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A FUNCTIONAL CLASSIFICATION ANALYSIS OF GOVERNMENT SPENDING MULTIPLIERS

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Abstract

Using a panel of 33 OECD countries we estimate government spending multipliers for 11 different categories (functions) of spending: General Public Services, Defense, Public Order and Safety, Transport & Communication, Economic Services, Environment Protection, Housing and Community Amenities, Health, Education, Recreation, Culture and Religion, and Social Protection. We also account for variations in the state of the business cycle (recession vs expansion). Our results suggest that Public Services, Defense, Public Order, Transport & Communication, Health, Recreation and Education produce positive and high multipliers, whereas multipliers for Economic Services are negative, and multipliers for Environmental Protection, Housing and Social Protection are insignificant. In addition, multipliers for Public Services, Defense, Public Order, Transport & Communication, Health, Recreation and Education are higher in recession than in expansion.

Keywords: Government Spending Multipliers, Functional Classification, State-Dependent Multipliers, Local Projections, Smooth-Transition Models

JEL-classifications: C33, E32, E62

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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.[1] 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 but some others may 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. In a worst case scenario, 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 government spending affect the macro-economy differently in times of economic strength and in times of economic weakness. Many recent studies provide evidence that support this idea. This distinction is crucial as in

[1] Batini et al. (2014) provide a summary on the definition, size and determinants of the government spending multiplier. In addition, a thorough survey of the theoretical and empirical literature on government spending multipliers can be found in Ramey (2011a) and a description of the identification approaches of government spending shocks in Ramey (2016).

“bad" times, policy makers are much more likely to use fiscal spending to stimulate the economy than in “good" times.[2]

In this paper we estimate disaggregated government spending multipliers, where government spending is classified according to the functional classification, as proposed by the IMF. [3] Unlike the typical economic classification, which breaks down government spending according to its economic nature,[4] the functional classification organizes government activities according to their purposes (for example 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 within each sector.

Using a panel of 33 OECD countries we estimate government spending multipliers for 11 different categories (functions) of spending: General Public Services, Defense, Public Order and Safety, Transport & Communication, Economic Services, Environment Protection, Housing and Community Amenities, Health, Education, Recreation, Culture and Religion, and Social Protection. The horizon we consider is five years after the shock. To the best of our knowledge this is the first paper to address this issue in the short-run as most of the studies that employ the functional classification focus on the long-run effects of the functional components on growth (see section 2 for a brief review of the literature). We also examine whether these results vary with the state of the business cycle (i.e. in recession and expansion).

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. Public Services, Defense, Public Order and Safety, Transport & Communication, Health, Recreation and Education give positive and high multipliers, whereas multipliers for Economic Services are negative, and multipliers for Environmental Protection, Housing and Social Protection are insignificant. In addition, multipliers for Public Services, Defense, Public Order, Transport & Communication, Health, Recreation and Education are higher in recession than in expansion.

This paper is organized as follows: section 2 summarizes the related literature. section 3 provides a description of government spending decomposing it according to its functional classification and the sub-components of each function, discusses the dataset and the methodology employed. section 4 presents the main findings of the paper and section 5 presents some robustness experiments. Finally, section 6 contains some concluding remarks.

[2]See for example Auerbach and Gorodnichenko (2012, 2013a) and Canzoneri et al. (2016) among others.

[3]See IMF (2014) for a discussion.

[4]See Konstantinou and Partheniou (2021) for a discussion on multipliers according to the economic classification of government spending.

2 Related Literature

The functional classification of government spending is not commonly used 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. This is built upon the theoretical framework developed by Barro (1990) and Devarajan et al. (1996), which supports the idea that government spending can be growth-enhancing when entering the private sector production function.

Most empirical studies examine the effects of some particular public spending categories on growth, such as defense, education, health, transportation & communication, and social security, since these are the components that are thought to affect growth the most. Devarajan et al. (1996), in a sample containing OECD countries with high income, find a significant (and positive) result only for transportation & communication expenditure. More recently, Acosta-Ormaechea et al. (2013), using a panel of 56 countries (14 low-, 16 medium- and 26 high-income countries), suggest that a reallocation involving a rise in education spending has a positive and statistically robust effect on growth, especially when this is associated with an offsetting reduction in social protection spending, while Afonso and Jalles (2014) find that social security spending has a negative effect on growth (for OECD countries), but spending on education boosts growth (for emerging economies).

Kneller et al. (1999) group functional components based on their productivity aspects. They treat expenditures with a substantial (physical or human) capital component as "productive", and those without a capital component as "non-productive". The "productive" expenditures group includes General Public Services,[5] Defense, Education, Health, Housing, and Transport & Communication expenditure, while the "non-productive" expenditures group consists of Social security and Welfare, Recreation, and Economic Services,[6] expenditure. Their findings suggest that productive expenditure has a positive effect on growth, but unproductive expenditure seems to have a zero effect. In a follow-up paper, Bleaney et al. (2001), confirm the above results.

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) treat heterogeneous short-run dynamics explicitly within a long-run model. They also group expenditure components into productive and non-productive, as described above. 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

[5] These are mainly administration services.

[6] Mainly sector spending (e.g. agriculture, forestry) often in the form of subsidies, environmental management etc.

adjustment to a new long-run growth rate equilibrium. In a more recent work, Gemmell et al. (2016) extent the previous framework by including all of the functional components mentioned above in their model, ungrouped. They show, for a panel of OECD countries, that transport & communication and education create 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 theoretical framework, most papers focus on the relationship between growth and expenditure on education, health and infrastructure (Agénor, 2008; Agénor and Neanidis, 2011; Blankenau and Simpson, 2004; Dioikitopoulos, 2014; Semmler et al., 2011). The general result is that reallocating government expenditures towards these three components can be beneficial for long-run growth. Economides et al. (2020), consider all the main categories of public spending, such as spending on social protection (e.g. pensions), health, general public services (e.g. interest payments), education, economic affairs (e.g. public infrastructure), defense, and public-order safety, and show that spending on education and health outperforms all other categories.

Even though the functional classification of government spending is not commonly used in the literature, there are many studies that focus on the short-run effects of one of the functional components, the expense on defense. This is because defense shocks constitute natural exogenous shocks, which makes identification a lot easier and 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 only 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, depending on sample. 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 and Zubairy (2018) the 4-year-integral multiplier for the U.S. is 0.71. Owyang et al. (2013) and Ramey and Zubairy (2018) also check for state-dependence, i.e. whether the multipliers differ in periods of slack (high unemployment). Neither Owyang et al. (2013) nor Ramey and Zubairy (2018) find any evidence of state-dependence for the U.S.; however, Owyang et al. (2013) find a multiplier above 1 under slack for Canada. Ben Zeev and Pappa (2015), 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 and 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.

In this paper we aim to extend the framework of the defense multipliers estimation described above, and estimate short-run multipliers for each one of the functional categories.

3 Data and Methodology

3.1 Functional Classification of Government Spending

The functional classification of government spending employed by the IMF and the OECD includes ten categories: General Public Services; Defense; Public Order and Safety; Economic Affairs; Environment Protection; Housing and Community Amenities; Health; Recreation, Culture and Religion; Education; and Social Protection. The complete list of functions and what each function involves is given in Table 1, while Table 2 presents the shares of each component in total expenditure and GDP for the OECD average for 2015.[7] The largest share of government expenditure belongs to social protection (32.6%). 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, instead, are those of Recreation, Culture and Religion (1.5%), Housing and Community Amenities (1.4%), and, Environment Protection (1.3%).

General public services, as can be seen in Table 3, consist of administration services (31.2%), such as 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 (4%). A sizable component of general public services is public debt transactions, i.e. the interest payments and expense for underwriting and floating government loans. 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%. In what follows we exclude Public Debt Transactions and Foreign Economic Aid from General Public Services, in order to isolate the administration services part of this component of government spending, i.e. the "productive" part.

Economic affairs contain government expenses by industry. Examples of spending in this category include general regulation and supervision of the economy, grants, loans or subsidies to promote certain policies and programs, construction or operation of infrastructure; and expenditure in industries such as agriculture, energy, manufacturing, transport, and communication. As seen in Table 4, Transport amounts to the largest share in 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%. In order to make our results more easily interpretable, we have to decided to follow existing work (see Bleaney et al., 2001; Gemmell et al., 2011; Kneller et al., 1999) and split the Economic Affairs category into two parts: Transport & Communication (the sum of Transport and Communication components) and Economic Services (the rest of Economic

[7] Table A.1 and Table A.2 present the share of each components in total expenditure and GDP for each country in our dataset.

