repeat the above experiments on 49 Non-OECD economies listed in Table 4A.1. The results are summarized in Figure 4.5 – Figure 4.7 and Table 4.5 – Table 4.7.

We first note that when using the linear specification in Figure 4.5a the response of output and consumption is essentially zero, whereas investment respond significantly only five years after the shock (dropping by -0.86% of GDP). Using the state-dependent specification (Equation 4.3) in Figure 4.5b we note a similar picture: output and consumption do not seem to respond significantly at all horizons considered. Instead, we note that investment responds positively when the economy is in expansion: it increases between 1.40% and 2.02% of output (on impact and one year after the shock), and returns to its pre-shock value three years after the shock. A possible interpretation of this finding is that government expenditure *crowds in* private investment for a couple of years – leaving output and household consumption unaffected. Overall, however, increases in government compensation of employees does not seem to generate significant changes in output and consumption for Non-OECD countries.

A similar pattern is observed when the government spending variable we employ is the expense on goods and services. The response of all variables is indistinguishable from zero in the linear specification (Figure 4.6a), while we do observe some significant responses in the state-dependent specification (Figure 4.6b). When the economy is in expansion, only household consumption is found to increase but with a substantial delay, some three years after the shock (rising by 1.01% of output). The conclusion to be drawn again is that variations in the government purchases of goods and services do not tend to generate significant responses in output, consumption and investment.

When we look at the effects of government investment using a linear specification (Figure 4.7a), we get a slightly different picture. A rise in government investment is associated with a small and short-lived increase in output (by 0.39% impact and 0.32% one year ahead), leaving household consumption and private investment essentially unaffected. This finding is interesting, as it is in line with models in which households behave in a Ricardian manner: none of the transitory increase in output seems to translate in higher consumption.[12] When we turn to the state-dependent specification (Figure 4.7b) we get a similar picture: in expansions, output drops on impact by about 0.43% but quickly returns to its pre-shock level – with consumption and private investment being unaffected. During recessions, we observe that output increases

[12] It is true that one would expect such a behavior to apply to more developed countries. Yet this is what we find in our data.

only on impact (by 0.83%). Investment is also found to fall by 0.79% one year after the shock, with consumption being completely insulated from output variations. One way to interpret this finding is that it provides evidence both in favor of the textbook keynesian model but also in favor of ricardian models: during recessions a fiscal expansion leads to an increase in output which crowds out private investment, but household consumption is completely unaffected – probably reflecting higher savings to cover future tax obligations.

To make comparison with the results for OECD countries more transparent, in Table 4.5 – Table 4.7 we report estimates of the cumulative output multipliers for each component of government spending. One finding which is closely aligned with the results for OECD economies is that the multipliers of government expense on goods and services are essentially zero at all horizons and all states of the economy (see Table 4.6). In addition, we uncover no evidence of significant differences in the multipliers in recessions and expansions.

Another key difference difference is that when we employ a linear specification, the multipliers of compensation of government employees are zero for all horizons for Non-OECD economies (Panel A of Table 4.5), while they were significant at all horizons for OECD countries (Panel A of Table 4.1). Moreover, the multipliers are significant only on impact in expansions and recessions for Non-OECD economies (Panels B and C of Table 4.5), a finding quite different from that obtained for OECD economies (Panels B and C of Table 4.1). Again we observe that the point estimate in recessions seems larger than that we obtain in states of expansion, but testing for differences between them, we find no evidence supporting this hypothesis – in contrast with the findings for OECD economies, where significant differences in the multipliers were found for horizons up to two years.

Finally, in Table 4.7 we find that the multipliers are significant for at most one year after the shock – in sharp contrast with our findings for OECD countries (Table 4.3), where multipliers are significant almost at all horizons considered. We find that the impact multiplier in the linear specification is 0.39. Instead in states of expansion it is found to be everywhere insignificant, while in recessions it significant only on impact, where it is found to be 0.49, much lower of the value it attains for OECD economies. We note again that the point estimates are found to be larger in recessions than in expansions. Formally testing for equality across different states, we find strong evidence against the null of equality on impact, but not at longer horizons. This finding is in contrast to that obtained for OECD countries, where the multipliers of government investment differ only at long horizons.

4.3.3 Social Benefits

A useful extension to the above findings we consider is measuring the effects of an increase in social benefits. While we clearly understand that social benefits contain a serious cyclical component and are essentially automatic stabilizers, we believe that trying to measure their effects on output and consumption will definitely provide an answer to the question of how changes in social benefits affect macroeconomic outcomes. This task has been undertaken in recent work by Romer & Romer (2016) for the U.S. who identify exogenous variations in social security benefits relying on external sources. Instead, we adhere to our methodology here and extract 'exogenous' shocks to social benefits by means of a policy rule like (Equation 4.1). As the identifying assumption of exogenous variation in social benefits might be violated (e.g. the timing assumption we use), the results we present should be interpreted with a grain of salt in that they provide indications rather than conclusive evidence. Still, they are informative and of interest to policy makers.

The results from our impulse response analysis (Figure 4.4 and Figure 4.8) show that for both OECD and non-OECD economies, an increase in social benefits leaves output unaffected. This holds clearly when we employ a linear specification (e.g. equation (Equation 4.2)). When we employ a state-dependent specification (e.g. (Equation 4.3)) the overall picture is the same with the following differences: (*i*) output rises by 1.43% in recessions (one year after the shock) and by 1.61% in expansions (three years after the shock) for OECD economies; and (*ii*) output increases by 0.86% in recessions for non-OECD economies. Consumption on the other hand is found to increase in the linear model for both OECD and non-OECD economies for three years after the shock. When we employ a state-dependent specification, we note a similar pattern across both groups of economies, when the economies are in recessions. Instead, we find that consumption also increases in expansions, but only for OECD economies. This increase in private consumption after an increase in social benefits is also confirmed by Romer & Romer (2016). Finally, we note that investment falls significantly in the linear specification for horizons up to two years for OECD economies, but only at a five year horizon for non-OECD countries. Instead, in the state dependent specification the response of investment is very close to zero in expansions for both country groups, but in recessions it is close to zero only for non-OECD countries. For OECD countries, investment falls on impact and one year after the shock.

The overall conclusion that we can draw from these findings is that changes in social benefits generate significant responses of household consumption, especially in recessions. We find that this response is somewhat delayed for non-OECD countries (the response becomes significant five years after the change), but much faster for OECD economies (the response being significant one year after the shock). We also find that consumption responds significantly to social benefits in expansions, but only for OECD countries. Moreover, we have estimated output multipliers for social benefits (in Table 4.4 and Table 4.8) and found that these multipliers tend to be small - both in recessions and in expansions – and weakly significant at most at a two year horizon.[13] For OECD countries, in particular, the multiplier is found to be 0.698 on impact in expansion, and 0.894 in recession (one year after the shock). These results are in line with Furceri & Zdzienicka (2012), who find a multiplier of 0.6 for social benefits.

[13]Once again the evidence favoring differences of these multipliers in recessions and expansions are rather weak.

4.4 Robustness Analysis

Our results are robust to a series of changes in specification. Our data are transformed according to the Gordon-Krenn data transformation (that is we divide all variables with an estimate of potential GDP), therefore, it is important to test whether the way we estimate potential GDP affects our results. In our baseline specification potential GDP is estimated by fitting log real GDP to a third-degree polynomial in time, on a country-by-country basis, and then use its exponential. We consider two alternative specifications: one in which potential GDP is estimated through a second-degree polynomial in time, and one in which potential GDP is given by the trend GDP estimated by the Hodrick-Prescott filter. In both cases our results do not change.

In addition, we use a series of controls in order to account for several country characteristics, such as development, openness, exchange rate regime, commodity producer or not, monetary policy, government effectiveness, institutions. This test is mostly important for the non-OECD countries, because, as opposed to the OECD group, we are not aware whether they share any common characteristics. Our robustness tests show that controlling for these characteristics does not affect our results significantly. However, when we control for monetary policy (by including the money market interest rate), multipliers for non-OECD countries become more significant.

4.5 Conclusions

In this chapter we have investigated whether different components of government expenditure tend to stimulate the economy, focusing on the compensation of government employees, the government use of goods and services and government investment. Our choice has been driven by the need to obtain information about the size of the multipliers on specific classes of government spending. In our effort to account for differences pertaining to diverse countries and obtain as general results as possible, we have employed data on both 35 OECD and 49 non-OECD economies. Moreover, we have tried to assess whether the effects of fiscal spending vary by the state of the business cycle of the economy.

Our results show that the effects of government spending differs across groups of countries: compensation of government employees and government investment produce higher responses of output and higher multipliers for OECD economies, but estimates fall short of unity when we do not allow for state-dependent effects. Instead, purchases of goods and services do not seem to help stimulate the economy, producing effectively zero multipliers both for OECD and non-OECD countries, regardless of whether we condition on the state of the economy.

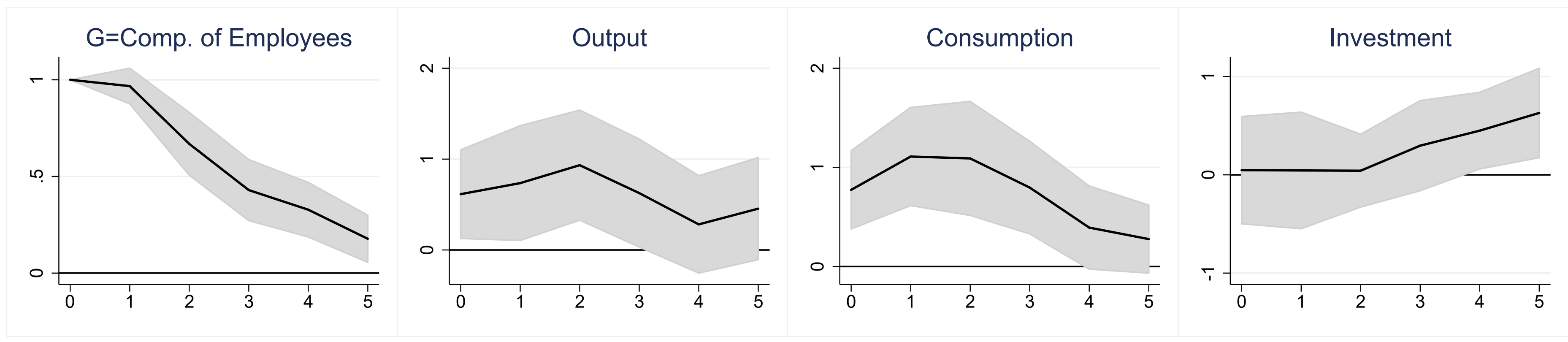
Moreover, we find that multipliers tend to differ depending on the state of the economy. For OECD economies this is clearly the case for the multiplier of the compensation of government employees: the (cumulative) multipliers differ significantly for horizons up to two years, being much higher in states of recession. Likewise, we find that the multiplier of government investment differs only at a five year horizon for OECD countries, again being higher during recessions. Instead, we find no difference in the multipliers of the compensation of government employees for non-OECD economies. However, the government investment multiplier for non-OECD counries is found to be significantly larger in periods of recession, but only for horizons of one year ahead.

Finally, we present evidence on the effects of social benefits on the macroeconomy. We find that the estimated multipliers are small in all cases, and in statistically significant only when accounting for the state of the business cycle. We nonetheless find that increases in social benefits lead to large increases in household consumption, both for OECD and non-OECD economies in states of recession; but only for OECD countries in states of expansion.

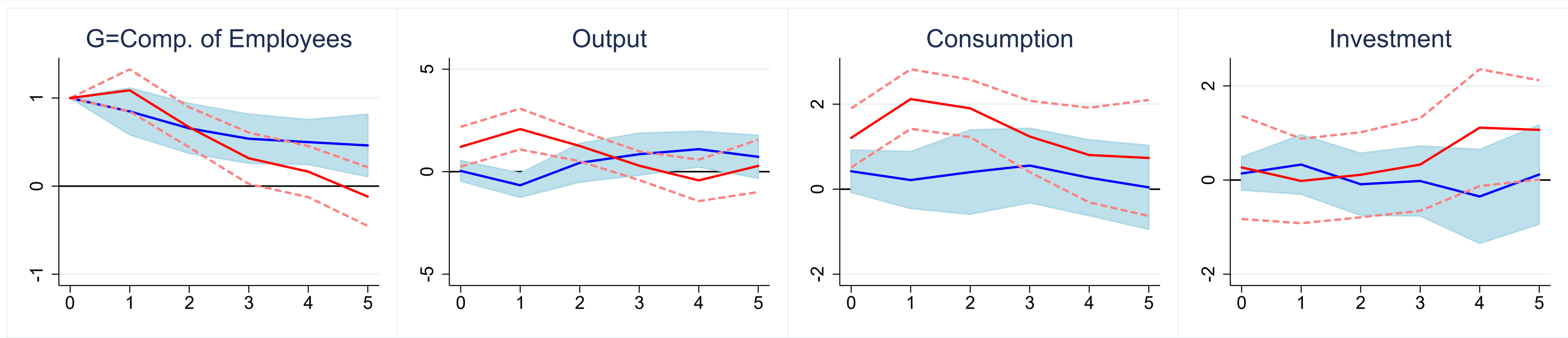
The results we have presented do come with caveats. We are forced to use historical data, so we do not have controlled experiments that would allow us to estimate average treatment effects. In addition, the period and countries we studied are characterized by particular paths of taxes, so our results are not directly applicable to the case fiscal consolidations where taxes might follow different paths. Finally, while the results for social benefits are interesting in their own sake, the 'shocks' identified might not be fully exogenous as we have already explained.

Figure 4.1: Responses to a shock to the Compensation of Government Employees for OECD Countries

(a) Linear Specification



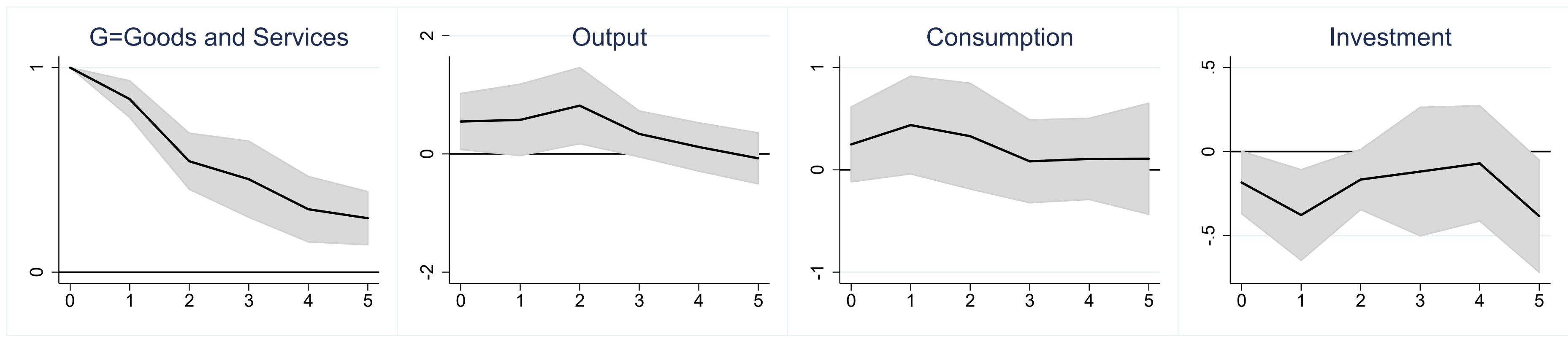
(b) State-Dependent Specification



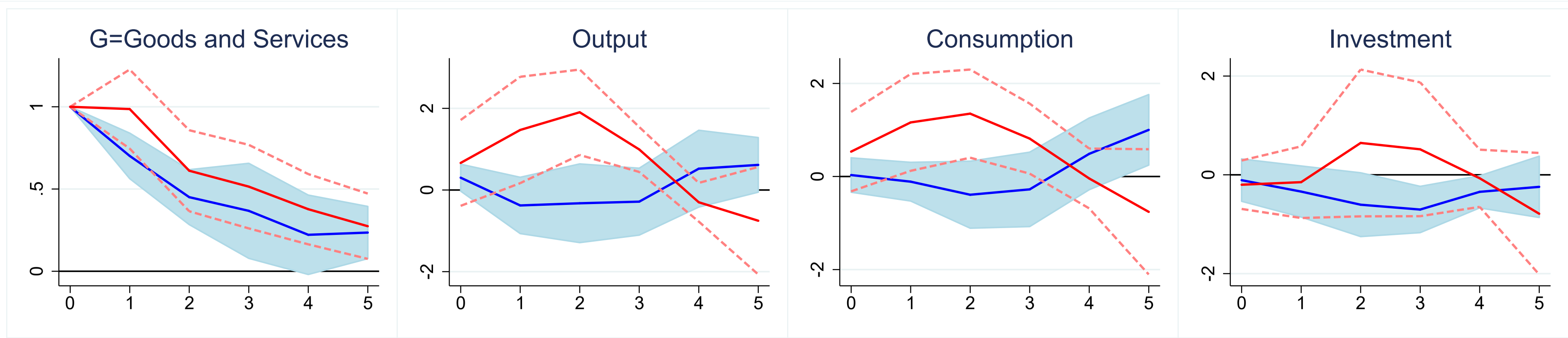
Notes for Figure 4.1. The figure reports the effects of a shock which raises the compensation of government employees by 1% of GDP for OECD countries. The shock was obtained by estimating Equation 4.1.The responses have been estimated using the method of local projections (Jordà, 2005) i.e. by estimating Equation 4.2 in the top and Equation 4.3 in the lower panel for each variable of interest (government spending, GDP, consumption and private investment). In panel (a) solid lines are point estimates and shaded areas denote the 90% confidence regions. In panel (b) solid blue lines and the shaded areas are the point estimates and the 90% confidence regions in the expansion state; and solid red lines and the regions by dashed lines are the point estimates and the 90% confidence regions in the recession state. The confidence regions have been constructed using clustered standard errors at the country level. The horizon is in years after the shock.