Affairs, which mainly consist of sector spending (e.g. agriculture, forestry)). This way we distinguish the "productive" part (Transport and Communication) from the "unproductive" part (Economic Services).

Following these steps, we end up with 11 sub-categories (functions) of government spending: General Public Services, Defense, Public Order and Safety, Transport & Communication, Economic Services, Environment Protection, Housing and Community Amenities, Health, Education, Recreation, Culture and Religion, Social Protection. 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 counter-cyclical) e.g. social protection. This makes identifying government spending shocks to such components a difficult task. However, we have decided to proceed by adopting a common identification strategy below, so that our results are easier to compare with those obtained in the existing literature.

3.2 Data

We have collected annual data for the period covering 1990 to 2018 for 33 OECD countries. The full list of countries in our dataset can be found in Table A.3 in the Appendix. Our fiscal expenditure variables come from IMF's Government Finance Statistics (GFS) which reports data on Expenditure by Function (COFOG). In addition dependent variables of interest in our analysis are output (to estimate government spending multipliers), household consumption and private investment for which were obtained from the World Bank's WDI database. In our analysis we also control for tax revenue and the level of public debt, which are also drawn from IMF: data on tax revenue from IMF's Government Finance Statistics (GFS, Revenue) and data on public debt from the Historical Public Debt Database (HPDD). Data sources and definitions are given in Table A.4, while Table 5 presents the descriptive statistics of all the variables in our dataset.

3.3 Identification of Fiscal Spending Shocks

In order to quantify the effects of different components of government spending, we employ a variant of the two step methodology discussed in Corsetti et al. (2012) instead of obtaining estimates of government spending shocks using a VAR methodology (see e.g. Bermperoglou et al., 2017; Caldara and Kamps, 2008; Chian Koh, 2016; Mountford and Uhlig, 2009, among others and the original contribution of (Blanchard and Perotti, 2002)). Adopting such a two-step approach entails certain benefits. First, it allows for considerable flexibility in estimating the effects of government spending shocks in different economic environments (e.g. in periods of recessions and expansions of the economy), which would have been harder using VARs. Second, given the unbalanced nature of our panel (we have less than 26 effective observations per country) estimating such effects by univariate regression methods will definitely increase

efficiency and precision of the estimates. Before we proceed though, we draw on Ramey and Zubairy (2018) and employ the transformation suggested by Gordon and Krenn (2010): we estimate 'potential' output, Y_t^p, which we then use to normalize all the variables in our work.[8] For instance, we let $g_{i,c,t} \equiv G_{i,c,t}/Y_t^p$, where $G_{i,c,t}$ is functional component i in country c during period t. 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.[9]

Having transformed our variables, we follow Corsetti et al. (2012) and assume a fiscal spending policy rule for component i in country c of the form:

$$\begin{aligned} g_{i,c,t} &= \alpha_i + b_1 g_{i,c,t-1} + b_2 g_{i,c,t-2} + \gamma_1 gdp_{c,t-1} + \gamma_2 gdp_{c,t-2} + \delta debt_{c,t-1} \\ &\quad + \tau tax_{c,t-1} + \theta t + \varepsilon_{i,c,t} \end{aligned} \tag{1}$$

where $g_{i,c,t}$ denotes government spending in component i in country c during period t (relative to potential output), $gdp_{c,t-1}$ is real output (relative to potential), t denotes a deterministic time trend and $\varepsilon_{i,c,t}$ captures discretionary policy changes in component i.[10] The specification also includes one lag of the average tax rate (revenues as a ratio to potent GDP) $tax_{c,t}$, and one lag of the debt-to-GDP ratio, $debt_{c,t-1}$ so that we account for the role of financing as well as the level of outstanding liabilities of the government. Note that since our panel dataset is highly unbalanced, we do not allow for country-specific coefficients in the policy rule as Corsetti et al. (2012) do, but rather we pool the coefficients across countries. Note also that by estimating (1) we assume a fiscal spending rule in the spirit of that adopted in Blanchard and Perotti (2002): identification is achieved by assuming that spending cannot respond simultaneous output changes, but only to past growth developments.[11]

[8] We estimate (log) trend real output by fitting log real GDP to a third-degree polynomial in time, on a country-by-country basis. Then "potential GDP" is estimated as an exponential of this fitted "trend". In doing so we assume that although some of the spending variables in this paper (such as education, health, etc.) may affect potential output in the long-run, this is so for long horizons — definitely well beyond the five year horizon that we look at our estimations below. 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, investment and consumption.

[9] A typical approach in the literature has been to use logs of variables (e.g. GDP and government spending) and transform the estimated elasticities into impulse responses ex post, using the sample average of the ratio of government spending to GDP ratio (see e.g. Auerbach and Gorodnichenko, 2012). However as Ramey and Zubairy (2018) explain this approach might be problematic as there may be variations in the sample averages employed – in our case sample averages do vary across countries.

[10] Fatás and Mihov (2003, 2006) employed a similar technique to obtain the discretionary component of government spending.

[11] Born and Müller (2012) have demonstrated that this timing assumption holds in annual data for the United States, United Kingdom, Canada, and Australia, while Beetsmaa et al. (2009) also present an alternative test which reaches the same conclusion.

3.4 Impulse Responses and Government Spending Multipliers Estimation

With government spending policy innovations ($\hat{\varepsilon}_{i,c,t}$) at hand from (1), it is possible to trace the dynamic effects of these innovations on key macroeconomic variables of interest, as well as to estimate cumulative output multipliers for horizons of up to h years-ahead – we chose to work with horizons up to five-year-ahead.[12] Univariate impulse responses may easily be obtained by means of local projections proposed by Jordà (2005).[13] When we employ a linear specification (where we do not account for the state of the economy), we estimate a model of the form:

$$y_{i,c,t+h} = \alpha_{i,c,h} + \phi_h \hat{\varepsilon}_{i,c,t} + \boldsymbol{\beta}_h' \mathbf{x}_{i,c,t-1} + \lambda_h t + \eta_{i,c,t+h} \tag{2}$$

where $y_{i,c,t+h}$ denotes a variable of interest (such as government expenditure in component i itself, real output, consumption and investment) h periods after the shock, $\mathbf{x}_{i,c,t-1}$ is a vector of control variables, $\boldsymbol{\beta}_h$ is a vector of coefficients and t is a time trend.[14] The vector $\mathbf{x}_{i,c,t-1}$ includes two lags of government spending in component i, two lags of GDP, one lag of debt and one lag of tax rate – similar to (1) above. We estimate a series of such models for horizons up to five years, i.e. $h = 0, ..., 5$. Then, the parameter ϕ_h captures the response of y to a shock in period t, h periods after the shock. Gathering up all the ϕ_h's, provides us with the Impulse Response Function (IRF) of the specific variable y.

This methodology can easily be extended to estimating non-linear models (Auerbach and Gorodnichenko, 2012, 2013a), so we estimate a state-dependent model by:

$$\begin{aligned} y_{i,c,t+h} \;=\; & \alpha_{i,c,h} + (1 - F(w_{c,t-1})) \left[\; \phi_{E,h} \hat{\varepsilon}_{i,c,t} + \boldsymbol{\beta}_{E,h}' \mathbf{x}_{i,t-1} \; \right] \\ & + F(w_{c,t-1}) \left[\; \phi_{R,h} \hat{\varepsilon}_{i,c,t} + \boldsymbol{\beta}_{R,h}' \mathbf{x}_{i,t-1} \; \right] + \lambda_h t + \eta_{i,c,t+h} \end{aligned} \tag{3}$$

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

$$F(w_{c,t}) = \frac{\exp(-\kappa w_{c,t})}{1 + \exp(-\kappa w_{c,t})}, \text{ with } \kappa > 0. \tag{4}$$

Here $F(w_{c,t})$ can be interpreted as the probability of being in a recession, given the state of the economy $w_{c,t}$. The parameter κ shows the smoothness of the transition between regimes: when $\kappa = 0$, we end up in the linear case, while when κ takes on very high values, the indicator looks like a usual dummy. We have chosen $w_{c,t}$ to be the 2-year moving average of GDP growth rate (standardized), so when $F(w_{c,t}) = 1$ the economy is in extreme recession, whereas when

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

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

[14] Obviously the presence of the index i in $y_{i,c,t}$ in (2) depends on whether we look at the effects on spending component i or not.