Figure 4.2: Responses to a shock to Government Purchases of Goods and Services for OECD Countries

(a) Linear Specification



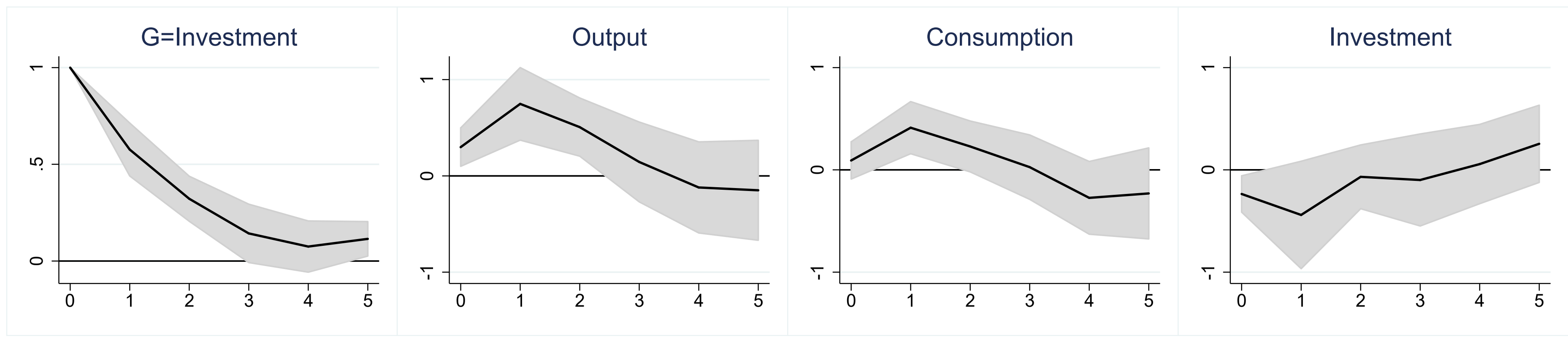
(b) State-Dependent Specification



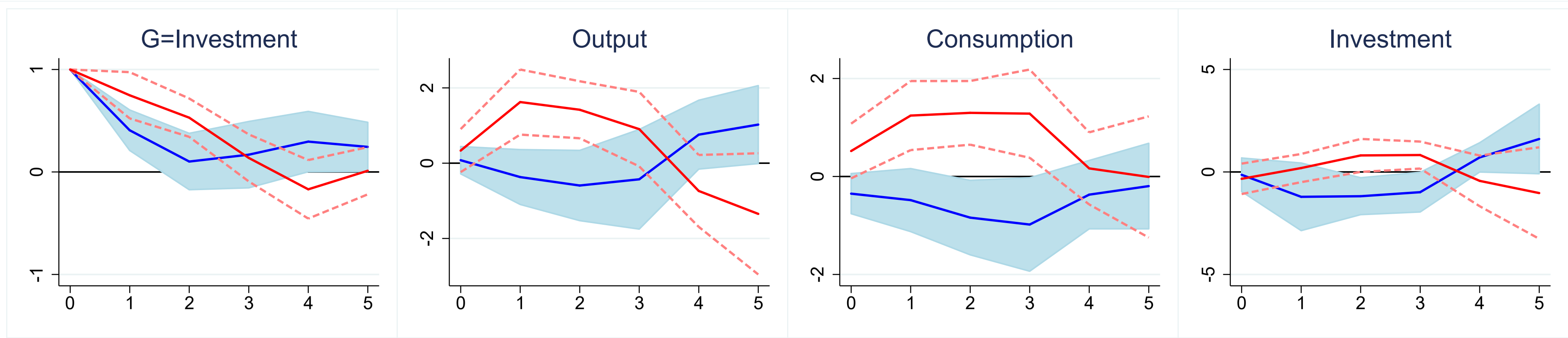
Notes for Figure 4.2. The figure reports the effects of a shock which raises government purchases of goods and services by 1% of GDP for OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Figure 4.3: Responses to a shock to Government Investment for OECD Countries

(a) Linear Specification



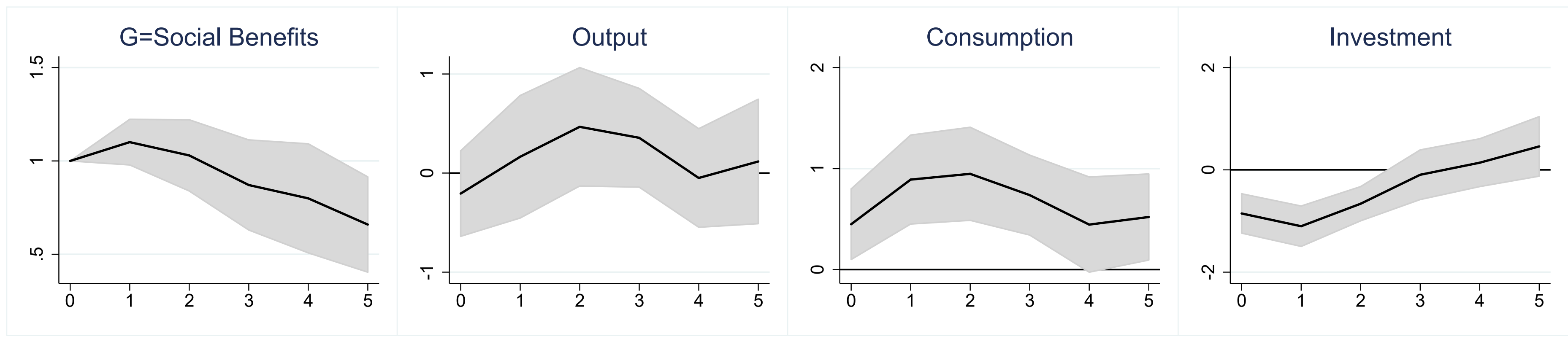
(b) State-Dependent Specification



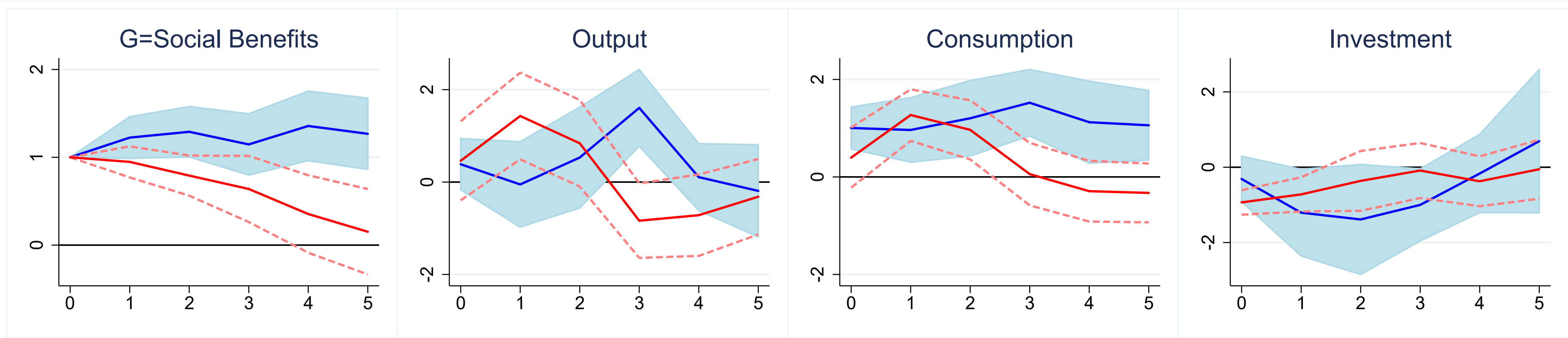
Notes for Figure 4.3. The figure reports the effects of a shock which raises government investment by 1% of GDP for OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Figure 4.4: Responses to a shock to Social Benefits for OECD Countries

(a) Linear Specification



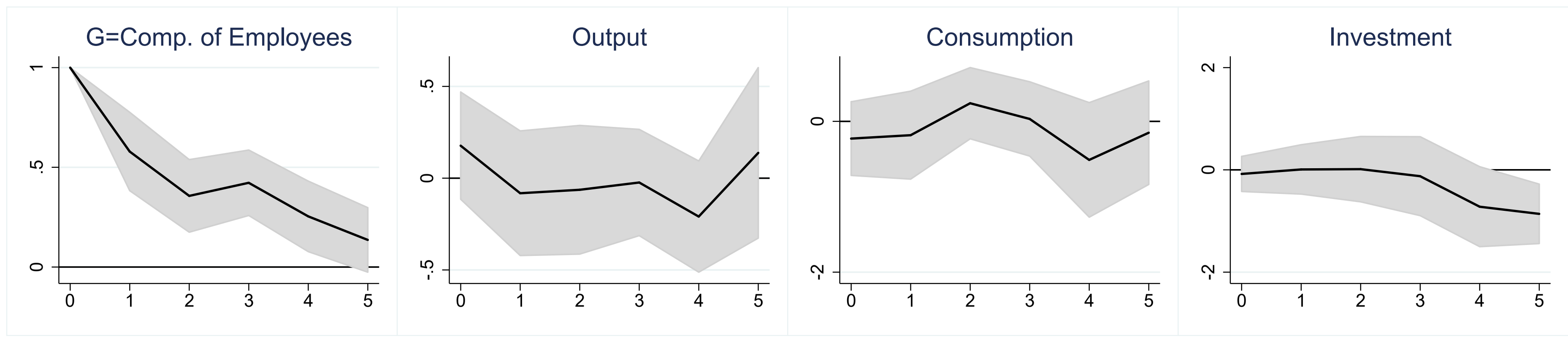
(b) State-Dependent Specification



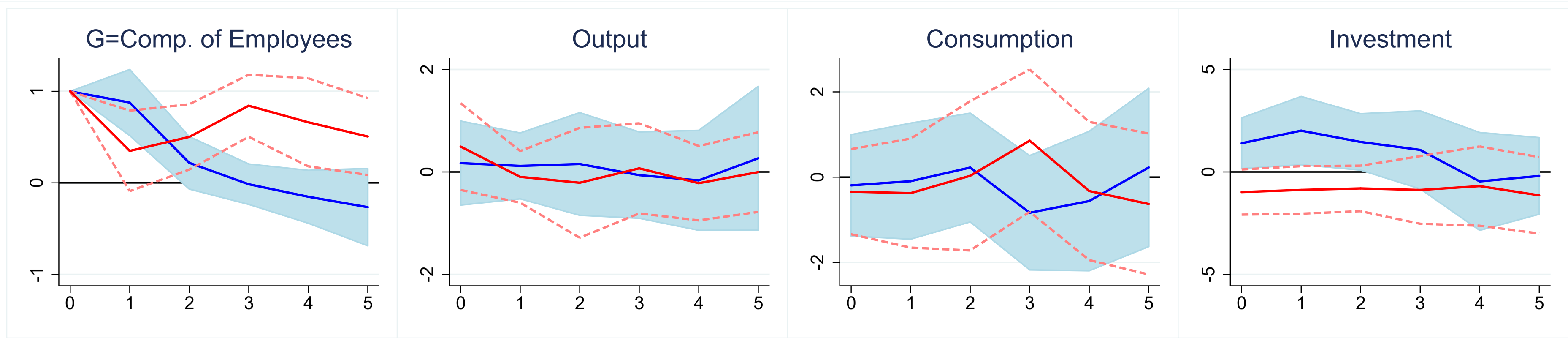
Notes for Figure 4.4. The figure reports the effects of a shock which raises social benefits by 1% of GDP for OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Figure 4.5: Responses to a shock to the Compensation of Government Employees for Non-OECD Countries

(a) Linear Specification



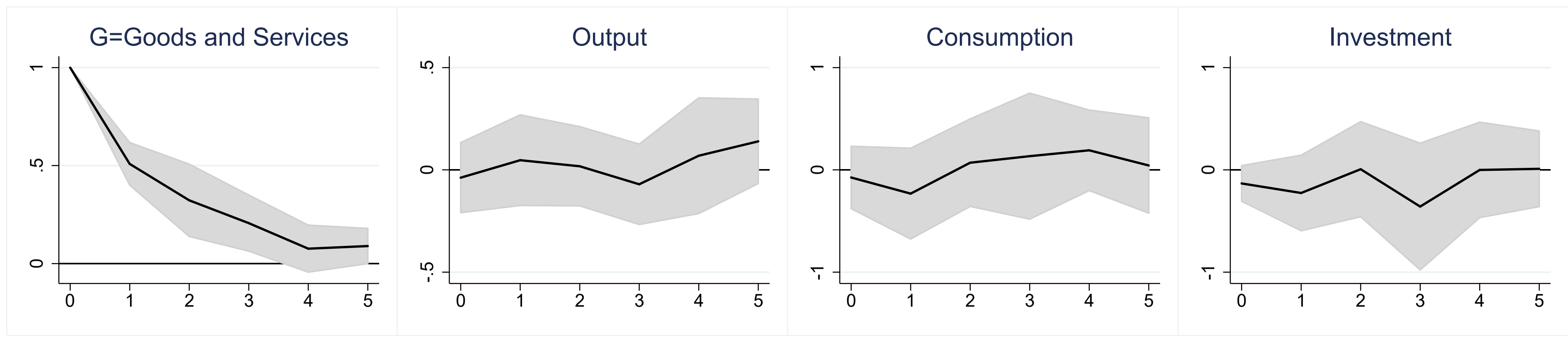
(b) State-Dependent Specification



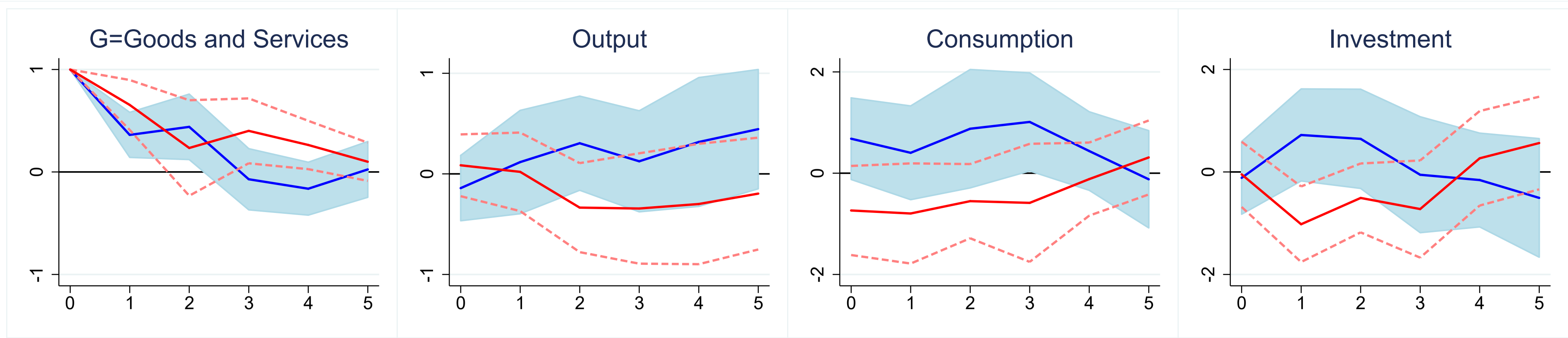
Notes for Figure 4.5. The figure reports the effects of a shock which raises the compensation of government employees by 1% of GDP for Non-OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Figure 4.6: Responses to a shock to Government Purchases of Goods and Services for Non-OECD Countries

(a) Linear Specification



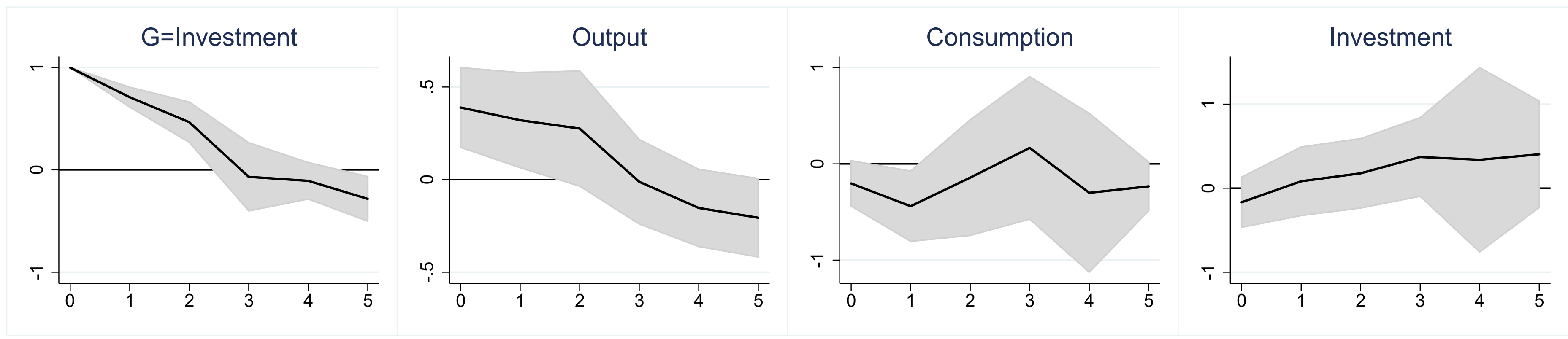
(b) State-Dependent Specification



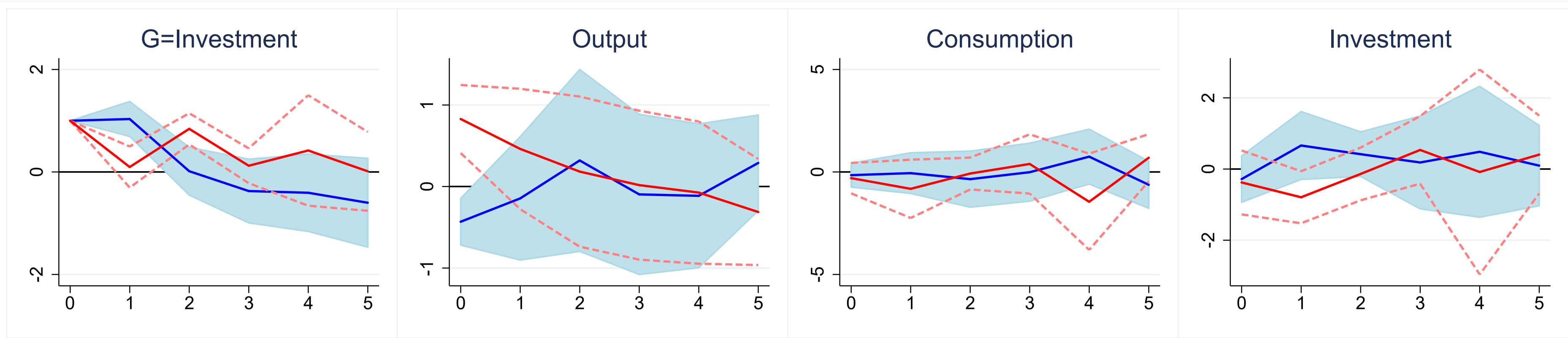
Notes for Figure 4.6. The figure reports the effects of a shock which raises government purchases of goods and services by 1% of GDP for Non-OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Figure 4.7: Responses to a shock to Government Investment for Non-OECD Countries

(a) Linear Specification



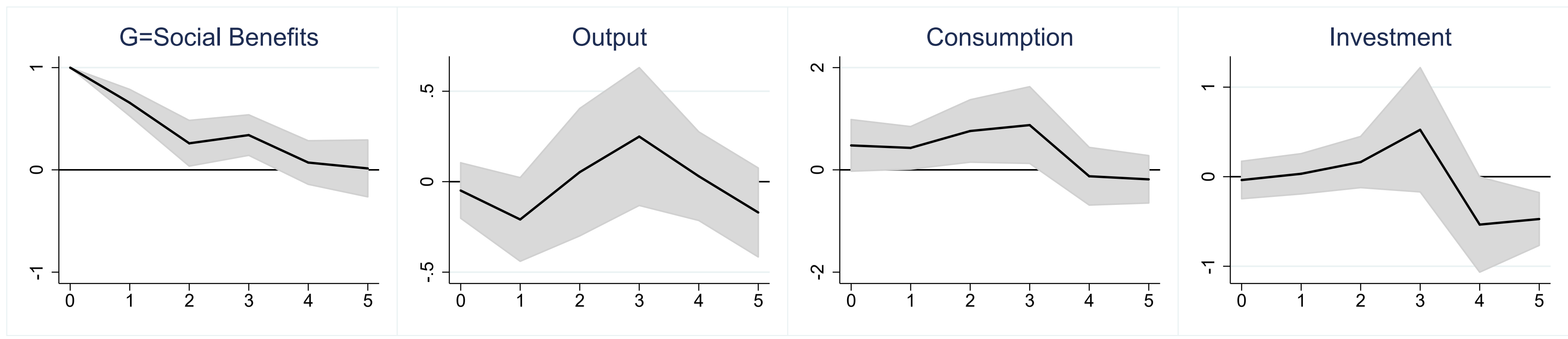
(b) State-Dependent Specification



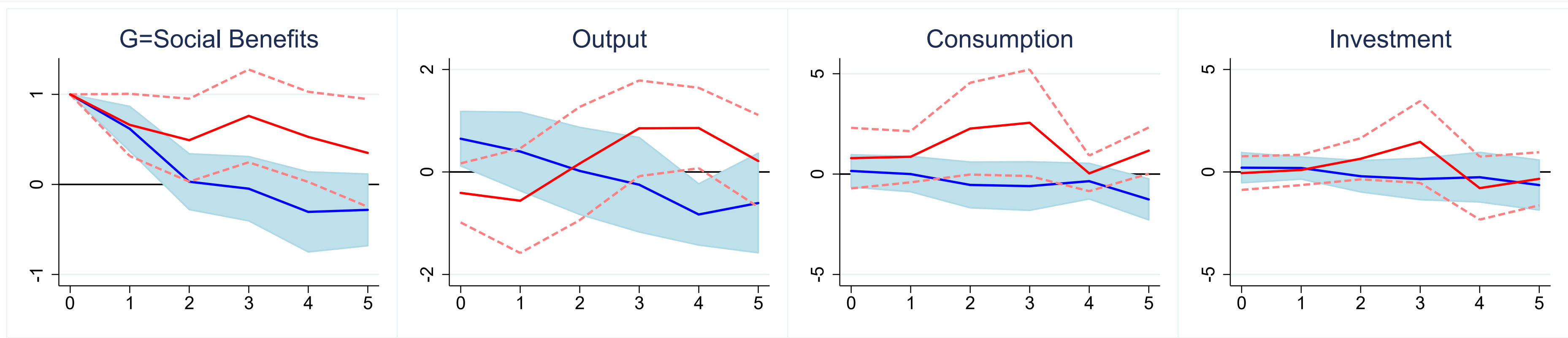
Notes for Figure 4.7. The figure reports the effects of a shock which raises government investment by 1% of GDP for Non-OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Figure 4.8: Responses to a shock to Social Benefits for Non-OECD Countries

(a) Linear Specification



(b) State-Dependent Specification



Notes for Figure 4.8. The figure reports the effects of a shock which raises social benefits by 1% of GDP for OECD countries. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 4.1.