$F(w_{c,t}) = 0$ the economy is in extreme expansion. We follow Auerbach and Gorodnichenko (2013a) and set $\kappa = 1.5$.[15] The vector $\mathbf{x}_{i,c,t-1}$ is identical to that in (2), $\boldsymbol{\beta}_{R,h}$ and $\boldsymbol{\beta}_{E,h}$ are parameter vectors in recession/expansion, and $\{\phi_{R,h}\}_{h=0}^{H}$ and $\{\phi_{E,h}\}_{h=0}^{H}$ are the responses of y in a state of recession/expansion respectively, to a shock in period t, h periods after the shock. For inferential purposes we use clustered standard errors at the country level.

In order to capture the dynamic effects of government spending on output and compare our findings with those in the existing literature, we also compute cumulative fiscal multipliers. These answer the relevant policy question, as they measure the cumulative change in output due to the cumulative change in government spending on component i for horizons of up to h years-ahead – we compute multipliers for up to five-year-ahead here.[16]

It is the possible to estimate these cumulative multipliers either using the estimated impulse responses from (2) or by using a one-step approach suggested in Ramey and Zubairy (2018), essentially amounting to an instrumental variable estimation, regressing the cumulative sum of output on the cumulative sum of government spending, using the estimated shock as an instrument. The added value of this approach is that it provides us with a point estimate of the multiplier but also with a standard error, making inference on multipliers simple.

Consider first the linear case, in which the model to be estimated is:

$$\sum_{j=0}^{h} y_{c,t+j} = \zeta_{i,h} + \mu_h \sum_{j=0}^{h} g_{i,c,t+j} + \boldsymbol{\xi}_h' \mathbf{x}_{i,c,t-1} + \lambda_h t + \upsilon_{i,c,t+h}, \quad h = 0, 1, \cdots, 5 \quad (5)$$

where $\sum_{j=0}^{h} y_{c,t+h}$ is the sum of output from period t to period $t+h$, $\sum_{j=0}^{h} g_{i,c,t+h}$ is the sum of the government spending on component i from period t to period $t+h$. The idea is to use the estimated shock $\hat{\varepsilon}_{i,c,t}$, as an instrument for $\sum_{j=0}^{h} g_{i,c,t+h}$. Then, the parameter μ_h is the h-period cumulative output multiplier. In the state-dependent case, we estimate an equation of the form:

$$\begin{aligned} \sum_{j=0}^{h} y_{c,t+j} \;=\; & \zeta_{i,h} + (1 - F(w_{c,t-1})) \left[\mu_{E,h} \sum_{j=0}^{h} g_{ic,,t+j} + \boldsymbol{\xi}_{E,h}' \mathbf{x}_{i,c,t-1} \right] + \\ & F(w_{c,t-1}) \left[\mu_{R,h} \sum_{j=0}^{h} g_{i,c,t+j} + \boldsymbol{\xi}_{R,h}' \mathbf{x}_{i,c,t-1} \right] + \lambda_h t + \upsilon_{i,t+h}, h = 0, 1, \cdots, 5 \end{aligned} \quad (6)$$

where we use $F(w_{c,t-1}) \cdot \hat{\varepsilon}_{i,c,t}$ and $(1 - F(w_{c,i,t-1})) \cdot \hat{\varepsilon}_{i,c,t}$ as instruments for $F(w_{c,t-1}) \cdot \sum_{j=0}^{h} g_{i,c,t+j}$ and $(1 - F(w_{c,t-1})) \cdot \sum_{j=0}^{h} g_{i,c,t+j}$, respectively. In this way we obtain the state-dependent multipliers $\mu_{E,h}$ and $\mu_{R,h}$ and their associated standard errors – we employ again clustered standard errors here.

[15] Auerbach and Gorodnichenko (2013a) calibrate κ, so that the economy spends about 20% of time in recession, where they define an economy to be in a recession if $F(w_{c,t}) > 0.8$. This is consistent with the duration of recessions in the US.

[16] As we employ the Gordon and 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.

4 Results

4.1 The Effects of Government Spending by Function

Here, we present our empirical findings regarding the effects of each one of the eleven components of government expenditure. In particular, Figure 1 presents the Impulse Response Functions (IRFs) of government expenditure components, output, private consumption and private investment, estimated using (2). 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). In addition, Table 7 presents cumulative output multipliers estimated using (5), and Table 9 presents the tests of instrument relevance.

The IRF of output when government expenditure is defined as Public Services indicates a positive effect on output, is significant for three years after the shock and peaks at 1.5% (year 3). Consumption has a similar response with output, although investment displays some crowding out effects. The cumulative multiplier of output confirms the above result, as it is positive and significant and varies from 1.50 (impact) to 2.66 (4-year integral). This is not surprising, since Public Services (after our modification) consist mainly of administration services, which are thought to be productive.

Defense and Public Order & Safety have similar effects on output; they both trigger a positive response although it lasts for two years only. Defense expenditures cause an increase in consumption as well. Output multipliers are above 1 for both categories; the Defense multiplier peaks at 2.07 (2 years after the shock), and Public Order & Safety multiplier at 3.67 (5 years after the shock). Our defense spending multiplier is a little higher than most previous estimates (Owyang et al., 2013; Perotti, 2014; Ramey, 2011b; Ramey and Zubairy, 2018); Ben Zeev and Pappa (2017), however, find a 5-year multiplier equal to 2.14. Both Defense and Public Order & Safety, aim at ensuring the protection of property rights, which in turn sets the bases for the development of private economic activity. Defense spending has even been characterized as productive by previous work (Bleaney et al., 2001; Gemmell et al., 2011; Kneller et al., 1999). Therefore, output's response to both of them is positive and strong, as expected.

Moving on to Transport & Communication, we see that the productive nature of this category is confirmed as we observe a positive effect on output. The IRFs suggest that output and consumption react positively, although this effect does not last very long. The multiplier is below 1 during the first years after the shock, but it reaches up to 1.08 at a three year horizon. On the contrary, Economic Services produce negative effects to output (as well as to consumption and investment), as expected. Environmental protection, on the other hand, seems to be ineffective. We believe that this happens because environmental protection strategies impose regulations and restrictions to firms, and even though these policies increase social welfare, they usually restrict firms' productivity.

Housing is characterized as one of the productive components of government spending, so

we would expect a positive effect on output. However, the response of output to a shock in Housing seems to be zero. These findings are in line with evidence reported in Gemmell et al. (2016), who also find an insignificant result of housing on output. Only investment has a short positive reaction, 1 year after the shock, that reaches up to 1.04%. The explanation we give is that the type of expenditure provided in this category (e.g. water supply, street lighting), requires several years to implement; therefore, the productive results may be visible in the long-run, but not so much in the short-run horizon we look at here.

Health and Education produce a clear productive outcome, consistent with the findings of many previous (theoretical and empirical) studies.[17] Output multipliers are everywhere significant, above 1, and increase as years goes by, implying that the effect becomes stronger with time. The 5-year integral multiplier is 2 for Health and 3.25 for Education. We also find evidence that Health increases private consumption, in line with Fiorito and Kollintzas (2004), who argue that spending on Health increases private consumption since healthy people tend to engage in more activities (e.g. travel, go out etc.), thereby consuming more.

An interesting as well as surprising result is that of Recreation. Even though it is considered to be a non-productive type of government expenditure, we can see that it produces a strong and positive effect on output; the output multiplier varies from 3.01 to 5.66 and is significant everywhere. We can also see that the response of consumption is positive for the first years (the IRF of consumption actually has the same shape with that of output). A possible explanation for this increase in consumption - apart from the obvious effect of the increased income of Recreation employees - is that Recreation is complementary to private consumption as pointed out by Fiorito and Kollintzas (2004). For example, someone who plans an evening at the theater may also buy new clothes, have a meal at a restaurant afterwards etc. Therefore, an increase in Recreation will increase private consumption and, in turn, output.

Finally, we see that Social Protection has a zero effect on output. Output multipliers are insignificant at all horizons. However, there is a positive reaction from consumption, two and three years after the shock that peaks at 0.49%, and a negative one from investment for the first two years after the shock, that peaks at -0.41% (year 1). This is a well expected outcome, since Social Protection mainly consists of old age spending (pensions)[18] which is counter-productive.

4.2 The Effects of Government Spending by Function in Recessions and Expansions

Our next step is to evaluate the degree by which the above estimates vary with the business cycle, i.e. when the economy is in a state of expansion or recession. For that matter, we estimate again IRFs and cumulative output multipliers as before, only this time we use the non-

[17] See for example the empirical evidence of Acosta-Ormaechea et al. (2013), Afonso and Jalles (2014), Gemmell et al. (2016), and the theoretical analysis of Agénor (2008), Agénor and Neanidis (2011), Dioikitopoulos (2014), Semmler et al. (2011), and Economides et al. (2020)

[18] Old age spending accounts for 53.5% of Social Protection (OECD, 2017, Table 2.57).

linear specifications in (3) and (6). The outcomes of these experiments are presented in Figure 2 and Table 8. Table 8 also reports a set p-values of tests of the null hypotheses that the multipliers do not differ across states of the economy.

We note that all of the effects of different spending components show signs of state-dependence, except for Defense, Environment and Housing.[19] The multipliers of Public Services are found to be higher in recessions than in expansions, but only on impact. Moreover the multipliers of Public Order & Safety are found to be twice as large in recession relative to the values they attain in expansions. One possible interpretation of this finding is that in recessions criminality is more likely to escalate, making expenditures on Public Order & Safety more necessary and more effective in restraining non-market activities.

We also find that the multipliers of Transport & Communication are above 1 in recessions, but this component is completely ineffective in expansions. Economic Services multipliers remain negative in both states; however they are smaller in magnitude in recessions, implying a milder drop in GDP. Instead the multipliers of Health expenditure are found to be higher in recessions for most periods (year 2 – year 4). Recreation on the other hand, is only effective during recessions. We also find that Education multipliers are high in both states; however, they are higher in recession than expansion. This occurs in the first years after the shock, suggesting that during a recession, spending on Education increases GDP more and sooner than expansion.

The fact that multipliers are higher in recession than in expansion can be explained if we take into consideration the fact that in recessions, some households face liquidity constraints and they consume all of their disposable income (Galí et al., 2007; Tagkalakis, 2008). Therefore, an increase in government spending, especially in components addressed mostly towards such households, increases their consumption. This is verified by looking at the IRFs of consumption in Figure 2; consumption is indeed higher in recession after an increase in Transport & Communication, Economic Services, Health, or Recreation.

Finally, our results for the Social Protection component suggest the opposite result: Social Protection tends to be more effective during expansions (but only in the first year after the shock), implying that social protection spending, (such as the pension system (old age)) works better when the economy is in expansion.

5 Robustness Analysis

In order to examine the validity of our results, we conducted a series of robustness experiments. First of all, we evaluated what happens when we try out alternative definitions for the state variable w in the transition function (4), 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

[19] Housing actually shows evidence of state-dependence at year 0, but since the multipliers are insignificant in both states, we consider Housing to be non state-dependent.

baseline specification.

In addition, as in our analysis we use the data transformation suggested by Gordon and Krenn (2010) (that is we divide all variables with an estimate of potential GDP), it is important to check whether the way we estimate potential output 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, we find that our results do not change either qualitatively or quantitatively.

6 Conclusions

In this paper, we have estimated short-run multipliers of different components government spending according to their functional classification, and allowed their effects to vary over the business cycle. Even though many studies have addressed the effects of different functions of government spending on long-run growth in the past, there are no empirical studies on the short-run effects on output. Our work therefore extends the existing literature by covering this issue. To tackle this, we use data for a panel of 33 OECD countries, covering the time-period 1990-2018 on government spending, which is disaggregated according to its functional classification. More specifically, we estimate output multipliers for the 11 following categories of government spending: General Public Services, Defense, Public Order and Safety, Transport & Communication, Economic Services, Environment Protection, Housing and Community Amenities, Health, Education, Recreation, Culture and Religion, Social Protection. The effects of these types of spending are evaluated by means of impulse response functions of output, which are estimated using local projections (as e.g. in Jordà, 2005) and cumulative output multipliers following the pioneering work of Ramey and Zubairy (2018).

Our results indicate that some functional components are more effective than others, in the sense that they produce higher output multipliers. Public Services, Defense, Public Order & Safety, Transport & Communication, Health, Recreation and Education display positive and high multipliers, whereas multipliers for Economic Services are negative, and multipliers for Environmental Protection, Housing and Social Protection are insignificant. In addition, multipliers for Public Services, Defense, Public Order & Safety, Transport & Communication, Health, Recreation and Education are found to be significantly higher in recessions than in expansions.

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Table 1: Classification of the Functions of Government (COFOG)

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

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

Table 2: Structure of General Government Expenditures Countries, OECD Average, 2015

	% of Total Expenditure	% of GDP
General public services	13.2	5.5
Defence	5.1	2.1
Public order and safety	4.3	1.8
Economic affairs	9.3	3.9
Environmental protection	1.3	0.5
Housing and community amenities	1.4	0.6
Health	18.7	7.8
Recreation, culture and religion	1.5	0.6
Education	12.6	5.2
Social protection	32.6	13.6

Source: OECD (2017, Tables 2.32 and 2.34)

Table 3: Structure of government expenditures by government function of General Public Services, OECDE Average, 2015

Executive and legislative organs, financial and fiscal affairs, external affairs	31.2 %
Foreign economic aid	4.0 %
General services	16.5 %
Basic research	8.2 %
R&D General public services	0.3 %
General public services n.e.c.	1.9 %
Public debt transactions	38.0 %
Transfers of a general character between different levels of government	0.01 %

Source: OECD (2017, Table 2.36)
OECD Europe (OECDE) includes the European member countries of the OECD; data for Iceland are not included in the OECD Europe average because of missing time series.

Table 4: Structure of government expenditures by government function of Economic Affairs, OECDE Average, 2015

General economic, commercial and labour affairs	22.0 %
Agriculture, forestry, fishing and hunting	6.2 %
Fuel and energy	7.3 %
Mining, manufacturing and construction	2.6 %
Transport	47.6 %
Communication	0.4 %
Other industries	3.6 %
R&D Economic affairs	8.1 %
Economic affairs n.e.c.	2.3 %

Source: OECD (2017, Table 2.38)
OECD Europe (OECDE) includes the European member countries of the OECD; data for Iceland are not included in the OECD Europe average because of missing time series.

Table 5: Descriptive Statistics

	Obs	Mean	SD	Min	Max
Public Services	431	3.68	1.15	1.34	6.91
Defense	566	1.53	1.16	0.02	8.84
Public Order	569	1.69	0.44	0.78	4.34
Transport & Communication	456	2.60	0.85	0.36	7.21
Economic Services	456	2.38	1.51	-0.46	20.45
Environmental Protection	542	0.74	0.29	0.09	1.70
Housing	569	0.66	0.32	-0.13	2.30
Health	569	6.24	1.48	1.49	9.28
Recreation	569	1.21	0.53	0.27	3.57
Education	569	5.35	0.98	3.18	8.09
Social Protection	569	15.79	4.32	6.44	25.48
Debt	536	60.34	37.49	3.66	249.11
Taxes	570	25.65	6.51	15.47	48.68
Private Concumption	570	48.69	7.71	25.69	68.17
Private Investment	287	13.20	2.67	7.29	24.50
GDP	570	1.5e+12	3.1e+12	1.1e+10	1.9e+13