Tables

Table 4.1: Cumulative Output Multipliers of Compensation of Government Employees for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.614**	0.583*	0.752**	0.760**	0.720*	0.780*
	(0.291)	(0.317)	(0.361)	(0.387)	(0.384)	(0.421)
Obs	674	632	590	551	512	476
Countries	34	34	33	33	32	31
First-Stage F	.	1226.9	297.0	147.5	98.43	72.24
Panel B: Expansion						
	0.730**	0.461	0.665	0.723	0.729	0.875
	(0.324)	(0.353)	(0.417)	(0.468)	(0.527)	(0.563)
Obs	674	632	590	551	512	476
Countries	34	34	33	33	32	31
First-Stage F	.	603.6	241.0	148.3	111.6	85.21
Panel C: Recession						
	1.250**	1.297***	1.473***	1.215***	0.996*	1.482**
	(0.514)	(0.496)	(0.451)	(0.449)	(0.548)	(0.642)
Obs	674	632	590	551	512	476
Countries	34	34	33	33	32	31
First-Stage F	.	758.9	209.9	95.31	58.21	33.56
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	2.65	11.81***	7.66***	1.69	0.21	1.24
$p-$value	0.1033	0.0006	0.0057	0.1935	0.6431	0.2659

Notes: Table 4.1 reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is the compensation of government employees. The horizon (top row) is in years after the shock. Panel A (Linear Model) presents the estimated output multipliers by estimating Equation 4.5, and Panels B and C (Expansion and Recession) present the estimated output multipliers by estimating Equation 4.6. In each panel the table also reports the number of observations, the number of countries included in the estimation (which vary because of the unbalanced nature of our dataset) and the first-stage F-statistic. The sample spans the period 1991-2015. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. Finally, Panel D reports tests of the null of equality of the multipliers across states of the economy and their associated $p-$values.

Table 4.2: Cumulative Output Multipliers of Government Expenditure on Goods and Services for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.548*	0.563*	0.586	0.481	0.330	0.147
	(0.282)	(0.332)	(0.392)	(0.365)	(0.353)	(0.329)
Obs	666	624	582	543	504	468
Countries	34	34	33	33	32	31
First-Stage F	.	1145.9	367.0	135.0	80.81	48.43
Panel B: Expansion						
	0.608**	0.602	0.350	0.242	0.0911	0.00189
	(0.246)	(0.375)	(0.447)	(0.484)	(0.526)	(0.504)
Obs	666	624	582	543	504	468
Countries	34	34	33	33	32	31
First-Stage F	.	735.3	566.5	273.9	165.3	127.7
Panel C: Recession						
	0.864	1.045*	0.919	0.640	0.315	0.00614
	(0.580)	(0.610)	(0.618)	(0.485)	(0.451)	(0.366)
Obs	666	624	582	543	504	468
Countries	34	34	33	33	32	31
First-Stage F	.	588.4	108.5	64.24	45.31	25.67
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	0.06	0.87	1.38	1.09	0.34	0.00
$p-$value	0.8014	0.3510	0.2399	0.2962	0.5624	0.9924

Notes: Table 4.2 reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on goods and services. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Table 4.3: Cumulative Output Multipliers of Government Investment for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.299^{**}	0.815^{***}	0.816^{***}	0.782^{***}	0.668^{**}	0.687^{**}
	(0.119)	(0.218)	(0.221)	(0.255)	(0.260)	(0.320)
Obs	673	629	585	544	503	464
Countries	35	35	34	34	33	31
First-Stage F	.	358.1	188.2	110.6	63.02	51.27
Panel B: Expansion						
	0.275	0.815^{***}	0.683^{*}	0.560	0.427	0.559
	(0.174)	(0.297)	(0.385)	(0.379)	(0.486)	(0.486)
Obs	673	629	585	544	503	464
Countries	35	35	34	34	33	31
First-Stage F	.	357.2	149.9	60.63	37.96	35.00
Panel C: Recession						
	0.393	1.291^{***}	1.288^{***}	1.429^{***}	1.286^{**}	1.781^{**}
	(0.260)	(0.335)	(0.330)	(0.475)	(0.559)	(0.737)
Obs	673	629	585	544	503	464
Countries	35	35	34	34	33	31
First-Stage F	.	177.4	98.11	63.28	33.23	25.16
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	0.79	2.12	2.47	1.79	1.36	5.28^{**}
$p-$value	0.3727	0.1452	0.1160	0.1808	0.2434	0.0216

Notes: Table 4.3 reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is government investment. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Table 4.4: Cumulative Output Multipliers of Social Benefits for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	-0.207	-0.0693	-0.0146	-0.0952	-0.122	-0.0319
	(0.257)	(0.292)	(0.319)	(0.275)	(0.268)	(0.261)
Obs	599	561	523	487	451	416
Countries	34	34	33	33	32	31
First-Stage F	.	797.2	270.5	132.0	85.31	64.67
Panel B: Expansion						
	0.698*	0.642	0.655	0.510	0.344	0.365
	(0.360)	(0.441)	(0.456)	(0.411)	(0.372)	(0.334)
Obs	599	561	523	487	451	416
Countries	34	34	33	33	32	31
First-Stage F	.	715.3	264.0	144.8	101.6	97.33
Panel C: Recession						
	0.620	0.894**	0.808*	0.323	0.0720	0.0785
	(0.444)	(0.452)	(0.468)	(0.383)	(0.407)	(0.438)
Obs	599	561	523	487	451	416
Countries	34	34	33	33	32	31
First-Stage F	.	729.1	242.9	85.12	65.63	43.55
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	5.20**	1.62	0.79	0.06	0.37	0.31
$p-$value	0.0226	0.2031	0.3746	0.8107	0.5447	0.5751

Notes: Table 4.4 reports the estimated cumulative output multipliers for OECD countries when the measure of 'government expenditure' is social benefits. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Table 4.5: Cumulative Output Multipliers of Compensation of Government Employees for Non-OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.177	-0.0361	-0.109	0.0906	0.179	0.184
	(0.175)	(0.308)	(0.436)	(0.456)	(0.458)	(0.404)
Obs	487	421	365	317	274	238
Countries	48	45	41	37	34	32
First-Stage F	.	174.0	128.5	89.85	66.73	53.27
Panel B: Expansion						
	0.556***	0.385	0.0242	0.189	0.204	0.108
	(0.198)	(0.379)	(0.578)	(0.642)	(0.699)	(0.844)
Obs	487	421	365	317	274	238
Countries	48	45	41	37	34	32
First-Stage F	.	432.7	270.1	258.7	108.1	12.58
Panel C: Recession						
	0.630**	0.133	-0.0336	0.311	0.312	0.359
	(0.284)	(0.288)	(0.406)	(0.402)	(0.330)	(0.292)
Obs	487	421	365	317	274	238
Countries	48	45	41	37	34	32
First-Stage F	.	87.59	81.91	56.07	36.79	30.23
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	0.13	0.82	0.04	0.26	0.27	1.03
$p-$value	0.7163	0.3664	0.8516	0.6120	0.6040	0.3090

Notes: Table 4.5 reports the estimated cumulative output multipliers for Non-OECD countries when the measure of government expenditure is the compensation of government employees. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Table 4.6: Cumulative Output Multipliers of Government Expenditure on Goods and Services for Non-OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	-0.0380	-0.0233	-0.0388	0.0206	0.00412	0.116
	(0.103)	(0.174)	(0.206)	(0.270)	(0.366)	(0.388)
Obs	482	415	358	310	266	231
Countries	48	45	41	37	33	31
First-Stage F	.	517.0	157.7	90.22	49.77	38.07
Panel B: Expansion						
	-0.0803	-0.0224	0.0470	0.206	0.252	0.710
	(0.130)	(0.283)	(0.312)	(0.349)	(0.505)	(0.585)
Obs	482	415	358	310	266	231
Countries	48	45	41	37	33	31
First-Stage F	.	452.3	113.9	84.53	57.13	40.28
Panel C: Recession						
	-0.0163	-0.0500	-0.170	-0.0876	-0.129	0.0684
	(0.141)	(0.207)	(0.220)	(0.278)	(0.363)	(0.460)
Obs	482	415	358	310	266	231
Countries	48	45	41	37	33	31
First-Stage F	.	248.3	67.17	43.83	26.02	21.70
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	1.17	0.03	1.18	1.77	1.32	2.34
$p-$value	0.2794	0.8665	0.2782	0.1829	0.2502	0.1259

Notes: Table 4.6 reports the estimated cumulative output multipliers for Non-OECD countries when the measure of government expenditure is expense on goods and services. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Table 4.7: Cumulative Output Multipliers of Government Investment for Non-OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.389***	0.395**	0.345	0.672	0.490	0.478
	(0.129)	(0.202)	(0.296)	(0.620)	(0.655)	(0.709)
Obs	462	393	337	292	251	218
Countries	49	45	39	35	31	29
First-Stage F	.	835.4	96.10	15.06	20.97	10.80
Panel B: Expansion						
	0.125	-0.0794	-0.157	-0.517	-1.034	-1.514
	(0.112)	(0.235)	(0.549)	(1.466)	(1.885)	(3.280)
Obs	462	393	337	292	251	218
Countries	49	45	39	35	31	29
First-Stage F	.	440.5	36.24	10.69	11.81	2.080
Panel C: Recession						
	0.489***	0.184	-0.00134	0.0878	0.0584	0.318
	(0.176)	(0.243)	(0.319)	(0.693)	(0.797)	(0.828)
Obs	462	393	337	292	251	218
Countries	49	45	39	35	31	29
First-Stage F	.	249.5	212.9	7.079	25.87	15.82
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	9.67***	1.29	0.15	0.37	0.78	0.50
$p-$value	0.0019	0.2559	0.7016	0.5438	0.3776	0.4815

Notes: Table 4.7 reports the estimated cumulative output multipliers for Non-OECD countries when the measure of government expenditure is government investment. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Table 4.8: Cumulative Output Multipliers of Social Benefits for Non-OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	-0.0489	-0.202	-0.0202	0.00574	-0.297	-0.452
	(0.0917)	(0.124)	(0.244)	(0.297)	(0.325)	(0.297)
Obs	446	382	327	277	238	205
Countries	48	45	41	34	31	29
First-Stage F	.	437.0	132.3	60.40	27.20	21.32
Panel B: Expansion						
	0.364**	0.225	0.266	0.285	-0.391	-0.907
	(0.174)	(0.186)	(0.364)	(0.505)	(0.527)	(0.675)
Obs	446	382	327	277	238	205
Countries	48	45	41	34	31	29
First-Stage F	.	392.3	101.9	32.11	13.71	6.905
Panel C: Recession						
	0.0928	-0.120	0.0766	0.164	-0.308	-0.538
	(0.184)	(0.254)	(0.394)	(0.420)	(0.380)	(0.380)
Obs	446	382	327	277	238	205
Countries	48	45	41	34	31	29
First-Stage F	.	368.2	172.4	135.1	70.41	56.14
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	1.79	2.91*	0.58	0.07	0.00	0.00
$p-$value	0.1815	0.0882	0.4463	0.7927	0.9861	0.9440

Notes: Table 4.8 reports the estimated cumulative output multipliers for OECD countries when the measure of 'government expenditure' is social benefits. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 4.1.

Appendix 4.A Data Description

Table 4A.1: List of Countries in the Dataset

OECD Countries		Non-OECD Countries			
1	Australia	1	Albania	36	Peru
2	Austria	2	Armenia, Republic of	37	Romania
3	Belgium	3	Azerbaijan, Republic of	38	Russian Federation
4	Canada	4	Belarus	39	San Marino
5	Chile	5	Bhutan	40	Serbia, Republic of
6	Czech Republic	6	Bolivia	41	Seychelles
7	Denmark	7	Bosnia and Herzegovina	42	Singapore
8	Estonia	8	Brazil	43	South Africa
9	Finland	9	Bulgaria	44	Thailand
10	France	10	China, P.R.: Hong Kong	45	Tunisia
11	Germany	11	Colombia	46	Ukraine
12	Greece	12	Congo, Republic of	47	United Arab Emirates
13	Hungary	13	Costa Rica	48	Uzbekistan
14	Iceland	14	Croatia	49	Yemen, Republic of
15	Ireland	15	Cyprus		
16	Israel	16	Egypt		
17	Italy	17	El Salvador		
18	Japan	18	Georgia		
19	Korea, Republic of	19	Honduras		
20	Latvia	20	Indonesia		
21	Luxembourg	21	Iran, Islamic Republic of		
22	Mexico	22	Jordan		
23	Netherlands	23	Kazakhstan		
24	New Zealand	24	Kiribati		
25	Norway	25	Lesotho		
26	Poland	26	Lithuania		
27	Portugal	27	Macedonia, FYR		
28	Slovak Republic	28	Maldives		
29	Slovenia	29	Malta		
30	Spain	30	Mauritius		
31	Sweden	31	Moldova		
32	Switzerland	32	Mongolia		
33	Turkey	33	Morocco		
34	United Kingdom	34	Myanmar		
35	United States	35	Paraguay		

Table 4A.2: Data Sources and Definitions

Variable	**Definition**	**Source**
Total Government Expense	Total Government Expense (W0|S1|G2)	IMF: Government Financial Statistics (GFS, Expense)
Government Expense on Compensation of Employees	Government Expense on Compensation of Employees (W0|S1|G21)	IMF: Government Financial Statistics (GFS, Expense)
Government Expense on Investment	Government Investment in Non-Financial Assets (G31|NG)	IMF: Government Financial Statistics (GFS, Main Aggregates and Balances)
Government Expense on the Use of Goods and Services	Government Expense on Use of Goods and Services (W0|S1|G22)	IMF: Government Financial Statistics (GFS, Expense)
Government Expense on Social Benefits	Government Expense on Social Benefits (W0|S1|G27)	IMF: Government Financial Statistics (GFS, Expense)
GDP	GDP, PPP (constant 2011 international U.S. Dollars)	World Bank: World Development Indicators
Private Consumption	Household final consumption expenditure	World Bank: World Development Indicators
Private Investment	OECD Countries: Private non-residential gross fixed capital formation, Non-OECD Countries: Gross Fixed Capital Formation, Private Sector	OECD Countries: OECD, Non-OECD Countries: World Bank: World Development Indicators
Debt	Public Debt	IMF: Historical Public Debt (HPDD)
Taxes	Tax revenue (W0|S1|G11)	IMF: Government Financial Statistics (GFS, Revenue)

Table 4A.4: Average Shares of Government Spending (G)

OECD Countries

Definition of G	**% of GDP**	**% of G**
Total Expense	42.59	100.00
Compensation of Employees	10.32	24.43
Goods and Services	6.15	14.76
Investment	3.42	8.44
Social Benefits	15.89	36.87

Non-OECD Countries

Definition of G	**% of GDP**	**% of G**
Total Expense	28.33	100.00
Compensation of Employees	9.11	32.56
Goods and Services	6.35	23.09
Investment	4.87	19.53
Social Benefits	6.83	21.95

Source: Authors' calculations

Chapter 5

The Effects of Government Spending: Evidence from OECD Countries Based on the Functional Classification of Government Expenditure

5.1 Introduction

The size of fiscal multipliers is a well-discussed topic among economists and the literature around it is constantly evolving. However, results tend to differ among studies, leading to the conclusion that some of the components of government spending may follow different transmission mechanisms and interact with the private sector activity in a different way than others. For that matter, it is important to see what are the effects for each component, separately, and the channels through which these effects are transmitted.

In this chapter we estimate disaggregated government spending multipliers, where government spending is classified according to the functional classification, as proposed by IMF (see IMF (2014) for a discussion). Unlike economic classification, which breaks down government spending according to its economic nature and is the one we have seen in Chapter 3 and Chapter 4, the functional classification, organizes government activities according to their purposes (such as defense, education, health, public order and safety, social security etc.). This type of classification is important in analyzing the allocation of resources among sectors. Estimating separate spending multipliers for each component offers a clearer view of the effectiveness of government spending on each sector. These days, when most governments seek to put their finances in order by cutting components of government spending, knowing the sectors in which government spending is less effective, can be crucial.

The majority of empirical studies that use the functional classification of government spending focus on the long-run effects of spending components on growth (Bleaney *et al.*, 2001; Devarajan *et al.*, 1996; Gemmell *et al.*, 2011, 2016; Kneller *et al.*, 1999). In the same spirit, but in a DSGE context, this issue is addressed by Economides *et al.* (2015), Agénor (2008), Agénor & Neanidis (2011), as well as Blankenau & Simpson (2004) and Dioikitopoulos (2014), who focus on education and health. The main idea supported in the above studies, is that public expenditure can be divided into two categories: the ”productive” expenditure and the ”non-productive” expenditure. ”Productive” expenditure components are the ones that enhance long-run growth by assisting private sector productivity. These components are education, health, defense, public order and safety, housing and transport and communication expenditure. On the other hand, ”non-productive” expenditure components are those that aim only at improving citizens' welfare, for example, social protection and welfare expenditure, expenditure on recreation and expenditure on economic services. This type of spending has either no -or sometimes even negative- effect on long-run growth.

Another strand of the literature, focuses on the response of consumption to changes in functional components of government spending. Fiorito & Kollintzas (2004) argue that some of the components, such as defense, public order, and justice constitute ”public goods”, while some other such as education, health, housing and community amenities and recreational, cultural and religious services, are ”merit goods”. The public goods are substitutes to private consumption, while merit goods work as complements to private consumption. This idea has also been verified by Bermperoglou *et al.* (2017), Perotti (2014), Pieroni & Lorusso (2015),Bouakez & Rebei (2007) and Fève *et al.* (2013).

Even though there are many studies who examine the effects of functions of government in the long-run, there are no empirical studies assessing the sort-run effects of spending packages by function. For that matter, this chapter attempts to shed light on this issue, by estimating government spending multipliers of each functional component of government spending. The horizon we consider is five years after the shock. Our results confirm our intuition of heterogeneity among the functions of government spending. More specifically, we find that some functional components are more effective than others, in the sense that they produce higher output multipliers. Defense, public order and safety, recreation, religion and culture, health and education give positive and strong multipliers, whereas multipliers for general public services and economic affairs are negative, and multipliers for housing, environmental protection and social protection are insignificant. Our results agree with the existing literature in that some components are more efficient because they are productive (education, health, defense, public order and safety) or they are complements to private consumption (education, health and recreational, cultural and religious services). In addition, we test whether the results are state-dependent, i.e. they vary with the business cycle, and find that multipliers for education, health, recreation, and social protection are higher in recession than in expansion.