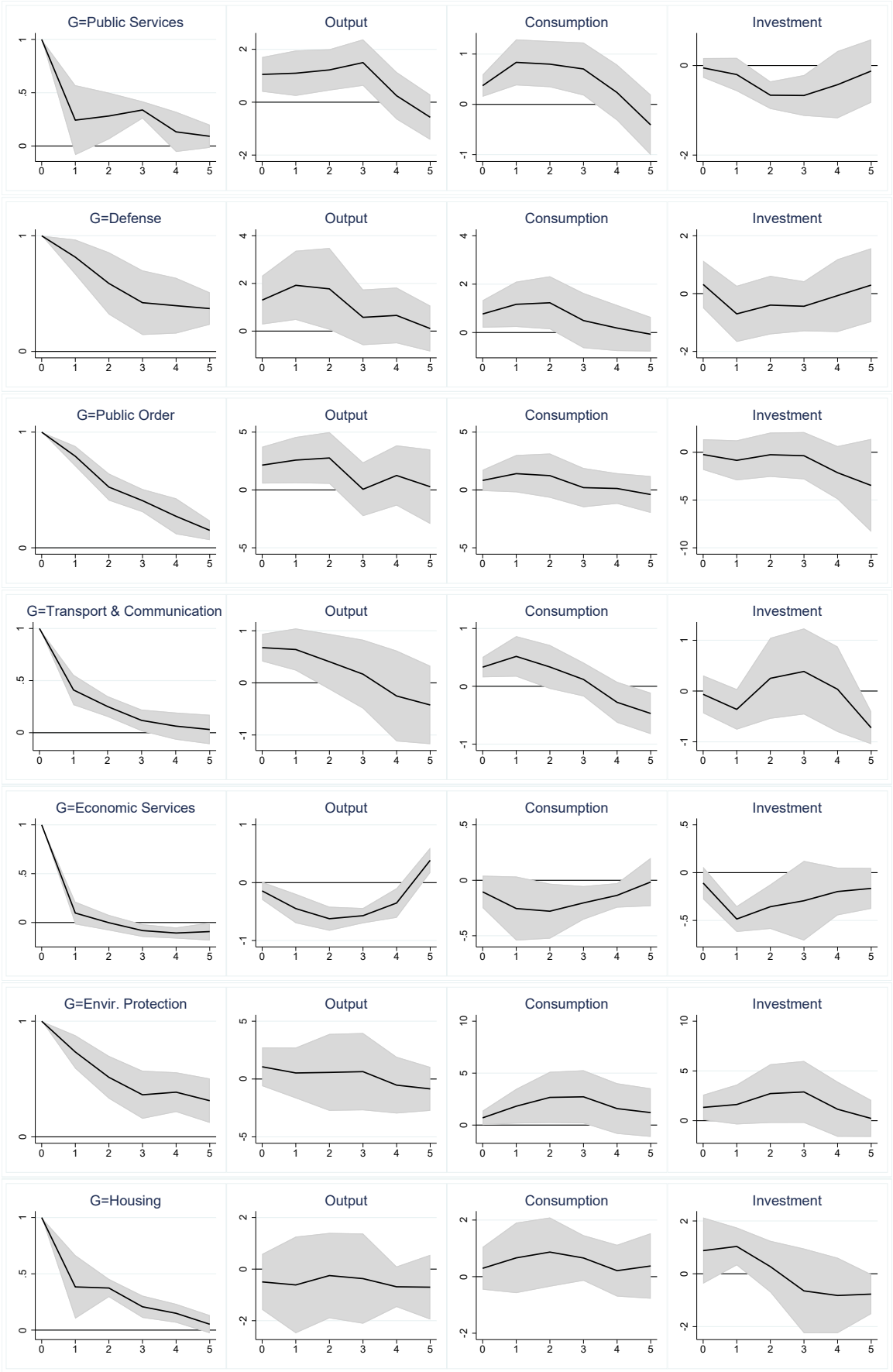
Notes: This table reports descriptive statistics for the variables in the dataset. All variables are expressed in percentage of GDP (except GDP which is in level).

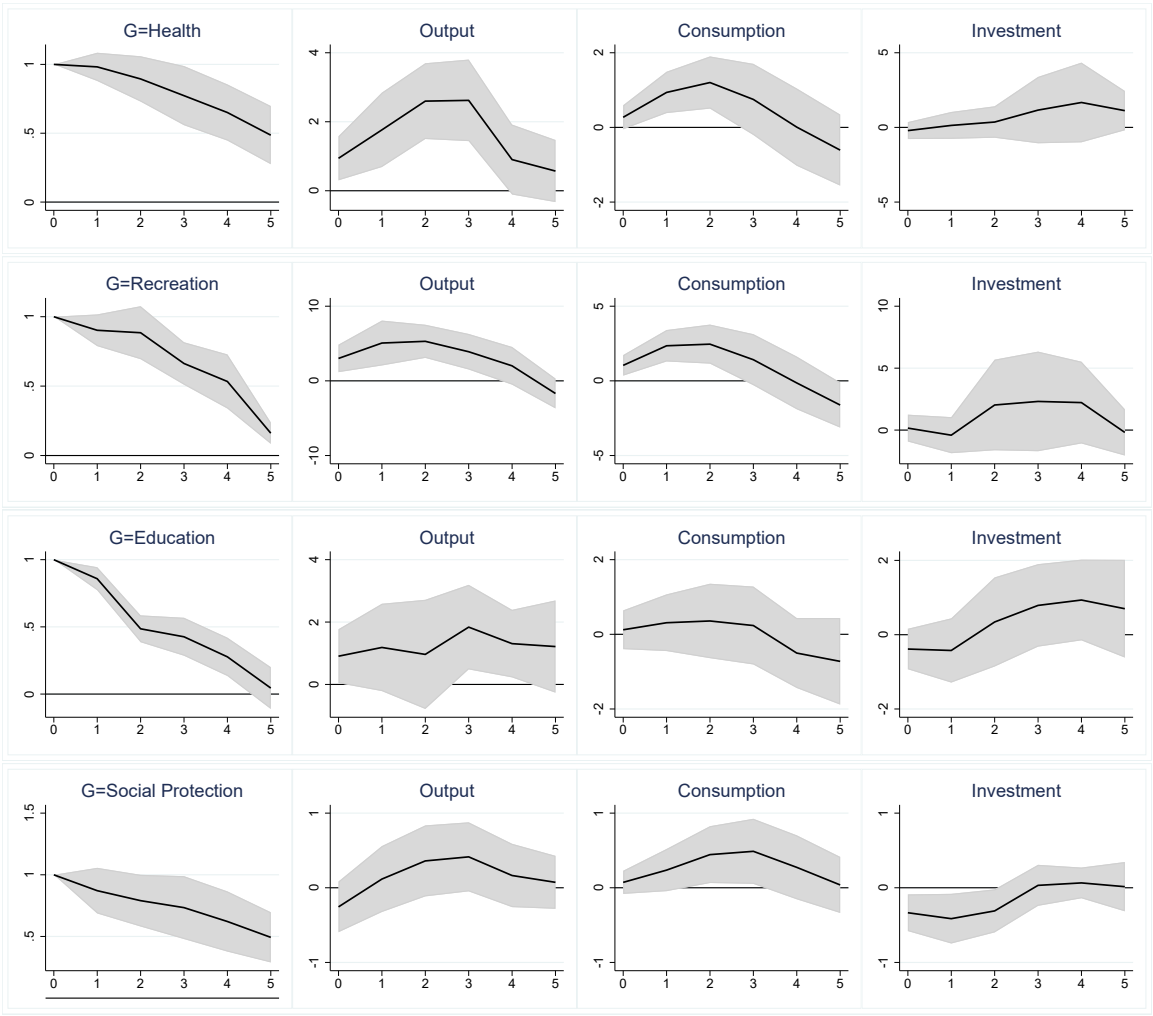
Table 6: Descriptive Statistics of Estimated Shock

	Obs	Mean	SD	Min	Max	Corr
Public Services	431	-0.00	0.32	-2.15	2.15	0.75
Defense	566	0.00	0.15	-0.85	0.98	0.47
Public Order	569	0.00	0.09	-0.86	0.49	0.77
Transport & Communication	456	-0.00	0.41	-1.10	3.22	0.72
Economic Services	456	0.00	1.24	-3.25	15.72	0.75
Environmental Protection	542	0.00	0.10	-0.57	0.66	0.10
Housing	569	0.00	0.14	-0.95	1.60	0.20
Health	569	-0.00	0.23	-1.09	1.23	0.79
Recreation	569	-0.00	0.10	-0.49	1.14	0.82
Education	569	0.00	0.19	-0.69	0.82	0.79
Social Protection	569	-0.00	0.53	-3.72	4.45	0.81

Notes: This table reports descriptive statistics for the estimated shock. The last column presents the correlation of the estimated shock with the government spending growth for each component.