This chapter is organized as follows: Section 5.2 provides a description of the functions of government spending and their parts; Section 5.3 describes the dataset and the methodology, while Section 5.4 presents the results. Finally, Section 5.6 discusses and concludes.

5.2 Functional Classification of Government Spending

The IMF classification of government spending by function includes ten categories: general public services; defence; public order and safety; economic affairs; environmental protection; housing and community amenities; health; recreation, culture and religion; education; and social protection. The complete list of functions and their parts is presented in Table 5A.4. General public services consist of administration, operation, or support of executive or legislative organs, administration and operation of financial and fiscal affairs, administration and operation of external affairs, as well as foreign economic aid. A sizable component of general public services is public debt transactions, i.e. the interest payments and expense for underwriting and floating government loans.[1] Defense includes military defense, civil defense and foreign military aid, while public order and safety includes police services, fire protection services, law courts and prisons. Economic affairs contain government expenses by industry. Examples of spending in this category are: general regulation and supervision of the economy, grants, loans or subsidies to promote certain policies and programs, construction or operation of infrastructure; in industries such as agriculture, energy, manufacturing, transport, and communication[2]. Environmental protection includes waste management, waste water management, pollution abatement, and protection of biodiversity and landscape. Housing and community amenities consist of operations relevant to households, such as community development, water supply, and, street lighting. Health includes medical products, appliances and equipment, outpatient services (e.g. services delivered at home or the outpatient clinics of hospitals), hospital services, and public health services (e.g. blood-bank operation); recreation, culture and religion includes recreational and sporting services, cultural services, broadcasting and publishing services, and religious and other community services, while education includes spending on all levels of education. Finally, social security incorporates all types of benefits, such as sickness and disability, old age, survivors, family and children, unemployment, and housing.

To get a feeling of the different categories of governmnet spending, Table 5A.6 and Table 5A.7 present the shares of the components of government spending on total government spending and GDP, respectively, for OECD countries. The largest share of government expenditure in 2015 is owned by social protection, which has an average of 32.6% among OECD countries. Health has the second largest share, which reaches up to 18.7% of total government expenditure. General public services and education follow with an average of 13.2% and 12.6% of government expenditure, respectively. Economic affairs account for 9.3% of total expenditure, while defense and public order and safety are very close with an average of 5.14% and 4.3%, respectively. The lowest shares, though, are those of recreation, culture and religion

[1]In 2015, the average share of public debt transactions in general public spending among the European member countries of the OECD was 38%, while the average share of administration services was 31.2% (OECD, 2017, Table 2.36).

[2]Transport owns the biggest share on economic affairs, which is 47.6% for the average of European member countries of OECD in 2015; General economic, commercial and labour affairs follows with 22%; while the shares of the rest of the industries are below 10% (OECD, 2017, Table 2.38)

(1.5%), housing and community amenities (1.4%), and, environmental protection (1.3%).

We should highlight here that some of the components of government spending discussed above are more endogenous than others, in the sense that they respond to fluctuations in output (i.e. they are countercyclical) e.g. social protection. This makes identifying government spending shocks to such components a difficult task. But decided to proceed by adopting a common identification scheme below, so that our results are easier to compare with those obtained in the previous chapters of this thesis, as well as the existing literature.

5.3 Data and Methodology

5.3.1 Data

We have collected annual data for the period covering 1991 to 2016 on 31 OECD countries. The full list of countries in our dataset can be found in Table 5A.1 in the Appendix. All of our variables come from IMF, except for GDP, which comes from WDI. Data sources and definitions are given in Table 5A.2.

Note that we use Gordon and Krenn data transformation, that is we divide all variables by an estimate of potential output. Even though some of the spending variables in this chapter (such as education, health, etc) may affect potential output in the long-run, this is so log horizons definitely well beyond the five year horizon that we employ here. So we assume that changes in these types of spending do not affect current periods potential output, and focus on their effect on cyclical changes in output.

5.3.2 Identification of Fiscal Spending Shocks

In order to identify the effects of different components of government spending we employ a variant of the methodology discussed in Corsetti *et al.* (2012), which follows the strategy of Perotti (1999) and Tagkalakis (2008). We do so for two reasons. First, standard VARs are unsuitable for our purposes as the time span of the data available is relatively short (we have a maximum of 25 observations per country), and the estimated effects would be imprecisely estimated – let alone the fact that our panel is unbalanced. Second, as we would also like to assess the effects of fiscal spending shocks in different economic environments (e.g. in periods of recessions and expansions of the economy), the two-step approach adopted here allows for considerable flexibility in estimating such effects.[3]

The first step in our work consists of obtaining series of fiscal policy innovations for each country i in the sample, for different components of fiscal spending. The usual practice in the literature has been to use the log variables (for example GDP and government spending) and

[3]Using linear panel VARs it would be possible to examine differences of the effects of government spending across subsets of the data, using sample splits, but it would be difficult to account for time-varying regimes, such as presence of a recession.

transform the estimated elasticities into impulse responses ex post, using the sample average of the ratio of GDP to government spending (see e.g. Auerbach & Gorodnichenko, 2012b). Ramey & Zubairy (2018) explain that such practice might cause biases due to variations of the sample average – which applies to our case as well, with sample averages varying considerably across countries. To avoid such bias, we follow the suggestion of Ramey & Zubairy (2018) and employ the Gordon & Krenn (2010) transformation: we divide government spending and GDP by an estimate of potential, or trend GDP.[4] This puts all variables in the same units, which means that there is no need for an ex-post transformation, also making the interpretation of impulse responses easier.

With this transformation at hand, following Corsetti *et al.* (2012) we postulate a fiscal policy rule of the form:

$$g_{i,t} = \alpha_i + \lambda_1 g_{i,t-1} + \lambda_2 g_{i,t-2} + \gamma_1 gdp_{i,t-1} + \gamma_2 gdp_{i,t-2} + \delta debt_{i,t-1} + \tau tax_{i,t-1} + \theta trend_t + \varepsilon_{i,t} \tag{5.1}$$

where $g_{i,t}$ denotes government spending, $gdp_{i,t-1}$ is real output, $trend_t$ denotes a deterministic time trend and $\varepsilon_{i,t}$ captures discretionary policy changes. In order to account for the role of financing as well as the level of outstanding liabilities of the government, we control for taxes by adding one lag of the average tax rate (revenues as a ratio of GDP) $tax_{i,t}$,and one lag of the debt-to-GDP ratio, $debt_{i,t-1}$. Because of the unbalanced nature of our panel dataset, we do not allow for country-specific coefficients in the policy rule, but rather we pool the coefficients across countries. It is important to highlight that by estimating (5.1) we posit a fiscal policy rule in the spirit of the rule adopted in Blanchard & Perotti (2002): identification is achieved by assuming that spending cannot respond simultaneous output changes, but only to past growth developments. Note furthermore that the Blanchard-Perotti identification has been employed on annual data by authors like Beetsmaa *et al.* (2006) and Bénétrix & Lane (2013b).[5]

5.3.3 Model Estimation Using Local Projections

Having obtained our fiscal policy innovations ($\hat{\varepsilon}_{i,t}$) from (5.1), in a second step we trace the dynamic effects of these innovations on key macroeconomic variables of interest.[6] To this end we use the method of local projections proposed by Jordà (2005).[7] In particular, in the linear case (where we abstract from any variations in the state of the economy), we estimate a model of the form:

$$y_{i,t+h} = \eta_{i,h} + \beta_h \hat{\varepsilon}_{i,t} + \boldsymbol{\psi}_h (L) \mathbf{x}_{i,t-1} + \kappa_h trend_t + v_{i,t+h} \tag{5.2}$$

[4]In order to estimate (log) trend real output, we fit log real GDP to a third-degree polynomial in time, on a country-by-country basis. Then "potential GDP" is estimated as an exponential trend.

[5]Born & Müller (2012) show that this timing assumption is valid with annual data for the United States, United Kingdom, Canada, and Australia. Beetsmaa *et al.* (2009) also present an alternative test which reaches the same conclusion.

[6]We use the normalized shock, i.e. the shock is divided by its standard deviation.

[7] See also Auerbach & Gorodnichenko (2012a), Auerbach & Gorodnichenko (2013), Jordà & Taylor (2016), Owyang *et al.* (2013) and Ramey & Zubairy (2018) inter alia for applications employing local projections methods.

where $y_{i,t+h}$ denotes a variable of interest (such as government spending itself and GDP) h periods after the shock, $\mathbf{x}_{i,t-1}$ is a vector of control variables, $\boldsymbol{\psi}_h(L)$ is a polynomial in the lag operator and $trend_t$ is a time trend. The vector $\mathbf{x}_{i,t-1}$ includes two lags of government spending, two lags of GDP, one lag of debt and one lag of tax rate – similar to (5.1) above. We estimate this model with fixed effects panel regressions for an horizon of 5 years after the shock, i.e. we estimate the above equation for $h = 0, ..., 5$. In this context the parameter β_h defines the response of y to a shock in period t, h periods after the shock. Gathering up all the β_h's, provides us with the Impulse Response Function (IRF) of the specific variable y.

The local projection approach can easily be adopted to estimating non-linear models. In particular, when we wish to estimate a state-dependent model, this is easily done by estimating:

$$\begin{aligned} y_{i,t+h} &= \eta_{i,h} + (1 - F(z_{i,t-1})) \left[\beta_{E,h}\hat{\varepsilon}_{i,t} + \boldsymbol{\psi}_{E,h}(L)\mathbf{x}_{i,t-1} \right] \\ &\quad + F(z_{i,t-1}) \left[\beta_{R,h}\hat{\varepsilon}_{i,t} + \boldsymbol{\psi}_{R,h}(L)\mathbf{x}_{i,t-1} \right] + \kappa_h trend_t + v_{i,t+h} \end{aligned} \tag{5.3}$$

where $F(.)$ is the transition function, which is given by the logistic function:

$$F(z_{i,t}) = \frac{exp(-\gamma z_{i,t})}{1 + exp(-\gamma z_{i,t})}, \text{ with } \gamma > 0. \tag{5.4}$$

Here $F(z_{i,t})$ can be interpreted as the probability of being in a recession, given the state of the economy $z_{i,t}$. The parameter γ shows the smoothness of the transition between regimes: when $\gamma = 0$, we get the linear case, while when γ takes on very high values, the state indicator resembles a usual dummy. We choose $z_{i,t}$ to be the 2-year moving average of GDP growth rate (normalized). When $F(z_{i,t}) = 1$ the economy is in extreme recession, while when $F(z_{i,t}) = 0$ the economy is in extreme expansion. We follow Auerbach & Gorodnichenko (2012a) and set $\gamma = 1.5$.[8] The vector $\mathbf{x}_{i,t-1}$ is the same set of control variables as in (5.2), $\boldsymbol{\psi}_{E,h}(L)$ and $\boldsymbol{\psi}_{R,h}(L)$ are polynomials in the lag operator in expansions and recessions, and $\{\beta_{E,h}\}_{h=0}^{H}$ and $\{\beta_{R,h}\}_{h=0}^{H}$ are the responses of y in a state of expansion and recession respectively, to a shock in period t, h periods after the shock. In our work we employ clustered standard errors at the country level.

5.3.4 Cumulative Multipliers

In order to capture the dynamic effects of government spending on output and compare our findings with those of the existing literature, it is possible to compute multipliers that measure the effect of an increase in government expenditure on output some h periods after the shock, or to compute cumulative multipliers. The latter answer the policy question of interest, as they measure the cumulative change in GDP relative to the cumulative change in government spending for horizons of up to h years-ahead – we compute multipliers for up to five-year-ahead

[8] Auerbach & Gorodnichenko (2012a) calibrate γ, so that the economy spends about 20% of time in recession, where they define an economy to be in a recession if $F(z_{i,t}) > 0.8$. This is consistent with the duration of recessions in the US.

in our work.[9]

It is be possible to estimate cumulative multipliers (in linear models) using the following three steps: (1) estimate equation (5.2) for output and government spending, for each horizon up to h; (2) sum β_h's for output and government spending, respectively; and, (3) compute the cumulative multipliers as the ratio of the sum of β_h's for output to the sum of β_h's for government spending. Ramey & Zubairy (2018) suggest an alternative method which is equivalent to above procedure but produces multiplier estimates in one step. In particular, the 1-step procedure consists of an instrumental variable estimation of the sum of GDP on the sum of government spending, using the estimated shock as an instrument.[10] The clear benefit of the 1-step procedure is that while being similar to the 3-step estimation strategy, it provides us with a point estimate of the multiplier but also with a standard error, making inference on multipliers easier.

Lets us first consider the model in the linear case, which reads:

$$\sum_{j=0}^{h} y_{i,t+j} = \chi_{i,h} + m_h \sum_{j=0}^{h} g_{i,t+j} + \boldsymbol{\psi}_h(L)\mathbf{x}_{i,t-1} + \phi_h trend_t + \omega_{i,t+h}, \quad h = 0, 1, \cdots, 5 \quad (5.5)$$

where $\sum_{j=0}^{h} y_{i,t+h}$ is the sum of GDP from t to $t+h$, $\sum_{j=0}^{h} g_{i,t+h}$ is the sum of the government spending component from t to $t+h$. The idea is to use the estimated shock $\hat{\varepsilon}_{i,t}$, as an instrument for $\sum_{j=0}^{h} g_{i,t+h}$. Then, m_h is the h-period cumulative output multiplier.

In the state-dependent case, we estimate an equation of the form:

$$\begin{aligned}\sum_{j=0}^{h} y_{i,t+j} \quad = \quad & \chi_{i,h} + (1 - F(z_{i,t-1})) \left[m_{E,h} \sum_{j=0}^{h} g_{i,t+j} + \boldsymbol{\psi}_{E,h}(L)\, \mathbf{x}_{i,t-1} \right] + \\ & F(z_{i,t-1}) \left[m_{R,h} \sum_{j=0}^{h} g_{i,t+j} + \boldsymbol{\psi}_{R,h}(L)\, \mathbf{x}_{i,t-1} \right] + \phi_h trend_t + \omega_{i,t+h}, h = 0, 1, \cdots, 5\end{aligned} \quad (5.6)$$

where we use $F(z_{i,t-1}) \cdot \hat{\varepsilon}_{i,t}$ and $(1 - F(z_{i,t-1})) \cdot \hat{\varepsilon}_{i,t}$ as instruments for $F(z_{i,t-1}) \cdot \sum_{j=0}^{h} g_{i,t+j}$ and $(1 - F(z_{i,t-1})) \cdot \sum_{j=0}^{h} g_{i,t+j}$, respectively. This procedure provides us with state-dependent multipliers $m_{E,h}$ and $m_{R,h}$ and their associated standard errors – we also employ clustered standard errors when estimating multipliers.

[9] Since we employ the Gordon & Krenn (2010) transformation — i.e. we divide all variables with an estimate of potential GDP – all variables are expressed in the same units, hence we avoid the need for an ex-post transformation.

[10] Ramey & Zubairy (2018) explain that the multipliers from the two procedures should be equal if one uses the exact same sample for all of the regressions and also drops the last h observations.

5.4 Results

5.4.1 Main Findings for OECD Countries

Here, we present our empirical findings regarding the effects of different components of government expenditure according to their functional classification. In particular, Figures 5.1-5.10 present the IRFs of government expenditure components and output, estimated using Equation 5.2 and Equation 5.3. They show the response of each variable when a shock to the respective component of government spending increases government spending by 1% of GDP (changes are also measured in percent of potential GDP). On the other hand, Tables 5.1-5.10, present cumulative multipliers estimated using Equation 5.5 and Equation 5.6, for the linear and the state-dependent case, respectively.

The IRF of output when government expenditure is defined as general public services (Figure 5.1), indicates a negative effect on output, a few years after the shock. In the linear case it is equal to -0.74%, 3 years after the shock, and reaches up to -1.12%, 5 years after the shock. We get a similar result in expansion, while in recession there is a negative effect in year 2 (-0.74%). Cumulative multipliers in Table 5.1 imply the same; the only difference is in expansion, where the multiplier on impact is equal to 0.762. This is also the only year in which multipliers in expansion differ than those in recession, according to tests of equality of multipliers in Panel D. For years 3-5, multipliers are negative and increase in magnitude as we move in time, reaching up to -1.6 under the linear specification and -2.5 in the non-linear model. The negative effect of general public services on output is not surprising, since a large part of this component are expenses that are not directed back to the economy, such as public debt transactions. The negative multiplier we find agrees with Gemmell *et al.* (2016), who also find a negative effect of public services on GDP growth.

Figure 5.2 describes the effects of an increase in government expenditure on defense on output. We can see that in the linear specification a 1% of GDP in defense, increases output by 1.47% on impact, but then the effect becomes insignificant. The effect is also found to be insignificant in expansions and recessions. The estimated cumulative multipliers (Table 5.2) suggest the same, with the multipliers on impact being equal to 1.47 for the linear case, 1.73 in expansion and 2.64 in recession. The effect of the shock remains significant for another year in the linear model and in expansion, but is insignificant at all other horizons and specifications. Tests of equality of multipliers in expansion and recession do not indicate any sign of state-dependence. The linear multiplier is close to what Ramey (2011b), Auerbach & Gorodnichenko (2012b) and Zervas (2016) find for U.S., but a little higher than Owyang *et al.* (2013) and Ramey & Zubairy (2018) (2-year integral multiplier between 0.6-0.7). In the non-linear model, our results are a little higher than those reported in Ramey & Zubairy (2018) for U.S., but our findings also point in the absence of state-dependence. However, our recession multiplier is close to Auerbach & Gorodnichenko (2012b), who find a high multiplier in recession, reaching up to 4.

Government expenditure on public order and safety (Figure 5.3) has a similar patten with defense. In the linear specification, output has a positive response for the first two years after the years after the shock, which is equal to 2.71% on impact, 4.26% and 4.61% one and two years after the shock, respectively. After that, the effect vanishes. In expansion, the response of output is initially zero, becomes significantly positive only at two years after the shock (8.55%), and then becomes insignificant again. On the other hand, in recession, there is a positive effect on impact equal to 7.63% of GDP and 10.23% in year 1, which vanishes at long horizons. The estimated cumulative multipliers in Table 5.3 agree with the above patterns, since multipliers are strongly significant and large in magnitude for horizons 0,1 and 2 years ahead, but they become insignificant after that. It seems that they peak at year 1, where the multipliers are 3.29 for the linear case, 5.28 in expansions and 9.3 in recessions. A formal test of equality of multipliers in expansions and recessions, suggests that the multipliers are indeed different under the two states, on impact and one year after the expenditure increase. Expenditure on public order and safety, aims at ensuring the protection of property rights, which in turn sets the bases for private economic activity. Therefore, the response of output to public order and safety is positive and strong. The multiplier is also higher in recession than expansion, most likely because in recession, households lack liquidity and are less likely to spend on protecting their property rights; government expense on that matter will be more effective.

Economic affairs, on the other hand, seem to produce a negative effect on output (Figure 5.4). In the linear specification, the response of output is negative and less than -0.5, everywhere but the five-year horizon (in which it tends to increase). In expansion it follows the same pattern, but in recession it is zero for horizons up to four years, and negative at a five year horizon, at which it goes down to -1.11. The cumulative multiplier (Table 5.4) for the linear specification is also negative and varies from -0.07 to -2.08 (at the four-year horizon). In expansion, it is -0.926 and -1.81 at horizons of one and tw years, respectively, and zero everywhere else; while in recession, varies from -0.15 to -2.4 (it also peaks at a four-year horizon). In addition, the multipliers in expansion and recession differ at the one-year horizon, with the multiplier in recession being larger. According to previous studies who employ the functional classification (Bleaney *et al.*, 2001; Gemmell *et al.*, 2011, 2016; Kneller *et al.*, 1999), economic affairs contain a productive part (transport and communications expenditure, or infrastructure in general), as well as a non-productive part (economic services, which consists mainly of sector spending (e.g. agriculture, forestry) of subsidies or grants, etc.). Even though conventional wisdom suggests that infrastructure increases growth, these productive results are usually visible in the long-run, since new infrastructure inputs will require a few years before they are fully constructed and operative. Therefore, in the short-run horizon we test here, even the productive parts act as non-productive, resulting to a negative multiplier.