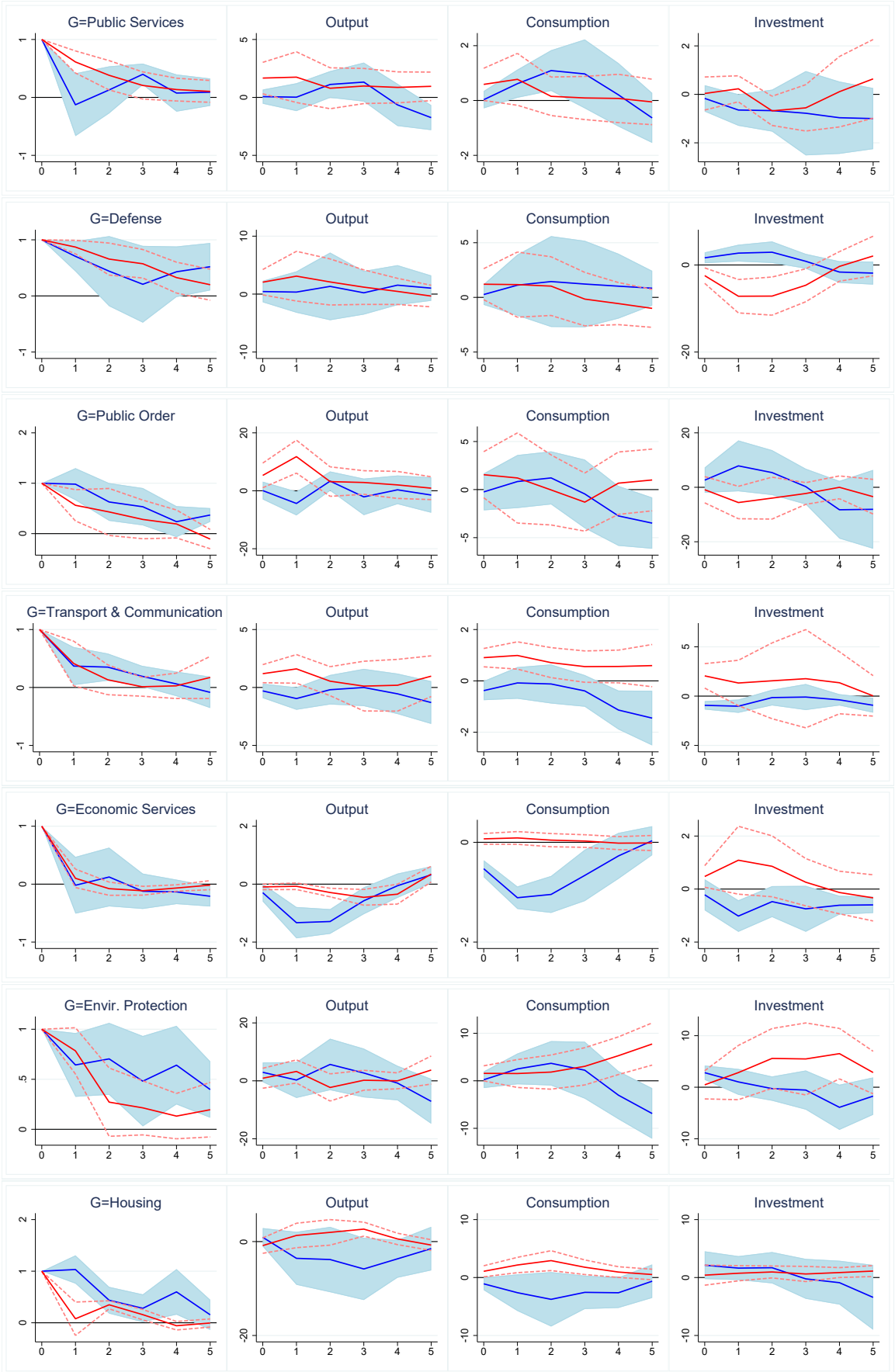
Figure 1: Impulse Responses to Government Spending Shocks - Linear Specification

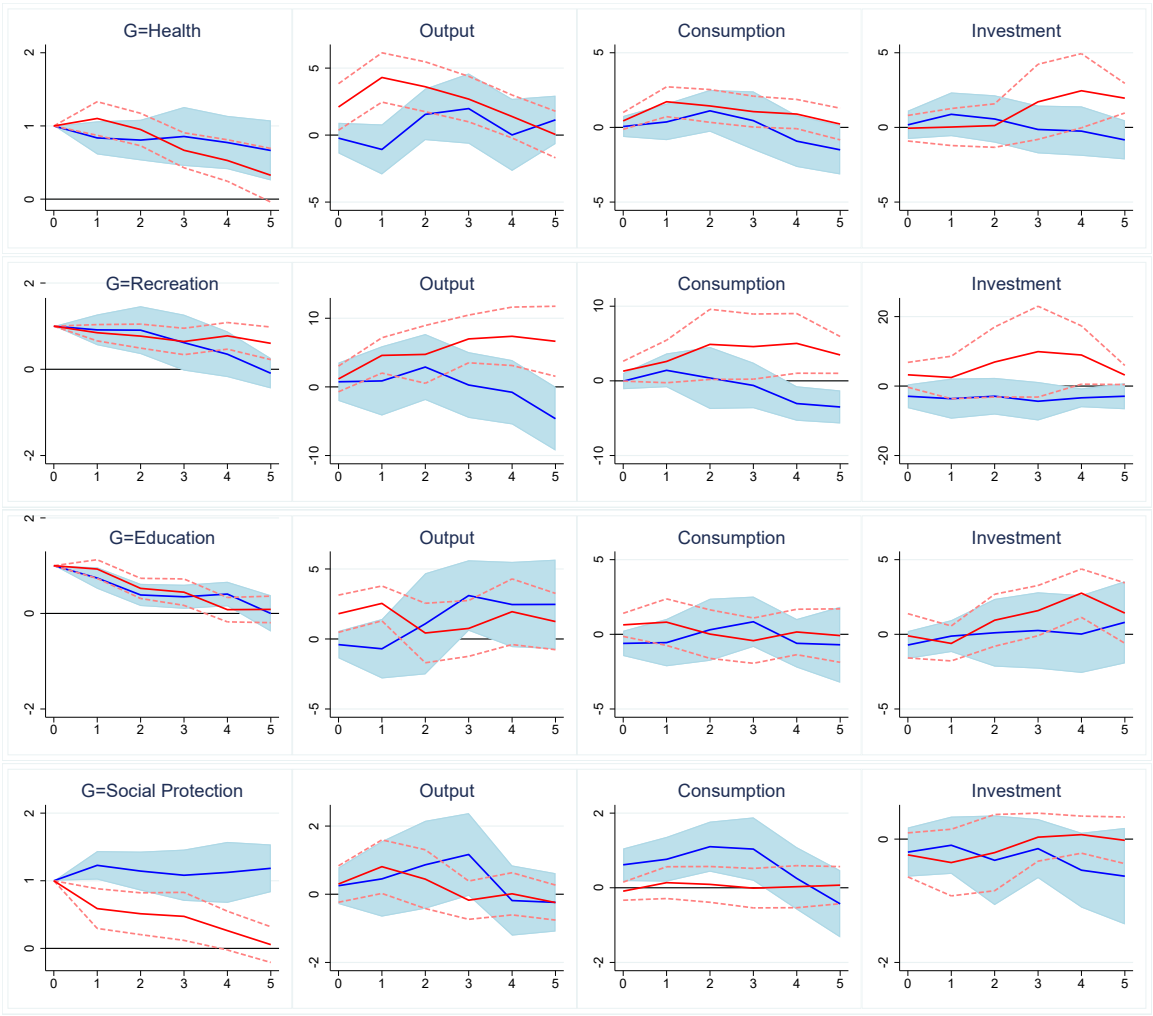




The figure reports the effects of a shock which raises government expenditure on general public services by 1% of GDP. The shock was obtained by estimating Equation 1.The responses have been estimated using the method of local projections (Jordà, 2005) i.e. by estimating (Equation 2) for each variable of interest (government spending, GDP, Private Consumption, Private Investment). Solid lines are point estimates and shaded areas denote the 90% confidence regions. The confidence regions have been constructed using clustered standard errors at the country level. The horizon is in years after the shock.