Figure 5.5 shows that government expense on environmental protection is mostly ineffective, both in the linear and the non-linear model. On the other hand, cumulative multipliers in Table 5.5 show that there are some effects in expansion and in recession, even though the multipliers in the linear specification are invariable insignificant. In expansions, the multiplier varies from 3.476 to 4.844 over the first 2 years after the shock. In recessions, although it is insignificant on impact, it takes on values from 2.533 to 9.298 over horizons of up to 5 years. However, formal tests in Panel D indicate that we are unable to reject the null of no state-dependence. Our results, therefore, imply that government expense on environmental protection has a strong effect on output both in expansions and recessions, although in recessions, it is more persistent and increases over time. This is because environmental protection strategies impose regulations and restrictions to firms, who are forced to change their policies over time. These changes, however, take years to implement; therefore, the effects of environmental protection policies are more visible as times goes by.

Housing and community amenities is one of the productive components of government spending, so we would expect a positive effect on output. However, Figure 5.6 and Table 5.6 suggest that the response of output to a shock in housing and community amenities will be either zero or negative. The only statistically significant result is a negative response of output in the linear and the expansion case, 4 and 5 years after the shock, as depicted in Figure 5.6. On the contrary, cumulative multipliers (Table 5.6) are all insignificant. These findings are in line with evidence reported in Gemmell *et al.* (2016), who also find an insignificant result of housing on output. As in economic affairs (infrastructure), the type of expenditure provided in this category (e.g. water supply, street lighting), requires several years to implement; therefore, the productive results are not visible in the short-run horizon we test here.

Government expenditure on health is believed to trigger a positive effect in the long-run growth, by increasing private sector productivity (Gemmell *et al.*, 2016; Kneller *et al.*, 1999). In accordance with this view, but at shorter horizons in Figure 5.7 we can see that the response of output is positive for horizons up to three years after the shock and reaches up to 4.02% at a two-year horizon. In expansion, the effect is found insignificant on impact, but then it reaches 3.56% three years after the shock, and becomes insignificant thereafter. The effects during recession follow a similar pattern as the linear specification. When looking at the cumulative multipliers in Table 5.7 we note that they are almost everywhere significant, positive, and increasing at longer horizons. In the linear model, multipliers range from 0.797 to 1.514; in expansion they vary from 1.662 to 2.270, while in recession from 1.456 up to 3.074. Testing to see whether multipliers differ in expansions and in recessions in Panel D, we find that this is indeed the case with multipliers in recessions being higher. A possible interpretation of this finding is that an increase in government expenditure on health translates quickly in higher health conditions for the labor force and the general public, and results in higher (short-term) productivity gains and output.[11] Moreover, the fact that the multipliers of government health spending are found to be larger in recessions probably reflects the fact that during recessions, the number of households

[11]This of course does not imply that the productivity improvements are not spread to horizons much longer that the ones study here, in accordance with the theoretical models of Agénor & Neanidis (2011); Dioikitopoulos (2014); Economides *et al.* (2015) and the empirical findings in Gemmell *et al.* (2016); Kneller *et al.* (1999).

facing liquidity constraints rises, and private health services become unaffordable, with a large fraction of individuals substituting private for public health services. Under such conditions, government expenditure on health will be more effective.

Expenditure on recreation, culture and religion (Figure 5.8) has a positive effect on output. In the linear specification, the response of output is 3.58% on impact, peaks at 4.82% of GDP one year after the shock, and then starts to diminish, until it dies out in the last two years. In expansion, the effect is zero, while in recession, its starts with being insignificant, attains a rise of 5.96% in the next year, and then remains positive and reaches up to 7.30%, 5 years after the shock. The multiplier on recreation, under the linear specification is large (varies from 3.588 to 4.341) and is significant everywhere. In expansion it is 2.337 on impact, but effectively zero afterwards. In recession, the multiplier is again significant everywhere, and it goes from 2.631 to 6.748. Tests of equality of multipliers in expansion and recession, in Panel D, suggest that the multipliers differ in years three to five. Even though recreation, culture and religion is classified as a non-productive type of government expenditure, which does not help in increasing output in the long-run (Kneller *et al.* (1999)), it is consider to act as complement to private consumption (Fiorito & Kollintzas, 2004). However, our results show that, in the short-run, increasing recreation expenditure, increases citizens' welfare and private consumption, which has has a strong and positive effect on output.

In Figure 5.9, we can see that the response of output in a 1% increase of government expenditure on education is 1.02% on impact and 1.62% two years after the shock. For all of the other horizons it is zero. In expansion, it follows a similar path, in which it becomes significant only in years two and three, where it is equal to 3.38% and 4.57%, respectively. In recession, the pattern is different; there is a response in output on impact, equal to 2.19% and one year after the shock, equal to 2.87%, but after that the effect fades away. Table 5.9 presents the cumulative multipliers for public expenditure on education. The multiplier in the linear model varies from 1.024 on impact to 1.607, four years after the shock, and 2.229, 5 years after the shock, but is insignificant in the in-between periods. There is a similar behavior in expansion, with the multiplier reaching up to 4.953 in the 5-year horizon. In recession it is significant everywhere but year three, while it ranges from 1.956 to 4.821. It should be noted that the multipliers increase in magnitude over the years. Many theoretical models and empirical studies predict that education is growth-enhancing in the long-run, since it is translated into investment in human capital. Our results agree with that notion, while they also show that the productive effects of education are observable even in the short-run. The tests of the equality of multipliers indicate a difference in the multipliers for the first two periods only, in which the recession multiplier is larger. Therefore, as opposed to expansion, in recession, output has a strong reaction even in the first years after the shock, implying that government expenditure on education is absorbed faster in a recessive state.

Finally, Figure 5.10 implies that output, most of the time, does not respond to an increase in social protection. Multipliers as given in Table 5.10, agree with that result in the linear case.

In expansion, the multiplier is significant and around 0.74 during the first three years, but then becomes insignificant. In recession, it is significant only one year after the shock, and is equal to 0.575. Tests of the equality of multipliers suggest that multipliers on impact are different between expansion and recession, but with the multiplier of expansion being larger this time. Previous studies (such as Gemmell *et al.* (2016)), suggest that social protections should have a zero or negative effect on long-run growth. In the linear case we find a zero effect, but we show that under expansion or recession there is a temporary, but positive effect on output.

5.4.2 Inspecting the Transmission Mechanism

The fact that we observe different multipliers for different components of government spending implies that each government spending type diffuses in the economy following a certain path that depends upon the nature of government spending. The aim of our study is to reveal the channels through which, each government spending component affects output and economic activity, in general. Our intuition leans towards the existence of three different transmission channels.

The first channel, as we have already discussed, is the ”productivity” channel which is supported by Kneller *et al.* (1999), Bleaney *et al.* (2001), Gemmell *et al.* (2011) and Gemmell *et al.* (2016). According to this idea some types of expenditures are productive in the sense that they contain a (physical or human) capital component, which supports private sector productivity. They produce a positive effect on output, which is more obvious in the long-run. Examples of productive components are: general public services (administration services), defense, public order and safety, economic affairs (infrastructure), housing and community amenities, education and health. On the other hand, some others are non-productive, as they aim only at increasing social welfare; for example, social protection, and recreation, culture and religion. They are expected to induce an insignificant or even negative effect on output. Our findings partly confirm this hypothesis. We can see that components such as defense, public order and safety, health and education give positive and strong multipliers. On the contrary, multipliers for general public services and economic affairs are negative[12], while multipliers for housing and social protection are insignificant.

The second channel is the ”complementarity” channel, as described by Fiorito & Kollintzas (2004). They believe that some types of government spending are more likely to extract a positive reaction from private consumption than others. This depends crucially on the degree of complementarity between publicly and privately provided goods. They distinguish between ”public goods”: defense, general public services and public order and safety; and ”merit goods” education, health, housing and community amenities and recreational, cultural and religious services. Public goods are considered to be substitutes to private consumption, while merit

[12] It should be noted, however, that general public services and economic affairs are not purely ”productive” expenditures, as they also contain ”non-productive” expenditures, such public debt transactions and economic services.

goods are considered to be complements. For instance, increasing public schooling will increase demand for books, newspapers and magazines, since educated people tend to read more. Or, health spending will be associated to increased private consumption, since healthy people tend to engage in several activities, e.g. traveling, eating in restaurants, attending theaters, etc. The increase in consumption leads to a higher output multiplier. Our results suggest that this type of transition channel exists. Comparing between the overall effects, as described by the 5-year cumulative output multipliers, we see that among the ”productive” components, education and health have higher multipliers than defense, public order and safety, or general public services, implying the existence of complementarity between them and private consumption. Recreation also bears a very high and significant multiplier, despite the fact that is one of the ”non-productive” components.

Finally, a third channel arises through the wealth effect created by an increase in government spending. ”Public goods” are provided exclusively by the government, while ”merit goods” can be either publicly or privately provided. When the government provides a good that could otherwise be privately purchased, such as education or health services, it reliefs the household of that burden, creating a positive wealth effect. This positive wealth effect, which is absent in the case of public goods, causes households to increase their private consumption and investment expenses. In the presence of rule-of-thumb consumers, the reason consumption increases is straight-forward. But even if households are optimizing, the positive wealth effect mitigates the negative wealth effect created by the anticipation of future taxes. Therefore, compared to an increase in public goods spending, an increase in merit goods spending is expected to increase (or reduce by a smaller amount) consumption and investment, and, in turn, output, implying a higher multiplier for ”merit goods” than ”public goods” spending. Note that the ”wealth” channel operates in the same direction as the ”complementarity” channel. As we have already discussed above, our results confirm such a hypothesis.

5.5 Robustness Analysis

In order to test the validity of our results we conduct a series of robustness analysis. First of all, we test what happens when we try out alternative definitions for the state variable z, such as: the 2-year moving average of GDP growth rate, detrended with Hodrick-Prescott filter; log GDP, detrended with Hodrick-Prescott filter; and the unemployment rate. The results we get in all of the above cases are similar to our baseline specification.

In addition, since we use the Gordon-Krenn data transformation (that is we divide all variables with an estimate of potential GDP), it is important to check whether the way we estimate potential GDP affects our results. In our baseline specification potential GDP is estimated by fitting log real GDP to a third-degree polynomial in time, on a country-by-country basis, and then use its exponential. We consider two alternative specifications: one in which potential GDP is estimated through a second-degree polynomial in time, and one in which potential GDP is given by the trend GDP estimated by the Hodrick-Prescott filter. In both cases our results do not change.

5.6 Conclusions

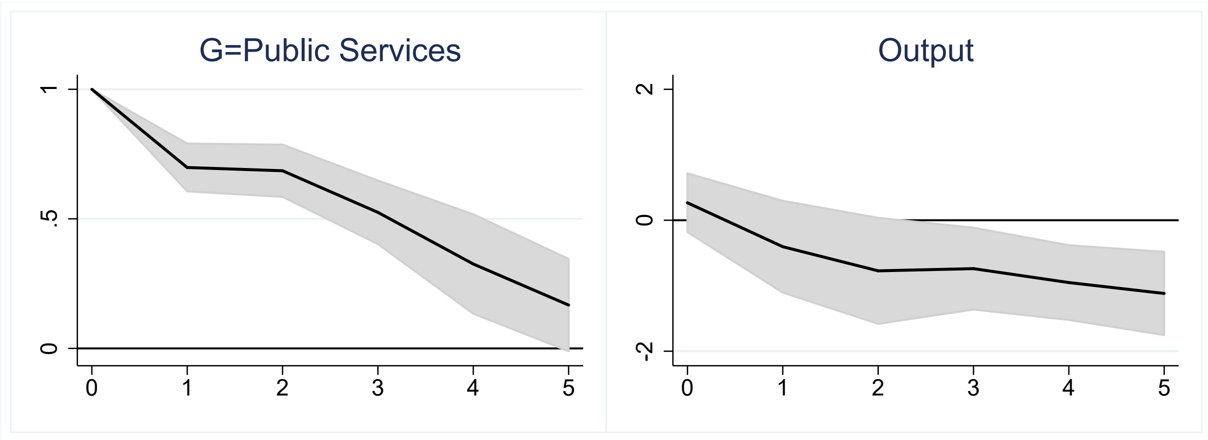
In this chapter, we have estimated short-run multipliers for government spending over the business cycle. Even though many studies have addressed the effects of government spending on long-run growth in the past, there are no empirical studies on the short-run effects on output. Our work attempts to extend the existing literature by covering this issue. Government spending is disaggregated according to the functional classification, as proposed by the IMF. More specifically, we estimate output multipliers for the ten following categories of government spending: general public services, defense, public order and safety, economic affairs, environmental protection, housing and community amenities, health, recreation, culture and religion, education, and social protection. We use data for a panel of 31 OECD countries, for the time-period 1991-2015. We report impulse response functions of output, which are estimated using local projections as proposed by Jordà (2005), and cumulative output multipliers, estimated as in Ramey & Zubairy (2018).

Our results indicate that some functional components are more effective than others, since they produce higher output multipliers. Defense, public order and safety, health and education give positive and strong multipliers, whereas multipliers for general public services and economic affairs are negative, and multipliers for housing and social protection are insignificant. In addition, multipliers for education, health, recreation, and social protection are higher in recession than in expansion.

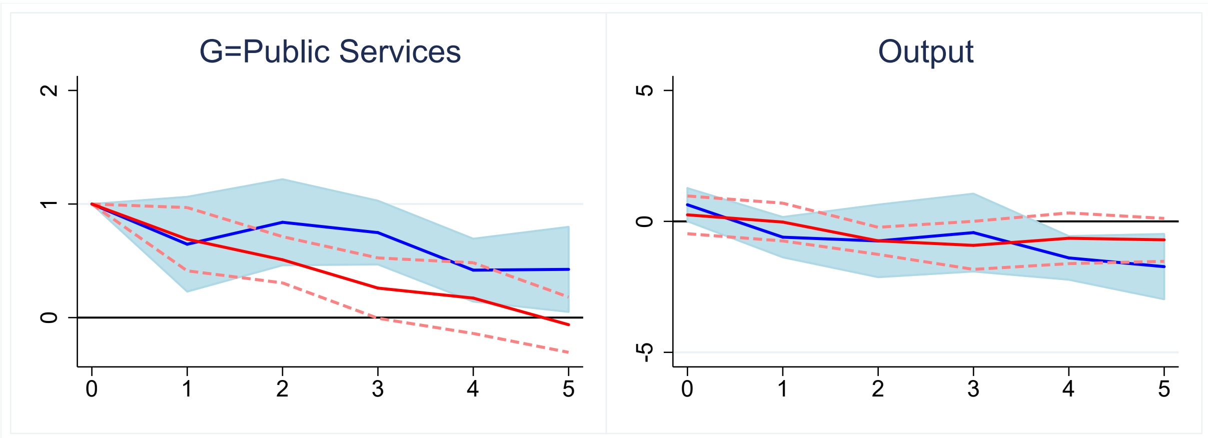
In an attempt to specify the transition mechanism, we suggest the existence of three possible transmission mechanisms: the ”productive” channel, the ”complementarity” channel, and the ”wealth” channel. The first suggests that components that assist private-sector productivity, such as defense, public order, housing, education and health enhance output growth. Indeed, we find that all of the above categories (except for housing which is insignificant) have positive and strong output multipliers. On the other hand, the ”complementarity” channel claims that public goods (such as defense and public order) are substitutes to private consumption, while merit goods (such as education, health, and recreation) are complements. Our results confirm this idea, since we find bigger multipliers for merit goods than public goods. Finally, a ”wealth” channel, operating in the same direction as the ”complementarity” channel, suggests that there is a positive wealth effect for households when they receive merit goods, which is not present in the case of public goods.

Figure 5.1: Responses to a shock to General Public Services for OECD countries

(a) Linear Specification



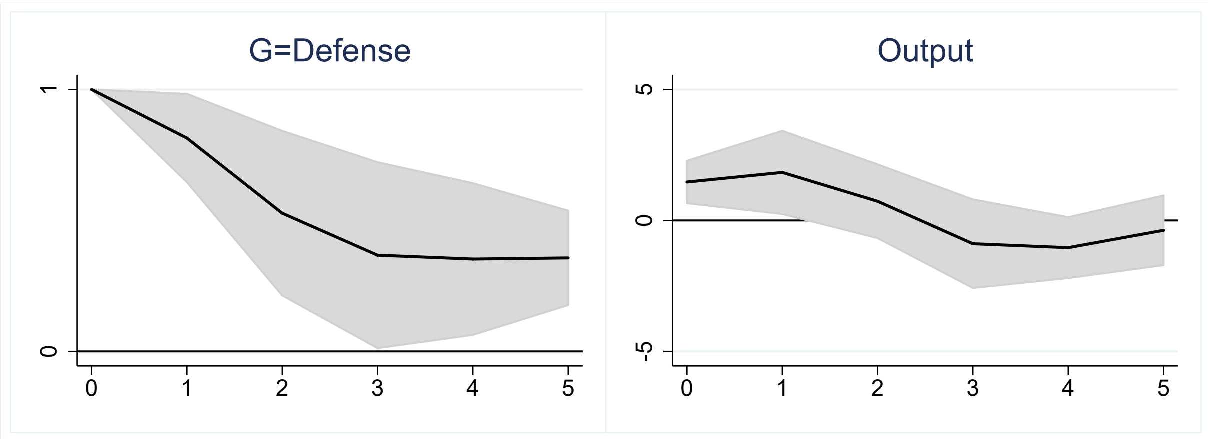
(b) State-Dependent Specification



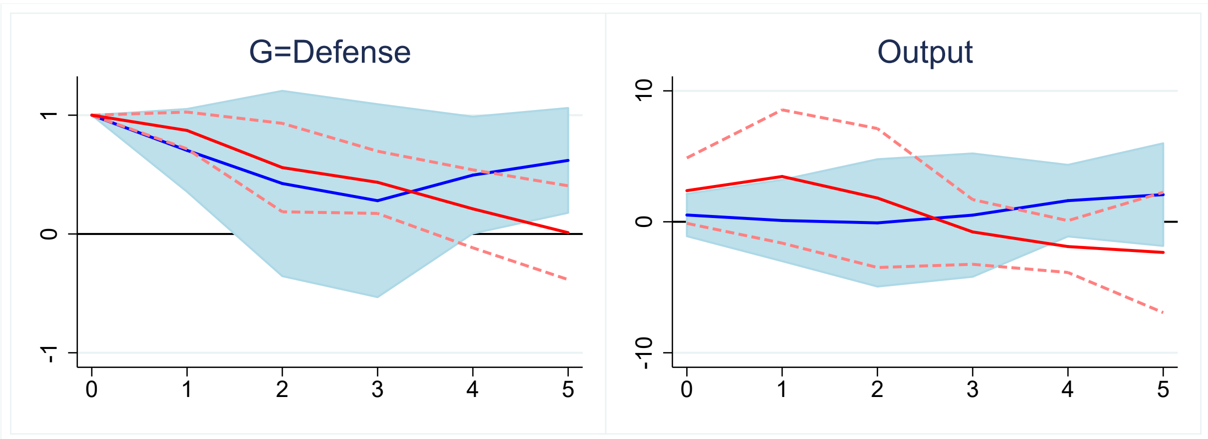
Notes for Figure 5.1. The figure reports the effects of a shock which raises government expenditure on general public services by 1% of GDP. The shock was obtained by estimating (Equation 5.1).The responses have been estimated using the method of local projections (Jordà, 2005) i.e. by estimating (Equation 5.2) in the top and (Equation 5.3) in the lower panel for each variable of interest (government spending, GDP). In panel (a) solid lines are point estimates and shaded areas denote the 90% confidence regions. In panel (b) solid blue lines and the shaded areas are the point estimates and the 90% confidence regions in the expansion state; and solid red lines and the regions by dashed lines are the point estimates and the 90% confidence regions in the recession state. The confidence regions have been constructed using clustered standard errors at the country level. The horizon is in years after the shock.

Figure 5.2: Responses to a shock to Defense for OECD countries

(a) Linear Specification



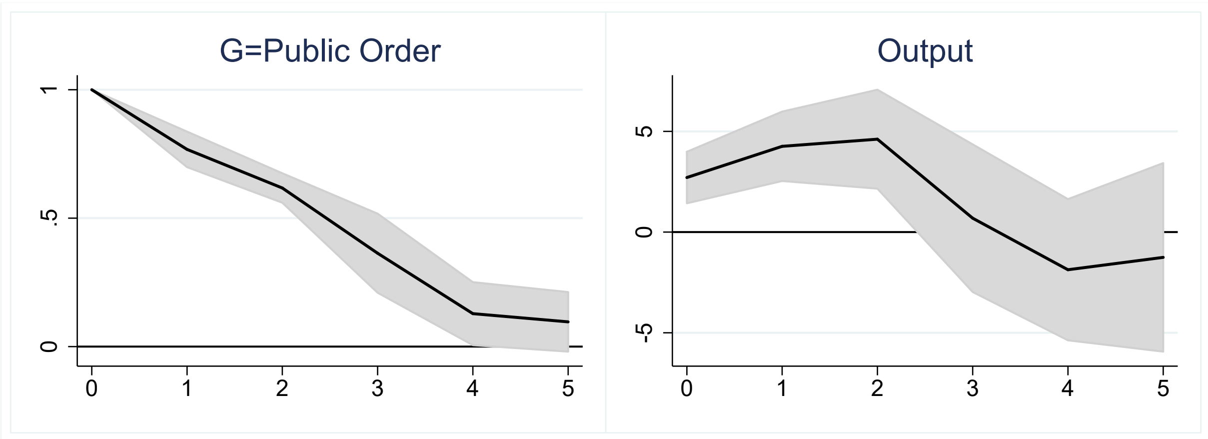
(b) State-Dependent Specification



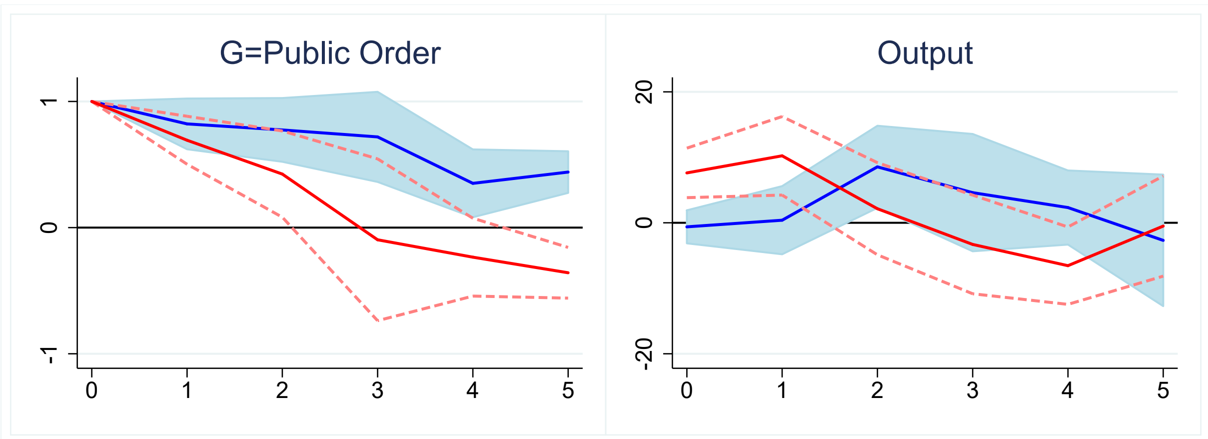
Notes for Figure 5.2. The figure reports the effects of a shock which raises government expenditure on public order and safety by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.3: Responses to a shock to Public Order and Safety for OECD countries

(a) Linear Specification



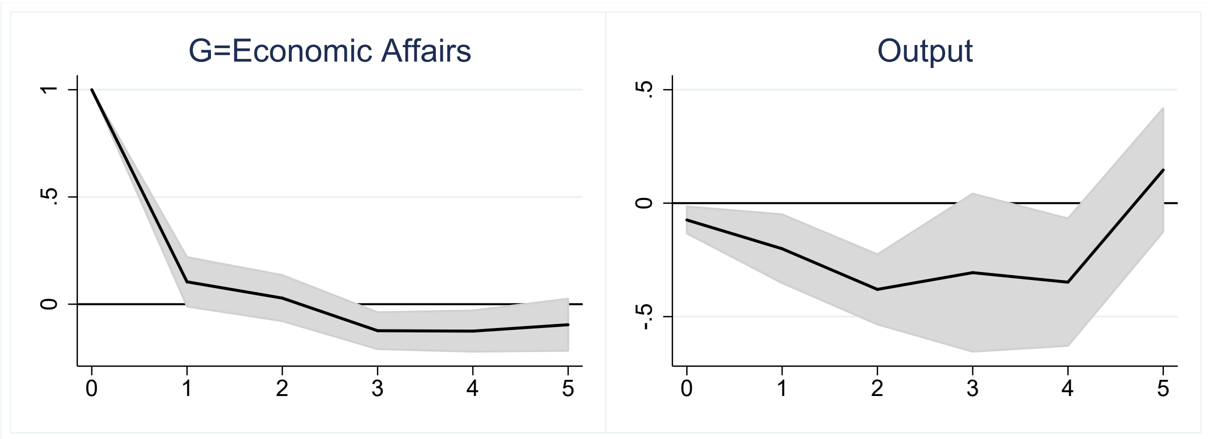
(b) State-Dependent Specification



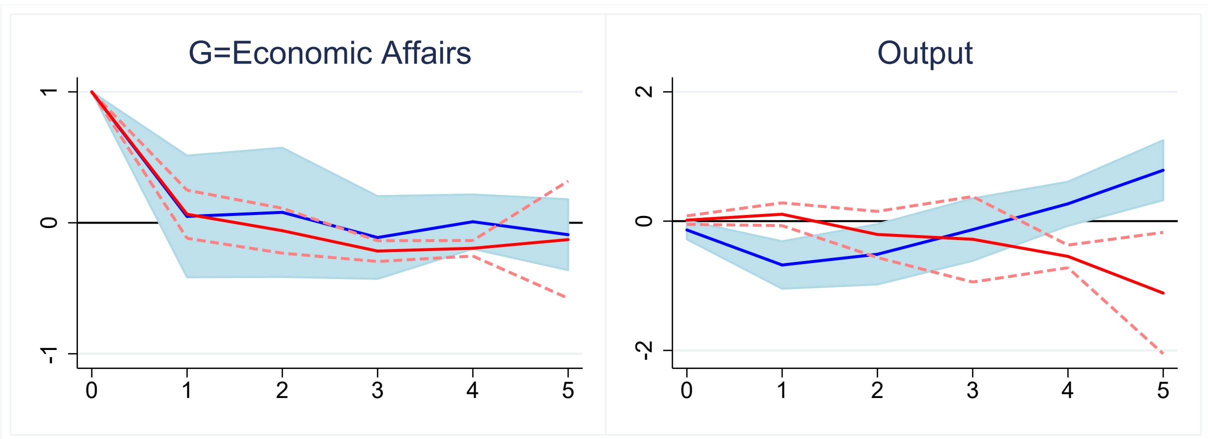
Notes for Figure 5.3. The figure reports the effects of a shock which raises government expenditure on public order and safety by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.4: Responses to a shock to Economic Affairs for OECD countries

(a) Linear Specification



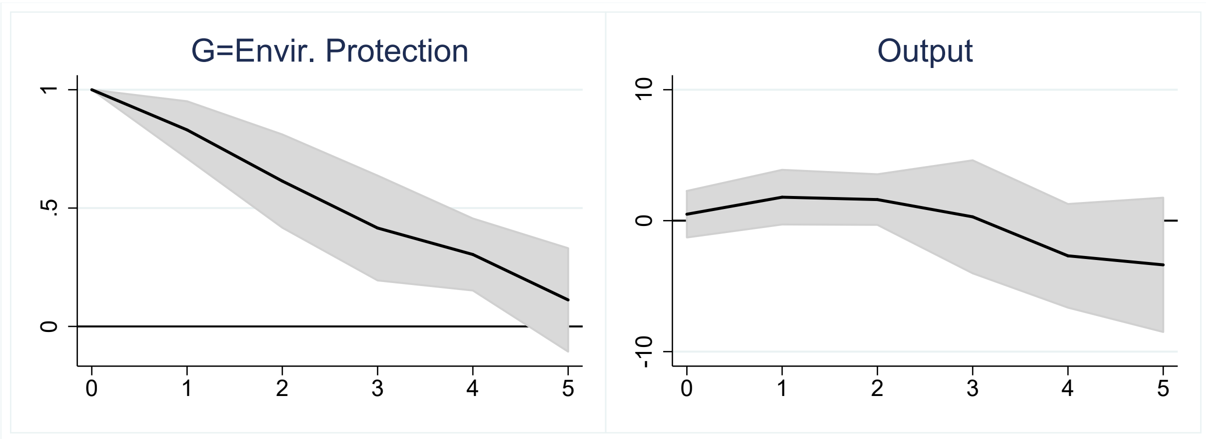
(b) State-Dependent Specification



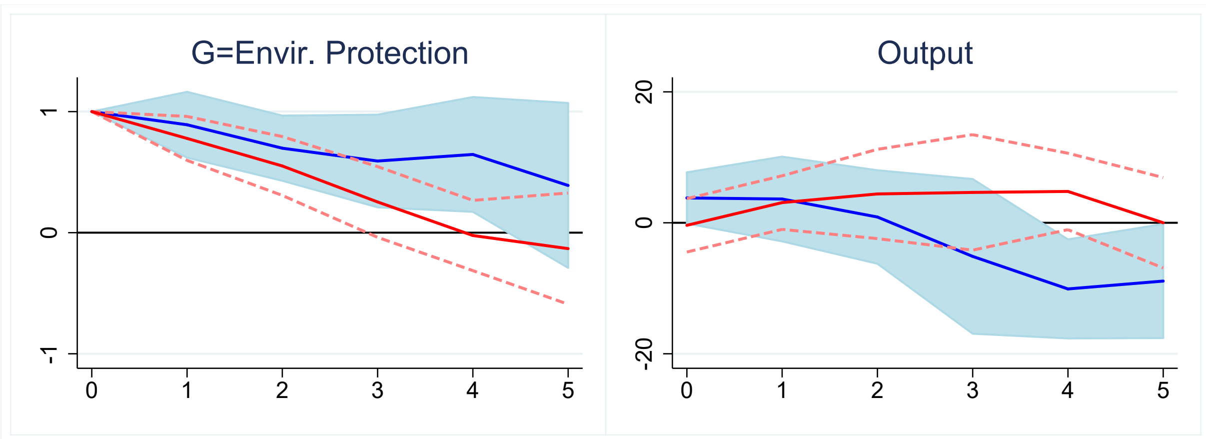
Notes for Figure 5.4. The figure reports the effects of a shock which raises government expenditure on economic affairs by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.5: Responses to a shock to Environmental Protection for OECD countries

(a) Linear Specification



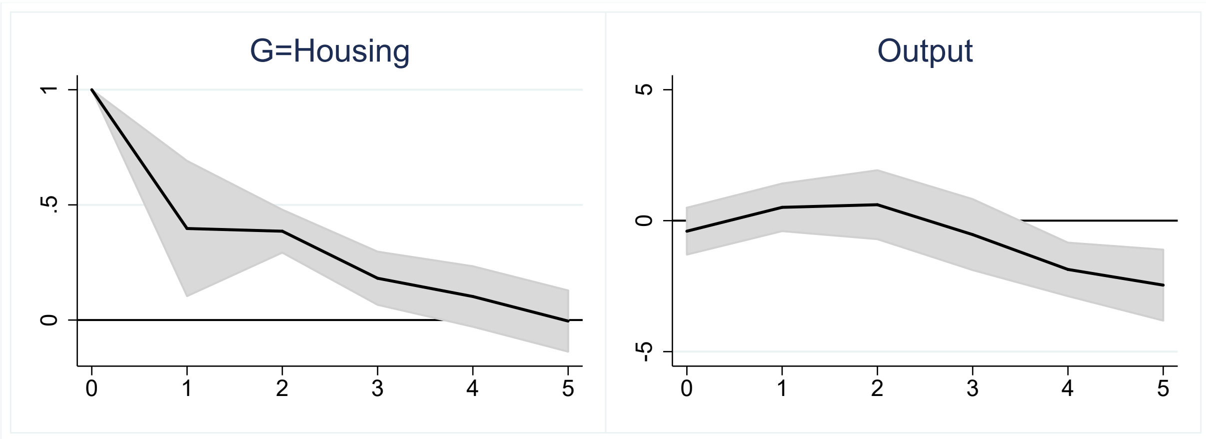
(b) State-Dependent Specification



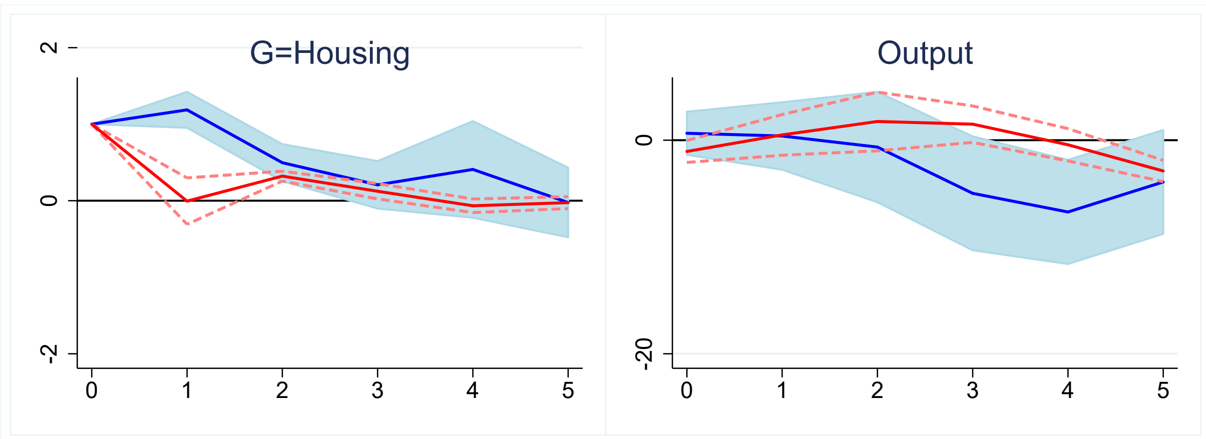
Notes for Figure 5.5. The figure reports the effects of a shock which raises government expenditure on environmental protection by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.6: Responses to a shock to Housing and Community Amenities for OECD countries

(a) Linear Specification



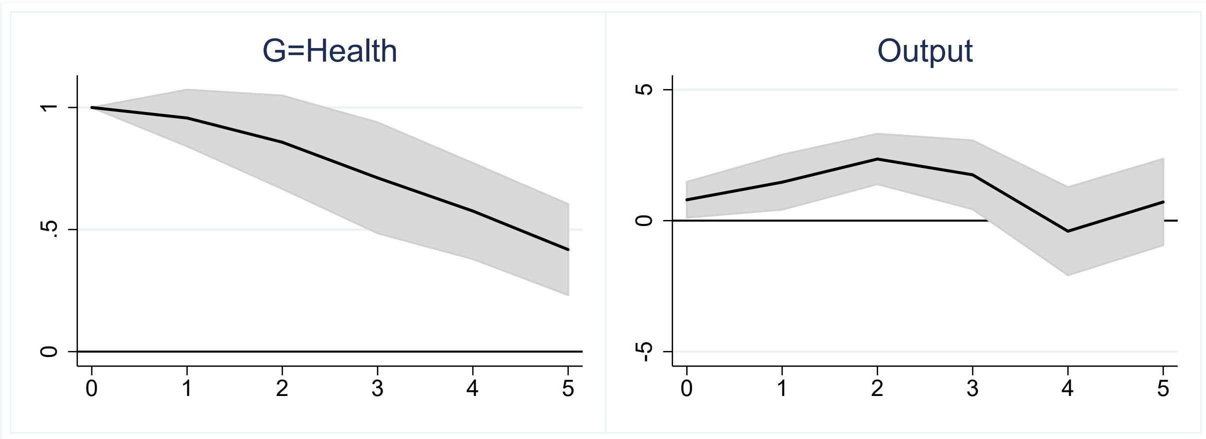
(b) State-Dependent Specification



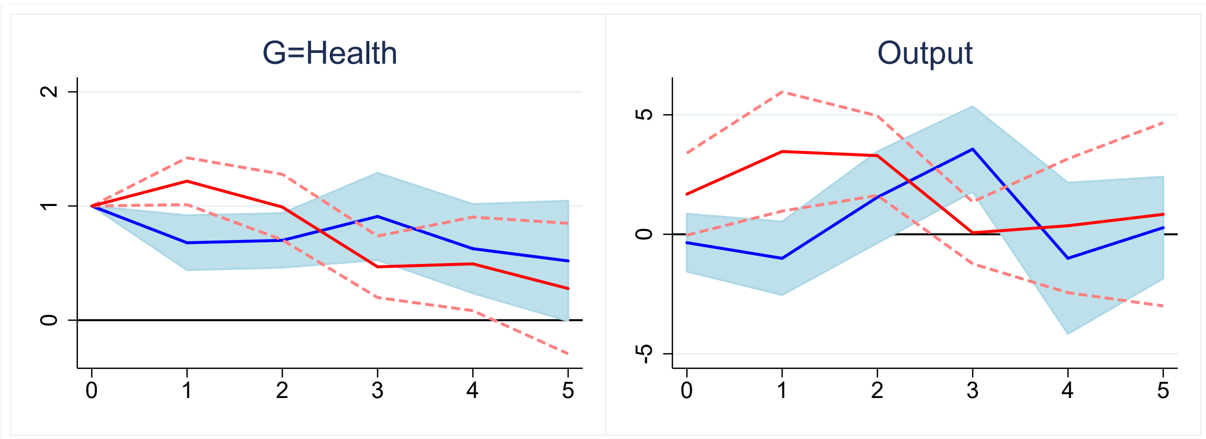
Notes for Figure 5.6. The figure reports the effects of a shock which raises government expenditure on housing and community amenities by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.7: Responses to a shock to Health for OECD countries