Figure 2: Impulse Responses to Government Spending Shocks - Non-linear Specification





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 1.The responses have been estimated using the method of local projections (Jordà, 2005) i.e. by estimating (Equation 3) for each variable of interest (government spending, GDP, Private Consumption, Private Investment). 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.

Table 7: Cumulative Output Multipliers - Linear Specification

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Public Services	1.05***	1.64**	1.96**	2.42**	2.66**	2.38**
	(0.39)	(0.68)	(0.84)	(1.09)	(1.20)	(1.04)
Defense	1.30**	1.77**	2.07**	2.00*	1.68	1.76
	(0.61)	(0.77)	(0.87)	(1.05)	(1.23)	(1.09)
Public Order	2.15**	2.81**	3.47**	2.79*	1.75	3.67*
	(0.95)	(1.26)	(1.48)	(1.45)	(1.64)	(2.18)
Transport & Communication	0.68***	0.91***	0.99***	1.08**	0.58	0.88
	(0.16)	(0.23)	(0.31)	(0.44)	(0.89)	(0.76)
Economic Services	-0.14	-0.53**	-1.12***	-1.86***	-2.64***	-2.39**
	(0.09)	(0.23)	(0.33)	(0.32)	(0.53)	(1.11)
Environmental Protection	1.06	0.82	0.55	1.97	0.36	0.52
	(1.00)	(1.17)	(1.47)	(1.67)	(2.11)	(1.87)
Housing	-0.49	-0.86	-1.07	-0.85	-1.75	-2.08
	(0.64)	(1.15)	(1.46)	(1.39)	(1.36)	(1.34)
Health	0.94**	1.34***	1.79***	1.93***	1.97***	2.00***
	(0.38)	(0.47)	(0.52)	(0.49)	(0.47)	(0.46)
Recreation	3.01***	4.25***	4.86***	5.92***	5.52***	5.66***
	(1.10)	(1.54)	(1.60)	(1.61)	(1.45)	(1.80)
Education	0.91*	1.16*	1.50*	1.95**	2.61***	3.25***
	(0.51)	(0.69)	(0.88)	(0.95)	(0.84)	(0.85)
Social Protection	-0.26	-0.05	0.13	0.12	0.03	0.08
	(0.20)	(0.23)	(0.25)	(0.27)	(0.32)	(0.33)

Notes: The table reports cumulative output multipliers estimated using the linear specification described in Equation 5. Standard errors clustered at the country level are reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level of significance, respectively.

Table 8: Cumulative Output Multipliers - Nonlinear Specification

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Public Services						
Expansion	0.96***	1.58***	2.12***	2.78***	3.00**	2.32*
	(0.33)	(0.43)	(0.47)	(0.89)	(1.24)	(1.26)
Recession	1.78**	2.56**	2.74**	3.18**	3.26*	3.21**
	(0.70)	(1.11)	(1.34)	(1.54)	(1.68)	(1.34)
$p-$value	0.09	0.32	0.70	0.63	0.68	0.35
Defense						
Expansion	1.57*	2.01*	2.45	2.88*	2.87	3.45**
	(0.81)	(1.10)	(1.75)	(1.71)	(1.88)	(1.56)
Recession	2.28**	3.12**	3.64**	3.56*	3.18	2.85
	(0.97)	(1.48)	(1.59)	(2.04)	(2.55)	(2.19)
$p-$value	0.59	0.46	0.50	0.65	0.78	0.90
Public Order						
Expansion	3.19***	3.04**	4.52***	3.67**	1.30	4.65
	(1.20)	(1.30)	(1.44)	(1.66)	(3.40)	(3.14)
Recession	5.26***	9.13***	10.59***	8.84***	6.48***	7.33*
	(1.73)	(2.06)	(2.02)	(1.90)	(2.36)	(3.81)
$p-$value	0.14	0.00	0.00	0.01	0.06	0.14
Transport & Communication						
Expansion	0.48	0.39	0.37	0.49	-0.23	-0.31
	(0.32)	(0.43)	(0.59)	(0.72)	(1.36)	(1.92)
Recession	1.00***	1.41***	1.46**	1.48	0.47	2.17**
	(0.32)	(0.49)	(0.64)	(1.11)	(2.03)	(0.97)
$p-$value	0.25	0.01	0.05	0.32	0.69	0.13
Economic Services						
Expansion	-0.37*	-1.95***	-3.73***	-6.01***	-9.28**	-12.62
	(0.21)	(0.41)	(0.63)	(1.88)	(4.37)	(12.87)
Recession	-0.16***	-0.50***	-1.14***	-1.98***	-2.80***	-1.09
	(0.05)	(0.11)	(0.23)	(0.52)	(0.99)	(1.40)
$p-$value	0.55	0.00	0.00	0.25	0.55	0.75
Environmental Protection						
Expansion	3.59***	3.36	3.57	6.94*	3.62	3.02
	(1.35)	(2.33)	(3.40)	(3.96)	(4.89)	(4.34)
Recession	2.70*	3.68**	3.60*	4.85**	2.65	2.45
	(1.43)	(1.54)	(1.98)	(2.20)	(2.04)	(2.32)
$p-$value	0.43	0.74	0.89	0.67	0.91	0.99

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Table 8 – continued

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Housing						
Expansion	0.34	-1.45	-2.93	-3.03	-5.22	-5.88
	(1.37)	(2.27)	(3.47)	(3.70)	(4.05)	(4.65)
Recession	-0.61	-0.18	0.42	0.82	-0.25	-1.41
	(1.06)	(1.61)	(1.56)	(1.50)	(1.51)	(1.66)
$p-$value	0.02	0.63	0.35	0.30	0.26	0.43
Health						
Expansion	0.99**	1.21*	2.25***	2.35**	2.64**	3.55***
	(0.45)	(0.62)	(0.85)	(0.98)	(1.17)	(1.22)
Recession	1.92***	2.69***	3.26***	3.30***	3.29***	2.71***
	(0.75)	(0.69)	(0.66)	(0.58)	(0.53)	(0.47)
$p-$value	0.13	0.01	0.02	0.03	0.06	0.88
Recreation						
Expansion	1.34	2.32	3.50	3.86	3.55	4.16
	(1.47)	(2.09)	(2.13)	(2.65)	(2.52)	(3.47)
Recession	1.60	3.78**	5.50***	6.66***	7.02***	7.00***
	(1.12)	(1.52)	(1.68)	(1.74)	(1.52)	(1.62)
$p-$value	0.83	0.35	0.18	0.06	0.00	0.00
Education						
Expansion	0.54	0.72	1.66	2.71*	4.16**	6.48***
	(0.51)	(0.85)	(1.18)	(1.48)	(1.63)	(1.67)
Recession	1.54**	2.04***	2.38***	2.98***	4.76***	5.38***
	(0.67)	(0.66)	(0.91)	(1.07)	(1.14)	(1.21)
$p-$value	0.00	0.01	0.20	0.53	0.31	0.71
Social Protection						
Expansion	0.51*	0.85*	1.13**	0.97*	0.63	0.72
	(0.30)	(0.45)	(0.51)	(0.55)	(0.61)	(0.55)
Recession	0.40	0.78**	0.88**	0.61	0.30	0.10
	(0.26)	(0.34)	(0.39)	(0.38)	(0.48)	(0.48)
$p-$value	0.01	0.58	0.85	0.81	0.70	0.29

Notes: The table reports cumulative output multipliers estimated using the non-linear specification described in Equation 6. Standard errors clustered at the country level are reported in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level of significance, respectively. We also report p-values for differences in multipliers across states.