(a) Linear Specification



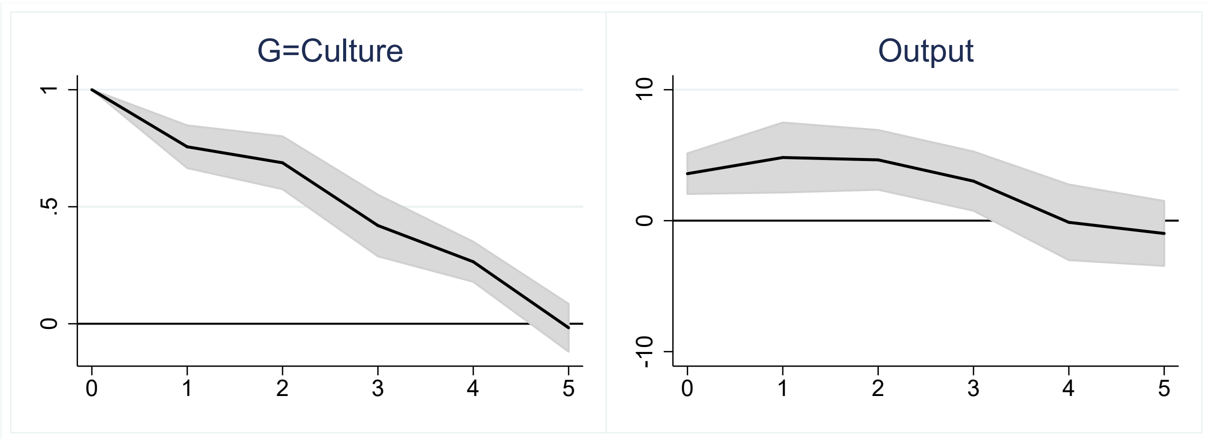
(b) State-Dependent Specification



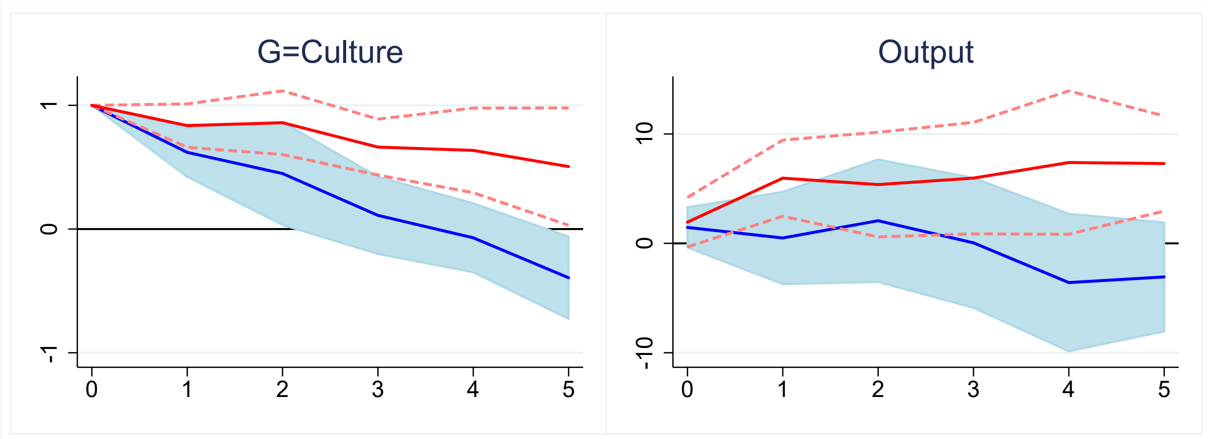
Notes for Figure 5.7. The figure reports the effects of a shock which raises government expenditure on health by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.8: Responses to a shock to Recreation, Culture and Religion for OECD countries

(a) Linear Specification



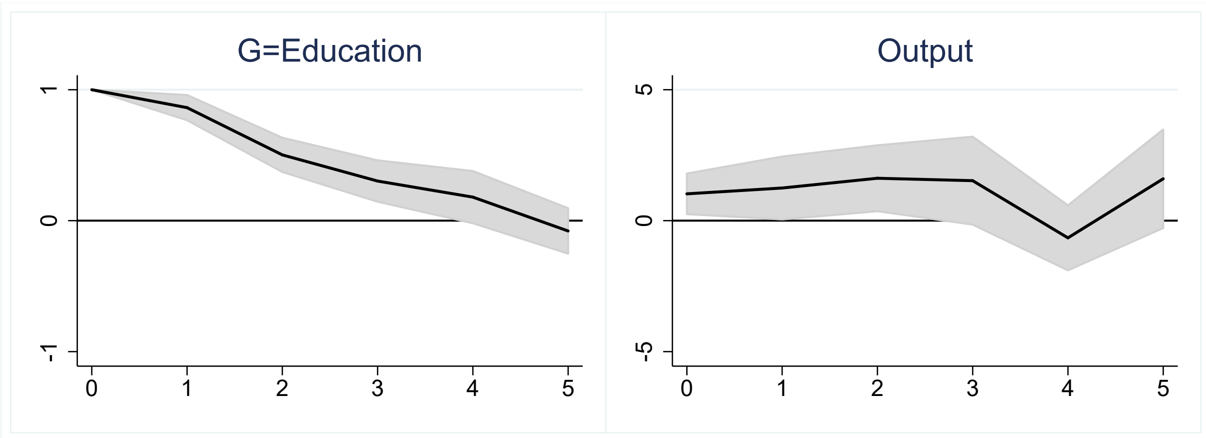
(b) State-Dependent Specification



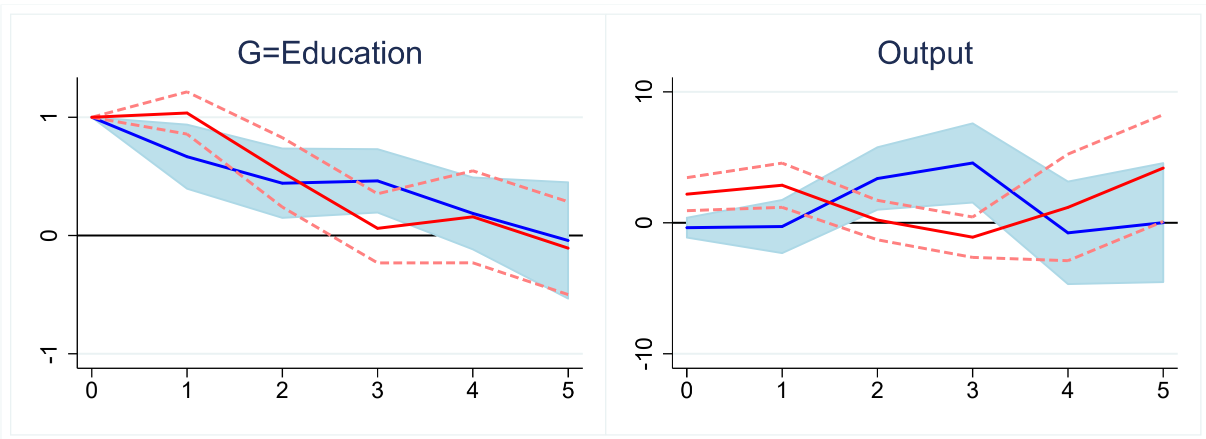
Notes for Figure 5.8. The figure reports the effects of a shock which raises government expenditure on recreation, culture and religion by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.9: Responses to a shock to Education for OECD countries

(a) Linear Specification



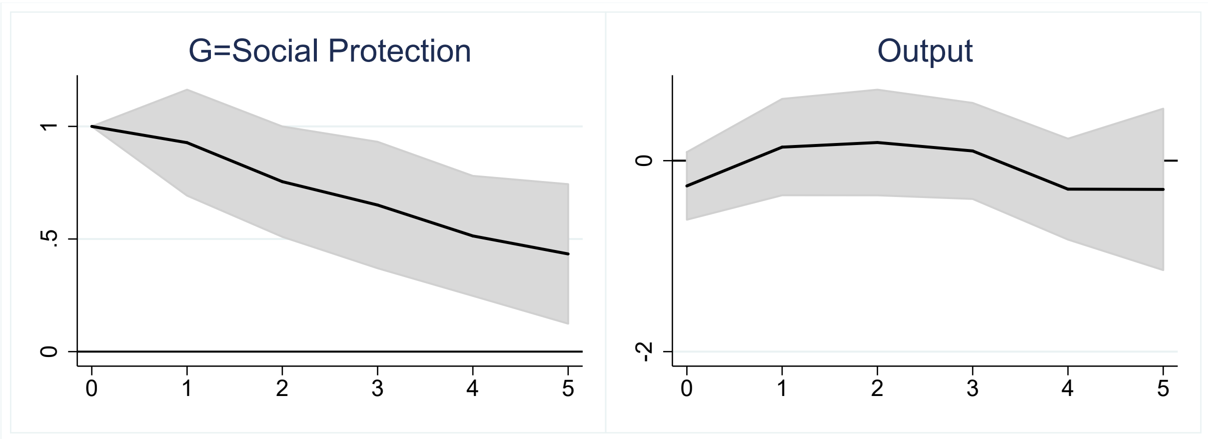
(b) State-Dependent Specification



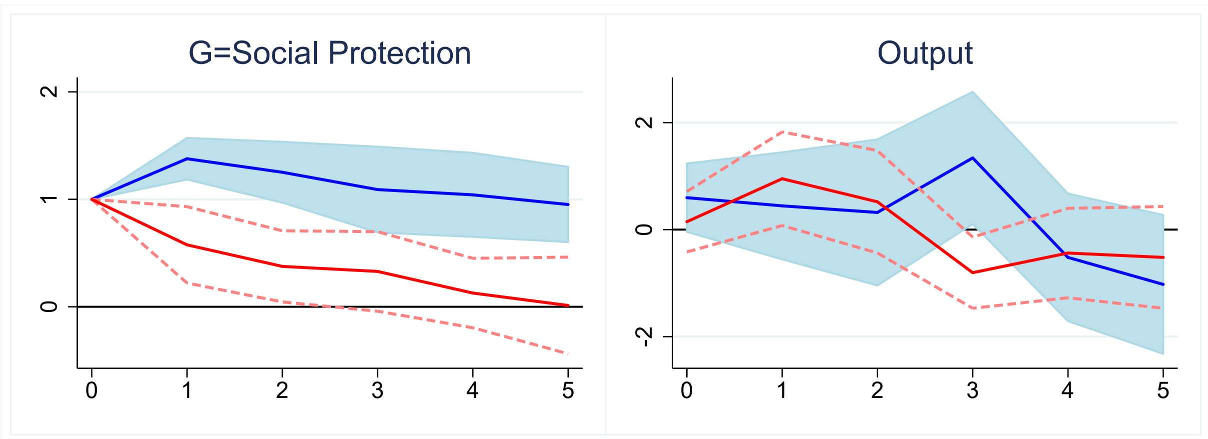
Notes for Figure 5.9. The figure reports the effects of a shock which raises government expenditure on education by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Figure 5.10: Responses to a shock to Social Protection for OECD countries

(a) Linear Specification



(b) State-Dependent Specification



Notes for **??**. The figure reports the effects of a shock which raises government expenditure on social protection by 1% of GDP. Panel (a) reports results from a linear specification and panel (b) from a state-dependent specification. See also notes for Figure 5.1.

Table 5.1: Cumulative Output Multipliers of Government Expenditure on General Public Services for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.268	-0.213	-0.494	-0.687*	-1.087***	-1.595***
	(0.267)	(0.411)	(0.408)	(0.397)	(0.353)	(0.391)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	913.4	434.7	225.4	80.44	35.74
Panel B: Expansion						
	0.762***	-0.00213	-0.486	-0.919	-1.635***	-2.529***
	(0.254)	(0.472)	(0.591)	(0.660)	(0.601)	(0.562)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	264.6	136.1	132.4	111.5	62.97
Panel C: Recession						
	0.525	0.0310	-0.498	-0.899**	-1.564***	-2.492***
	(0.360)	(0.424)	(0.343)	(0.363)	(0.413)	(0.568)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	268.4	177.9	72.91	26.88	12.02
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	3.69*	0.02	0.07	0.04	0.05	0.47
$p-$value	0.0549	0.9025	0.7849	0.8330	0.8236	0.4937

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is general public services. The horizon (top row) is in years after the shock. Panel A (Linear Model) presents the estimated output multipliers by estimating (Equation 5.5), and Panels B and C (Expansion and Recession) present the estimated output multipliers by estimating (Equation 5.6). In each panel the table also reports the number of observations, the number of countries included in the estimation (which vary because of the unbalanced nature of our dataset) and the first-stage F-statistic. The sample spans the period 1991-2015. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. Finally, Panel D reports tests of the null of equality of the multipliers across states of the economy and their associated $p-$values.

Table 5.2: Cumulative Output Multipliers of Government Expenditure on Defense for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	1.469***	1.494*	1.265	0.910	0.440	-0.166
	(0.483)	(0.800)	(0.879)	(0.883)	(0.875)	(0.834)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	312.5	61.62	28.14	18.65	15.35
Panel B: Expansion						
	1.726***	2.005**	1.959	2.119	1.706	1.310
	(0.529)	(0.785)	(1.252)	(1.505)	(1.615)	(1.233)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	380.9	44.43	15.69	12.55	13.24
Panel C: Recession						
	2.641**	2.881	2.071	1.558	0.965	-0.00232
	(1.154)	(1.932)	(1.857)	(1.856)	(1.684)	(1.281)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	382.3	79.23	48.88	66.60	61.07
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	1.01	0.27	0.01	0.03	0.07	1.05
$p-$value	0.3142	0.6054	0.9353	0.8710	0.7843	0.3049

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on defense. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.3: Cumulative Output Multipliers of Government Expenditure on Public Order and Safety for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	2.709***	3.288***	3.025***	1.650	0.674	1.934
	(0.761)	(0.859)	(1.170)	(1.716)	(2.737)	(3.121)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	1764.8	2355.5	410.7	99.35	199.1
Panel B: Expansion						
	3.683***	5.277***	4.978***	4.136**	2.964	5.177
	(0.755)	(1.491)	(1.718)	(1.971)	(3.940)	(4.255)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	1229.5	643.5	306.2	95.31	68.77
Panel C: Recession						
	7.109***	9.300***	6.985***	3.420	2.351	4.097
	(1.593)	(1.851)	(1.880)	(2.755)	(3.901)	(4.916)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	953.6	395.1	49.63	24.68	27.06
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	7.31***	4.67**	1.13	0.11	0.0003	0.0046
$p-$value	0.0068	0.0308	0.2870	0.7414	0.9863	0.9458

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on public order and safety. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.4: Cumulative Output Multipliers of Economic Affairs for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
			Panel A: Linear Model			
	-0.0741**	-0.312***	-0.548***	-1.342***	-2.081***	-1.569*
	(0.0354)	(0.103)	(0.188)	(0.323)	(0.632)	(0.827)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	248.5	87.74	36.80	19.91	4.291
			Panel B: Expansion			
	-0.131	-0.926***	-1.813**	-3.976	-6.433	-9.835
	(0.0885)	(0.322)	(0.815)	(2.696)	(5.961)	(18.98)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	59.90	10.42	2.254	1.013	0.232
			Panel C: Recession			
	-0.0219	-0.149*	-0.280	-1.563***	-2.440***	-1.038
	(0.0341)	(0.0862)	(0.350)	(0.505)	(0.798)	(1.087)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	254.2	64.21	19.54	12.71	10.15
			Panel D: Tests of Equality of Multipliers			
$\chi^2(1)$	0.1443	6.3331**	2.3695	0.2288	0.0022	0.1485
$p-$value	0.7041	0.0119	0.1237	0.6324	0.9628	0.7000

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on goods and services. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.5: Cumulative Output Multipliers of Government Expenditure on Environmental Protection for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.493	0.573	1.177	1.914	1.238	1.221
	(1.056)	(1.119)	(1.397)	(1.919)	(2.092)	(2.356)
Obs	521	486	451	417	386	355
Countries	31	31	30	29	29	28
First-stage F	.	618.9	166.7	72.45	88.64	66.69
Panel B: Expansion						
	3.476***	3.959*	4.844*	3.053	0.784	0.129
	(1.295)	(2.025)	(2.821)	(3.761)	(3.767)	(3.879)
Obs	521	486	451	417	386	355
Countries	31	31	30	29	29	28
First-stage F	.	1172.3	542.6	188.0	81.33	39.24
Panel C: Recession						
	1.500	2.533*	4.244**	5.093**	6.610**	9.298**
	(1.676)	(1.524)	(2.094)	(2.230)	(2.804)	(4.136)
Obs	521	486	451	417	386	355
Countries	31	31	30	29	29	28
First-stage F	.	258.5	110.5	40.57	41.15	18.32
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	0.836	0.266	0.0002	0.631	2.471	2.097
$p-$value	0.3605	0.6061	0.9892	0.4270	0.1160	0.1476

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on environmental protection. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.6: Cumulative Output Multipliers of Government Expenditure on Housing and Community Amenities for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	-0.402	0.0240	0.117	0.171	-0.453	-1.944
	(0.532)	(0.692)	(0.696)	(0.817)	(1.053)	(1.742)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	61.11	61.96	45.35	35.26	19.12
Panel B: Expansion						
	-0.0611	0.342	-0.00563	-1.157	-3.118	-6.074
	(1.174)	(1.306)	(1.627)	(2.326)	(3.690)	(6.408)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	353.8	165.1	62.20	21.40	8.084
Panel C: Recession						
	-0.857	-0.351	-0.341	-0.0936	-0.495	-3.015
	(0.622)	(1.180)	(1.253)	(1.193)	(1.644)	(2.217)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	42.72	65.86	46.55	36.81	26.24
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	3.78*	0.20	0.03	0.14	0.38	0.03
$p-$value	0.0520	0.6586	0.8535	0.7091	0.5381	0.8647

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on housing and community amenities. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.7: Cumulative Output Multipliers of Government Expenditure on Health for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	0.797**	1.030**	1.215***	1.256***	1.370***	1.514***
	(0.404)	(0.444)	(0.459)	(0.450)	(0.452)	(0.583)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	770.0	218.4	133.4	96.13	70.40
Panel B: Expansion						
	0.567	0.593	1.662**	2.057**	2.035**	2.270**
	(0.501)	(0.494)	(0.738)	(0.911)	(0.956)	(1.048)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	417.5	235.1	155.8	92.28	54.42
Panel C: Recession						
	1.456*	2.376***	2.461***	2.406***	2.554***	3.074***
	(0.755)	(0.678)	(0.545)	(0.519)	(0.608)	(0.731)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	516.6	162.4	91.90	59.88	39.73
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	0.85	9.79***	5.21**	1.90	2.08	3.84**
$p-$value	0.3552	0.0018	0.0225	0.1678	0.1492	0.0499

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on health. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.8: Cumulative Output Multipliers of Government Expenditure on Recreation, Culture and Religion for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	3.588***	4.148***	3.891***	4.182***	4.226**	4.341**
	(0.921)	(1.352)	(1.318)	(1.502)	(1.738)	(2.197)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	999.2	624.9	278.4	194.0	127.7
Panel B: Expansion						
	2.337**	2.204	1.475	1.173	0.918	1.914
	(1.049)	(1.749)	(1.846)	(2.294)	(2.737)	(3.831)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	606.4	200.0	101.5	67.15	40.33
Panel C: Recession						
	2.631**	3.898***	3.452***	4.016***	4.815***	6.748***
	(1.217)	(1.498)	(1.263)	(1.479)	(1.646)	(1.681)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	546.3	343.4	132.1	62.29	28.98
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	0.0004	1.60	2.18	3.72*	4.82**	6.45**
$p-$value	0.9831	0.2057	0.1403	0.0539	0.0281	0.0111

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on recreation, culture and religion. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.9: Cumulative Output Multipliers of Government Expenditure on Education for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A: Linear Model						
	1.024**	0.954	0.985	0.877	1.607**	2.229**
	(0.462)	(0.620)	(0.784)	(0.944)	(0.804)	(0.879)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	1005.0	317.7	172.0	76.40	40.50
Panel B: Expansion						
	0.797*	0.923	1.579	2.046	3.507***	4.953***
	(0.433)	(0.800)	(1.152)	(1.386)	(1.353)	(1.874)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	569.4	251.7	128.3	78.16	59.78
Panel C: Recession						
	1.956***	1.811***	1.532**	0.946	3.290***	4.821***
	(0.646)	(0.626)	(0.687)	(0.888)	(1.092)	(1.456)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	1354.0	349.6	171.6	79.89	29.32
Panel D: Tests of Equality of Multipliers						
$\chi^2(1)$	9.94**	3.12*	0.08	0.72	0.20	0.69
$p-$value	0.0016	0.0776	0.7741	0.3953	0.6588	0.4050

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is expense on education. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Table 5.10: Cumulative Output Multipliers of Social Protection for OECD Countries

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
			Panel A: Linear Model			
	-0.264	-0.204	-0.209	-0.254	-0.351	-0.285
	(0.211)	(0.250)	(0.272)	(0.311)	(0.403)	(0.495)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	181.2	83.34	51.25	46.98	36.23
			Panel B: Expansion			
Expansion	0.742**	0.742**	0.733*	0.593	0.278	0.305
	(0.331)	(0.377)	(0.405)	(0.450)	(0.503)	(0.511)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	422.8	202.0	87.74	54.99	55.55
			Panel C: Recession			
Recession	0.392	0.575*	0.405	0.116	-0.0875	-0.0859
	(0.271)	(0.337)	(0.336)	(0.356)	(0.439)	(0.518)
Obs	523	488	453	419	388	357
Countries	31	31	30	29	29	28
First-stage F	.	128.8	63.30	39.62	42.52	29.92
			Panel D: Tests of Equality of Multipliers			
$\chi^2(1)$	8.73***	0.03	0.20	1.36	1.15	0.81
$p-$value	0.0031	0.8725	0.6568	0.2437	0.2832	0.3692

Notes: The table reports the estimated cumulative output multipliers for OECD countries when the measure of government expenditure is social protection. Standard errors clustered at the country level are reported in parentheses, with *, ** and *** denoting significance at the 10%, 5% and 1% level of significance, respectively. See also notes for Table 5.1.

Appendix 5.A Data Description

Table 5A.1: List of Countries in the Dataset

OECD Countries	
1	Australia
2	Austria
3	Belgium
4	Czech Republic
5	Denmark
6	Estonia
7	Finland
8	France
9	Germany
10	Greece
11	Hungary
12	Iceland
13	Ireland
14	Israel
15	Italy
16	Japan
17	Latvia
18	Luxembourg
19	Netherlands
20	New Zealand
21	Norway
22	Poland
23	Portugal
24	Slovak Republic
25	Slovenia
26	Spain
27	Sweden
28	Switzerland
29	Turkey
30	United Kingdom
31	United States

Table 5A.2: Data Sources and Definitions

Variable	Definition	Source
Government Expenditure on Defense	Government Expenditure on Defense (GF02)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Education	Government Expenditure on Education (GF09)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Environment Protection	Government Expenditure on Environment Protection (GF05)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Public Services	Government Expenditure on General Public Services (GF01)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Health	Government Expenditure on Health (GF07)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Public Order and Safety	Government Expenditure on Public Order and Safety (GF030)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Culture	Government Expenditure on Recreation, Culture and Religion (GF08)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Social Protection	Government Protection on Social Protection (GF10)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Economic Affairs	Expenditure on Economic Affairs (GF04)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Housing and Community Amenities	Expenditure on Housing and Community Amenities (GF06)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
GDP	GDP, PPP (constant 2011 international U.S. Dollars)	World Bank: World Development Indicators
Debt	Public Debt	IMF: Historical Public Debt (HPDD)
Taxes	Tax revenue (W0|S1|G11)	IMF: Government Financial Statistics (GFS, Revenue)

Table 5A.4: Classification of the Functions of Government (COFOG)

General public services	**Housing and community amenities**
Executive and legislative organs, financial, and fiscal affairs, external affairs	Housing development
Foreign economic aid	Community development
General services	Water supply
Basic research	Street lighting
R&D general public services	R&D housing and community amenities
General public services n.e.c.	Housing and community amenities n.e.c.
Public debt transactions	
Transfers of a general character between different levels of government	**Health**
	Medical products, appliances and equipment
Defence	Outpatient services
Military defence	Hospital services
Civil defence	Public health services
Foreign military aid	R&D health
R&D defence	Health n.e.c.
Defence n.e.c.	
	Recreation, culture and religion
Public order and safety	Recreational and sporting services
Police services	Cultural services
Fire-protection services	Broadcasting and publishing services
Law courts	Religious and other community services
Prisons	R&D recreation, culture and religion
R&D public order and safety	Recreation, culture and religion n.e.c.
Public order and safety n.e.c.	
	Education
Economic affairs	Pre-primary and primary education
General economic, commercial and labour affairs	Secondary education
Agriculture, forestry, fishing and hunting	Post-secondary non-tertiary education
Fuel and energy	Tertiary education
Mining, manufacturing and construction	Education not definable by level
Transport	Subsidiary services to education
Communication	R&D education
Other industries	Education n.e.c.
R&D economic affairs	
Economic affairs n.e.c.	**Social protection**
	Sickness and disability
Environmental protection	Old age
Waste management	Survivors
Waste water management	Family and children
Pollution abatement	Unemployment
Protection of biodiversity and landscape	Housing
R&D environmental protection	Social exclusion n.e.c.
Environmental protection n.e.c.	R&D social protection
	Social protection n.e.c

Note: R&D = research and development; n.e.c. = not elsewhere classified.
Source: IMF (2014)

Table 5A.6: Structure of General Government Expenditures of OECD Countries by Function, 2015

	General public services	**Defence**	**Public order and safety**	**Economic affairs**	**Environ-mental protection**	**Housing and com-munity amenities**	**Health**	**Recreation, culture and reli-gion**	**Education**	**Social protection**
Australia	12.50	4.36	4.87	10.02	2.43	1.64	19.38	2.00	14.62	28.19
Austria	13.27	1.11	2.68	11.93	0.87	0.68	15.49	2.40	9.61	41.96
Belgium	15.06	1.56	3.27	11.99	1.61	0.62	14.23	2.22	11.92	37.51
Czech Rep	10.32	2.20	4.37	15.63	2.61	1.60	18.17	3.19	11.76	30.14
Denmark	13.53	2.05	1.79	6.68	0.81	0.45	15.61	3.21	12.84	43.02
Estonia	10.62	4.70	4.48	11.82	1.71	0.90	13.67	4.91	15.12	32.07
Finland	14.94	2.35	2.19	8.34	0.42	0.72	12.57	2.60	10.97	44.91
France	11.04	3.08	2.87	10.02	1.76	1.88	14.34	2.33	9.59	43.09
Germany	13.52	2.29	3.56	7.14	1.38	0.87	16.29	2.31	9.55	43.09
Greece	17.84	4.92	3.79	16.04	2.67	0.44	8.19	1.26	7.80	37.04
Hungary	17.78	1.10	4.12	17.26	2.45	2.16	10.62	4.30	10.31	29.90
Iceland	17.95	0.04	3.59	11.62	1.35	1.10	17.37	7.51	17.37	22.09
Ireland	13.85	1.19	3.69	11.49	1.35	1.96	19.34	1.97	12.45	32.71
Israel	13.58	14.94	3.86	5.93	1.25	0.07	12.70	3.55	17.12	27.02
Italy	16.64	2.38	3.71	8.06	1.92	1.21	14.14	1.47	7.88	42.59
Japan	10.44	2.34	3.21	9.48	2.93	1.74	19.45	0.94	8.72	40.74
Korea	16.58	7.80	3.99	16.14	2.48	2.62	12.51	2.15	16.32	19.41
Latvia	14.05	2.72	5.43	11.46	1.87	2.64	10.26	4.36	16.25	30.96
Luxembourg	10.46	0.66	2.37	11.88	2.58	1.23	10.85	2.82	12.37	44.77
Netherlands	11.12	2.53	4.02	8.80	3.17	0.71	17.71	3.11	12.05	36.78

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Table 5A.6 – continued

	General public services	**Defence**	**Public order and safety**	**Economic affairs**	**Environ-mental protection**	**Housing and com-munity amenities**	**Health**	**Recreation, culture and reli-gion**	**Education**	**Social protection**
Norway	9.57	3.14	2.20	10.52	1.79	1.55	17.17	3.04	11.19	39.82
Poland	11.83	3.78	5.33	11.09	1.47	1.70	11.21	2.72	12.56	38.32
Portugal	16.79	2.19	4.28	10.45	0.80	1.02	12.75	1.55	12.37	37.80
Slovak Rep	14.21	2.33	5.20	13.91	2.27	1.86	15.72	2.26	9.29	32.95
Slovenia	14.21	1.76	3.25	12.42	2.10	1.25	13.95	3.36	11.57	36.13
Spain	14.86	2.21	4.64	10.02	1.97	1.10	14.16	2.57	9.34	39.12
Sweden	14.08	2.26	2.60	8.36	0.58	1.48	13.84	2.18	13.00	41.63
Switzerland	12.62	2.76	4.99	10.96	2.07	0.57	6.51	2.44	17.22	39.85
UK	10.60	4.97	4.67	7.14	1.84	1.13	17.81	1.52	11.95	38.38
US	13.81	8.80	5.39	8.74	0.00	1.40	24.18	0.66	16.23	20.79
OECD	13.19	5.14	4.30	9.29	1.27	1.38	18.69	1.54	12.59	32.60
Colombia	14.13	4.98	6.82	11.91	1.39	1.74	15.24	2.35	14.25	27.20
Costa Rica	10.40	0.00	7.99	8.83	1.42	2.63	19.31	0.77	23.30	25.35
Lithuania	12.46	3.82	4.53	10.36	1.54	0.91	16.53	2.66	15.45	31.74

Notes: Sources: OECD National Accounts Statistics (database); Eurostat Government finance statistics (database). Data for Australia are based on Government finance statistics provided by the Australian Bureau of Statistics. Data for Iceland are not included in the OECD average due to missing time-series. Data are not available for Canada, Chile, Mexico, New Zealand and Turkey. Data for Korea, Colombia and Costa Rica refer to 2014 rather than 2015. Information on data for Israel: http://dx.doi.org/10.1787/888932315602.
Source: OECD (2017, Table 2.32)

Table 5A.7: Total General Government Expenditure of OECD Countries by Function, Percentage of GDP, 2012

	Total Expenditure	**General public services**	**Defence**	**Public order and safety**	**Economic affairs**	**Environmental protection**	**Housing and community amenities**	**Health**	**Recreation, culture and religion**	**Education**	**Social protection**
Austria	51.01	7.24	0.59	1.33	6.21	0.49	0.39	7.89	0.93	4.97	20.98
Belgium	54.90	8.60	0.93	1.82	7.49	0.91	0.38	7.96	1.27	6.34	19.20
Czech Rep	43.87	6.50	0.83	1.75	6.02	1.31	0.71	7.45	1.16	5.03	13.11
Denmark	58.81	9.31	1.42	1.03	3.70	0.41	0.29	8.78	1.86	7.08	24.92
Estonia	38.93	4.02	1.79	2.01	4.57	0.82	0.61	5.00	1.75	6.17	12.18
Finland	56.14	8.20	1.48	1.39	4.79	0.25	0.43	8.20	1.20	6.44	23.76
France	56.80	6.83	1.80	1.64	5.00	1.01	1.41	8.03	1.44	5.48	24.17
Germany	44.11	6.44	1.13	1.54	3.43	0.55	0.43	6.79	0.81	4.25	18.75
Hungary	48.59	9.60	0.73	1.94	6.23	0.70	0.88	5.16	1.93	4.70	16.73
Ireland	41.72	6.67	0.38	1.55	3.42	0.75	0.80	6.93	0.74	4.36	16.13
Israel	41.48	6.88	6.02	1.57	2.51	0.55	0.46	5.03	1.45	6.15	10.86
Italy	50.80	9.30	1.27	1.95	4.15	0.95	0.76	7.19	0.70	4.07	20.46
Japan	41.95	4.44	0.92	1.32	4.21	1.13	0.67	7.40	0.35	3.56	17.95
Korea	32.73	5.64	2.44	1.24	6.43	0.77	0.96	3.74	0.66	5.19	5.65
Luxembourg	44.08	5.69	0.38	1.03	4.24	1.06	0.79	5.04	1.18	5.39	19.27
Netherlands	47.13	5.19	1.17	1.93	4.46	1.56	0.51	8.31	1.65	5.54	16.79
Norway	42.93	4.30	1.36	0.93	4.37	0.77	0.65	7.26	1.34	4.89	17.07
Portugal	48.82	9.22	1.18	2.16	2.87	0.44	0.63	6.57	0.87	6.52	18.37

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Table 5A.7 – continued

	Total Expenditure	**General public services**	**Defence**	**Public order and safety**	**Economic affairs**	**Environmental protection**	**Housing and community amenities**	**Health**	**Recreation, culture and religion**	**Education**	**Social protection**
Slovak Rep	40.07	4.77	1.31	3.16	3.69	0.93	0.74	7.40	1.24	4.43	12.39
Slovenia	48.12	6.23	1.05	1.76	4.01	0.71	0.76	6.95	1.78	6.39	18.48
Spain	47.88	6.58	0.93	2.03	7.93	0.89	0.46	6.18	1.21	4.15	17.51
Sweden	52.59	7.67	1.40	1.38	4.50	0.34	0.72	6.91	1.07	6.55	22.05
Switzerland	33.25	4.04	0.98	1.66	3.89	0.70	0.20	2.13	0.83	6.04	12.78
UK	46.69	5.37	2.41	2.27	3.53	0.86	0.78	7.50	0.89	5.75	17.33
US	40.08	5.83	4.24	2.19	3.65	0.00	0.69	8.67	0.28	6.38	8.14

Source: (OECD, 2015, Table 24.1)

Chapter 6

Concluding Remarks

6.1 Conclusions

In Chapter 3, we have examined the effect of components of government spending on output over the business cycle, using the STVAR model as proposed by Auerbach & Gorodnichenko (2012b). We contribute to the literature by expanding their dataset up to 2017, in order to include the recent financial crisis. More specifically, we used U.S. quarterly data, on the period 1949:I-2017:III. The horizon we use is 20 quarters after the shock. We also used a finer disaggregation level than Auerbach & Gorodnichenko (2012b), that is we consider three different components of spending: government expense on compensation of employees, government expense on goods and services and government investment. Our results show that different components produce indeed different multipliers. In particular, cumulative multiplier on expense on compensation of employees is higher than the rest of them and around 2.42; cumulative multiplier on goods and services is negative; multiplier on government investment is around 1.32 in the early years and zero afterwards, while the overall effect of government investment is insignificant. Compensation of employees and government investment multipliers are higher in recession than in expansions; however this is not the case for the expense on goods and services. Finally, we also estimate the effects of social benefits on output. We find a multiplier that peaks at 0.99 and a cumulative multiplier equal to 2.04. Our results are in accordance with the literature in the majority of the cases.

In Chapter 4 we have investigated whether different components of government expenditure tend to stimulate the economy, focusing on the compensation of government employees, the government use of goods and services and government investment. Our choice has been driven by the need to obtain information about the size of the multipliers on specific classes of government spending. In our effort to account for differences pertaining to diverse countries and obtain as general results as possible, we have employed data on both 35 OECD and 49 non-OECD economies. Moreover, we have tried to assess whether the effects of fiscal spending vary by the state of the business cycle of the economy. Our results show that the effects of government spending differs across groups of countries: compensation of government employees and government investment produce higher responses of output and higher multipliers for OECD economies, but estimates fall short of unity when we do not allow for state-dependent effects. Instead, purchases of goods and services do not seem to help stimulate the economy, producing effectively zero multipliers both for OECD and non-OECD countries, regardless of whether we condition on the state of the economy. Moreover, we find that multipliers tend to differ depending on the state of the economy. For OECD economies this is clearly the case for the multiplier of the compensation of government employees: the (cumulative) multipliers differ significantly for horizons up to two years, being much higher in states of recession. Likewise, we find that the multiplier of government investment differs only at a five year horizon for OECD countries, again being higher during recessions. Instead, we find no difference in the multipliers of the compensation of government employees for non-OECD economies. However, the government investment multiplier for non-OECD counries is found to be significantly larger in periods of recession, but only for horizons of one year ahead. Finally, we present evidence on the effects of social benefits on the macroeconomy. We find that the estimated multipliers are small in all cases, and in statistically significant only when accounting for the state of the business cycle. We nonetheless find that increases in social benefits lead to large increases in household consumption, both for OECD and non-OECD economies in states of recession; but only for OECD countries in states of expansion.

Finally, in Chapter 5, we have estimated short-run multipliers for government spending over the business cycle. Even though many studies have addressed the effects of government spending on long-run growth in the past, there are no empirical studies on the short-run effects on output. Our work attempts to extend the existing literature by covering this issue. Government spending is disaggregated according to the functional classification, as proposed by the IMF. More specifically, we estimate output multipliers for the ten following categories of government spending: general public services, defense, public order and safety, economic affairs, environmental protection, housing and community amenities, health, recreation, culture and religion, education, and social protection. We use data for a panel of 31 OECD countries, for the time-period 1991-2015. We report impulse response functions of output, which are estimated using local projections as proposed by Jordà (2005), and cumulative output multipliers, estimated as in Ramey & Zubairy (2018).

Our results indicate that some functional components are more effective than others, since they produce higher output multipliers. Defense, public order and safety, health and education give positive and strong multipliers, whereas multipliers for general public services and economic affairs are negative, and multipliers for housing and social protection are insignificant. In addition, multipliers for education, health, recreation, and social protection are higher in recession than in expansion. In an attempt to specify the transition mechanism, we suggest the existence of three possible transmission mechanisms: the ”productive” channel, the ”complementarity” channel, and the ”wealth” channel. The first suggests that components that assist private-sector productivity, such as defense, public order, housing, education and health enhance output growth. Indeed, we find that all of the above categories (except for housing which is insignificant) have positive and strong output multipliers. On the other hand, the ”complementarity” channel claims that public goods (such as defense and public order) are substitutes to private consumption, while merit goods (such as education, health, and recreation) are complements. Our results confirm this idea, since we find bigger multipliers for merit goods than public goods. Finally, a ”wealth” channel, operating in the same direction as the ”complementarity” channel, suggests that there is a positive wealth effect for households when they receive merit goods, which is not present in the case of public goods.

6.2 Policy Implications

As we have already mentioned, knowing how the different components of government spending components affect the economy is more than just an academic curiosity. This type of information is also important in policy making, because when one has to design effective stabilization policies or stimulus packages, he must focus on components that have significant and rapid effects on the economy. On the other hand, fiscal consolidation plans that aim at reducing budget deficits should focus on the components that produce the smallest effects on economic activity.

Based on our results we can form a series of suggestions for policy-designing. When government spending is disaggregated based on the economic classification, as in Chapter 3 and Chapter 4, our results indicate that the expense on compensation of employees and government investment has positive effects on output. On the contrary, purchases of goods and services have zero -or even negative- effects on output. This is true in both the linear case and recession. It should also be noted that, the positive effects of an increase in compensation of employees are visible sooner (within a few quarters from the shock), while those of government investment are somewhat delayed, implying that the benefits of government investment accrue in the future, as it takes time for the stock of government capital to accumulate. Finally, as we can see in Chapter 4, compensation of employees and social benefits lead to an immediate and significant increase in private consumption. Therefore, when one wishes to stimulate aggregate demand, we believe that he should try an increase in compensation of employees or social benefits; or, if one aims at a higher long-run growth, then he should focus on government investment. On the other hand, reducing purchases of goods and services is less likely to hurt economic growth, than reducing any of the other components.

The functional classification, introduced in Chapter 5, helps us understand the effects of government spending within each sector and is important in deciding the allocation of resources among them. Education, health, as well as recreation, culture and religion have large and rapid positive effects on output that become even stronger as time goes by. This occurs both in a linear and a recessive environment. Defense and public order and safety also trigger a strong and positive response from output during the first years after the shock, but it does not last for a long time. Again this is observed in a linear and a recessive environment. Therefore, a policy plan that aims at increasing growth should focus on these five components. On the contrary, fiscal consolidation plans should include components that have zero, or negative effects on output, such as: general public services, economic affairs, housing and community amenities, and social protection.

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