Table 9: Tests of Instrument Relevance Across States

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Public Services						
Linear	.	38.72	21.20	228.2	123.7	87.05
Expansion	.	86.52	36.65	179.4	62.14	34.20
Recession	.	51.94	39.62	129.4	73.56	60.01
Defense						
Linear	.	388.0	91.48	40.94	27.38	26.29
Expansion	.	537.5	67.79	24.11	19.33	20.07
Recession	.	407.6	101.3	60.62	67.15	72.46
Public Order						
Linear	.	1123.4	490.6	335.3	154.3	184.2
Expansion	.	401.6	179.7	108.3	69.38	207.8
Recession	.	797.6	157.7	86.40	64.35	34.19
Transport & Communication						
Linear	.	255.0	165.6	90.65	48.12	34.06
Expansion	.	413.5	239.2	118.5	44.88	19.39
Recession	.	96.18	64.39	38.68	16.50	15.99
Economic Services						
Linear	.	243.1	121.0	71.32	36.52	6.847
Expansion	.	58.46	14.74	4.198	2.108	0.597
Recession	.	359.6	137.4	65.71	55.43	9.236
Environmental Protection						
Linear	.	389.7	162.7	71.79	63.17	55.21
Expansion	.	328.0	143.6	54.12	61.36	60.35
Recession	.	312.9	136.0	91.29	75.46	63.19
Housing						
Linear	.	64.89	75.89	56.34	49.34	37.30
Expansion	.	362.7	137.2	75.93	47.66	27.69
Recession	.	51.12	81.49	59.26	55.24	48.18
Health						
Linear	.	1007.7	313.3	178.1	116.2	82.60
Expansion	.	762.1	339.2	205.9	116.6	68.05
Recession	.	538.3	243.1	150.7	100.4	61.58
Recreation						
Linear	.	748.2	259.7	163.2	195.0	326.4
Expansion	.	260.8	79.81	32.78	36.50	49.35

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Table 9 – continued

Horizon after the shock	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Recession	.	645.1	317.7	152.9	95.71	54.56
Education						
Linear	.	1267.4	537.5	412.0	185.5	100.6
Expansion	.	833.6	400.0	264.2	122.3	84.33
Recession	.	572.0	272.7	280.4	155.4	93.07
Social Protection						
Linear	.	275.9	125.8	72.55	48.22	37.49
Expansion	.	565.6	259.2	133.1	85.67	74.42
Recession	.	178.1	88.54	52.30	35.82	28.18

Notes: The table reports the effective F-statistic from the regression of the sum of government spending through horizon h on the shock at t and all the other controls from the second stage.

Appendix A Data Description

Table A.1: Structure of General Government Expenditures of OECD Countries by Function, 2015

	General public services	**Defence**	**Public order and safety**	**Economic affairs**	**Environmental protection**	**Housing and community amenities**	**Health**	**Recreation, culture and religion**	**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
Latvia	14.05	2.72	5.43	11.46	1.87	2.64	10.26	4.36	16.25	30.96
Lithuania	12.46	3.82	4.53	10.36	1.54	0.91	16.53	2.66	15.45	31.74
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 A.1 – continued

	General public services	**Defence**	**Public order and safety**	**Economic affairs**	**Environmental protection**	**Housing and community amenities**	**Health**	**Recreation, culture and religion**	**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

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, New Zealand and Turkey. Information on data for Israel: http://dx.doi.org/10.1787/888932315602.

Source: OECD (2017, Table 2.32)

Table A.2: Total General Government Expenditure of OECD Countries by Function, Percentage of GDP, 2015

	General public services	**Defence**	**Public order and safety**	**Economic affairs**	**Environmental protection**	**Housing and community amenities**	**Health**	**Recreation, culture and religion**	**Education**	**Social protection**
Australia	4.5	1.6	1.8	3.6	0.9	0.6	7.0	0.7	5.3	10.2
Austria	6.9	0.6	1.4	6.2	0.4	0.4	8.0	1.2	5.0	21.7
Belgium	8.1	0.8	1.8	6.5	0.9	0.3	7.7	1.2	6.4	20.2
Czech Rep.	4.3	0.9	1.8	6.6	1.1	0.7	7.6	1.3	4.9	12.7
Denmark	7.4	1.1	1.0	3.7	0.4	0.2	8.6	1.8	7.0	23.6
Estonia	4.3	1.9	1.8	4.8	0.7	0.4	5.5	2.0	6.1	12.9
Finland	8.5	1.3	1.2	4.8	0.2	0.4	7.2	1.5	6.2	25.6
France	6.3	1.8	1.6	5.7	1.0	1.1	8.2	1.3	5.5	24.6
Germany	5.9	1.0	1.6	3.1	0.6	0.4	7.2	1.0	4.2	19.0
Greece	9.9	2.7	2.1	8.9	1.5	0.2	4.5	0.7	4.3	20.5
Hungary	8.9	0.5	2.1	8.6	1.2	1.1	5.3	2.1	5.2	15.0
Iceland	7.7	0.0	1.5	5.0	0.6	0.5	7.4	3.2	7.5	9.5
Ireland	4.1	0.4	1.1	3.4	0.4	0.6	5.7	0.6	3.7	9.6
Israel	5.4	5.9	1.5	2.4	0.5	0.0	5.0	1.4	6.8	10.7
Italy	8.4	1.2	1.9	4.1	1.0	0.6	7.1	0.7	4.0	21.4
Japan	4.1	0.9	1.3	3.7	1.2	0.7	7.7	0.4	3.4	16.1
Latvia	5.2	1.0	2.0	4.2	0.7	1.0	3.8	1.6	6.0	11.5
Lithuania	4.4	1.3	1.6	3.6	0.5	0.3	5.8	0.9	5.4	11.1
Luxembourg	4.3	0.3	1.0	4.9	1.1	0.5	4.5	1.2	5.1	18.5

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Table A.2 – continued

	General public services	**Defence**	**Public order and safety**	**Economic affairs**	**Environmental protection**	**Housing and community amenities**	**Health**	**Recreation, culture and religion**	**Education**	**Social protection**
Netherlands	5.0	1.1	1.8	4.0	1.4	0.3	8.0	1.4	5.4	16.6
Norway	4.7	1.5	1.1	5.1	0.9	0.8	8.4	1.5	5.5	19.4
Poland	4.9	1.6	2.2	4.6	0.6	0.7	4.7	1.1	5.2	15.9
Portugal	8.1	1.1	2.1	5.1	0.4	0.5	6.2	0.8	6.0	18.3
Slovak Rep.	6.5	1.1	2.4	6.3	1.0	0.8	7.2	1.0	4.2	15.0
Slovenia	6.8	0.8	1.6	6.0	1.0	0.6	6.7	1.6	5.6	17.4
Spain	6.5	1.0	2.0	4.4	0.9	0.5	6.2	1.1	4.1	17.1
Sweden	7.1	1.1	1.3	4.2	0.3	0.7	6.9	1.1	6.5	20.9
Switzerland	4.3	0.9	1.7	3.7	0.7	0.2	2.2	0.8	5.8	13.5
United Kingdom	4.5	2.1	2.0	3.1	0.8	0.5	7.6	0.7	5.1	16.4
United States	5.2	3.3	2.0	3.3	0.0	0.5	9.1	0.2	6.1	7.8
OECD	5.5	2.1	1.8	3.9	0.5	0.6	7.8	0.6	5.2	13.6

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, New Zealand and Turkey. Information on data for Israel: http://dx.doi.org/10.1787/888932315602.

Source: (OECD, 2017, Table 2.34)

Table A.3: List of OECD Countries in the Dataset

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

Table A.4: Data Sources and Definitions

Variable	**Definition**	**Source**
Government Expenditure on General Public Services	Government Expenditure on General Public Services (GF01) excluding Foreign Economic Aid (GF0102) and Public Debt Transactions (GF0107)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Defense	Government Expenditure on Defense (GF02)	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 Transport and Communication	Expenditure on Transport (GF0405) and Communication (GF0406)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
Government Expenditure on Economic Services	Expenditure on economic affairs (GF04) excluding Expenditure on Transport (GF0405) and Communication (GF0406)	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 Housing and Community Amenities	Government Expenditure on Housing and Community Amenities (GF06)	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 Education	Government Expenditure on Education (GF09)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)

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Table A.4 – continued

Variable	**Definition**	**Source**
Government Expenditure on Recreation, Culture and Religion	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 Expenditure on Social Protection (GF10)	IMF: Government Financial Statistics (GFS), Expenditure by Function of Government (COFOG)
GDP	GDP, PPP (constant 2017 international $)	World Bank: World Development Indicators
Consumption	Households and NPISHs Final consumption expenditure, PPP (constant 2017 international $)	World Bank: World Development Indicators
Investment	Gross fixed capital formation, private sector, PPP (constant 2017 international $)	World Bank: World Development Indicators
Debt	Public Debt	IMF: Historical Public Debt (HPDD)
Tax	Tax revenue (W0|S1|G11)	IMF: Government Financial Statistics (GFS, Revenue)

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