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Fiscal multipliers of central, state and local government and of the social security funds in Germany: evidence of a SVAR

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Non-technical summary

Research Question

Studies estimating the effect of sub-national fiscal policy measures on regional economic activity (known as 'local multipliers') have proliferated in recent years. Such estimates provide very little guidance about the overall GDP effects of aggregate national fiscal policies, however. As a consequence the latest research has focused on deriving aggregate national fiscal multipliers based on the estimation of local multipliers. This paper addresses this question from a different angle by disaggregating national fiscal multipliers along different levels of government.

Contribution

This paper contributes to the existing empirical literature on fiscal multipliers by applying a Structural Vector Autoregressive (SVAR) approach for Germany. The main innovation of this study is the sequential estimation for different models of various government subsectors and policy instruments using a disaggregated dataset that makes it possible to analyse and compare the effects of fiscal policy measures implemented at the various levels of government (central, state and local government) and by the social security funds.

Results

From a general government perspective, the results show that besides investment, it is particularly changes in social contributions that yield significant output effects. The GDP response to fiscal policy shocks of the various government sub-sectors turns out to be very heterogeneous. Investment expenditures at all public authorities (central, state and local) trigger positive and statistically significant output effects on impact. The initial positive effect, however, decreases over time and even becomes statistically signifcantly negative at state government level. Furthermore, it is only government consumption at state government level and monetary benefits at state government and social security level that induce statistically significant and positive effects on economic activity. Overall, the disaggregated results suggest that besides investment, it is chiefly expenditure with a large share of personnel-related outlays that can have positive effects on aggregate output.

Nichttechnische Zusammenfassung

Fragestellung

In jüngster Zeit erscheinen vermehrt Studien, die die Effekte teilstaatlicher fiskalpolitischer Maßnahmen auf die regionale Wirtschaftsaktivität (bekannt als „Lokale Multiplikatoren") untersuchen. Diese Schätzungen lassen allerdings nur wenig Rückschlüsse auf die Wirkung von gesamtstaatlichen fiskalpolitischen Maßnahmen auf nationaler Ebene zu. Somit hat sich die neueste Forschung darauf konzentriert aus teilstaatlichen Multiplikatoren die gesamtstaatlichen Effekte abzuleiten. Dieses Papier addressiert diese Frage aus einer anderen Perspektive und disaggregiert nationale Fiskalmultiplikatoren nach staatlichen Ebenen.

Beitrag

Dieses Papier trägt zur existierenden empirischen Literatur zu Fiskalmultiplikatoren bei, indem ein Strukturelles Vektorautoregressives Modell (SVAR) für Deutschland geschätzt wird. Die wesentliche Neuerung dieser Studie ist die sequentielle Schätzung von verschiedenen Modellen für verschiedene staatliche Teilsektoren und Politikinstrumente unter Verwendung eines disaggregierten Datensatzes. Dies ermöglicht die Effekte fiskalpolitischer Maßnahmen von den Gebietskörperschaften (Bund, Länder, Gemeinden) und den Sozialversicherungen zu analysieren und zu vergleichen.

Ergebnisse

Aus gesamtstaatlicher Sicht zeigen die Ergebnisse, dass neben den öffentlichen Investitionen insbesondere Änderungen in den Sozialversicherunsbeiträgen zu einer signifikanten Veränderung des Outputs führen. Die BIP-Wirkung auf Fiskalschocks der verschiedenen staatlichen Teilsektoren ist hingegen sehr heterogen. Investitionsausgaben führen bei allen Gebietskörperschaften (Bund, Länder, Gemeinden) in der ersten Periode zu einem signifikant positivem BIP-Effekt. Im Zeitverlauf nimmt dieser Effekt jedoch ab und wird auf Ebene der Länder sogar statistisch signifikant negativ. Des Weiteren haben Konsumausgaben nur auf Ebene der Länder und monetäre Sozialleistungen nur auf Ebene der Länder und der Sozialversicherungen einen signifikant positiven Effekten auf die gesamtwirtschaftliche Aktivität. Insgesamt legen die disaggregierten Ergebnisse nahe, dass neben Investitionen vor allem Ausgaben mit einem hohen Anteil personalbezogener Aufwendungen die BIP-Entwicklung positiv beeinflussen können.

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Abstract

By applying a Structural Vector Autoregressive (SVAR) approach this paper estimates the effects of fiscal policy shocks of different government sub-sectors on aggregate GDP in Germany. From a general government perspective, the results show that besides investment, it is particularly changes in social contributions that yield significant output effects. The GDP response to fiscal policy shocks of the various government sub-sectors turns out to be very heterogeneous. Investment expenditures at all public authorities (central, state and local) trigger positive and statistically significant output effects at least on impact. By contrast, it is only government consumption at state government level and monetary benefits at state government and social security level that induce statistically significant and positive effects on economic activity. Overall, the disaggregated results suggest that besides investment, it is chiefly expenditure with a large share of personnel-related outlays that can have positive effects on aggregate output.

Keywords: Fiscal Policy, Multipliers, VAR, Disaggregated Government Levels and Instruments
JEL classification: H71, H5, H30.

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1 Introduction

For some time now, sluggish economic growth has led to a discussion on whether the euro area's fiscal policy stance should be loosened. It is in view of this that Germany, in particular, has been faced with growing calls to make use of its fiscal space to increase aggregate demand. This paper contributes to the existing empirical literature on fiscal multipliers by applying a Structural Vector Autoregressive (SVAR) approach for Germany. The main innovation of this study is the sequential estimation for different models of various government sub-sectors and policy instruments using a disaggregated dataset that makes it possible to analyse and compare effects of fiscal policy shocks of various levels of government (central, state, local government as well as social security funds) on aggregate GDP.

Against the backdrop of discretionary fiscal stimulus packages and consolidation efforts in recent years a number of empirical and theoretical studies have appeared that investigate the effectiveness of fiscal policy measures (see, inter alia, Ilzetzki, Mendoza, and Vegh (2013), Auerbach and Gorodnichenko (2012), Christiano, Eichenbaum, and Rebelo (2011)). While the perspective and methodology of those studies vary, the common denominator of a large part of this literature focuses on general government fiscal measures. Only recently the function and effectiveness of spending by government sub-sectors have gained greater prominence. In particular, studies using cross-sectional variation in fiscal policy to estimate the effect of expansionary fiscal measures on regional economic activity (known as 'local multipliers') have proliferated, essentially observing a discernible positive relationship between local government expenditure and local economic activity (see Serrato and Wingender (2016), Acconcia, Corsetti, and Simonelli (2014), Chodorow-Reich, Feiveson, Liscow, and William (2012)). While the estimation of local multipliers has several advantages and provides new insights into the transmission of fiscal policy, the estimates are also subject to controversy regarding whether they provide any guidance about the effects of aggregate national fiscal policies.[1] As a consequence, the latest research has focused on the distinction between local multipliers and aggregate national fiscal multipliers (see Dupor and Guerrero (2017)).

This paper contributes to the literature on sub-national fiscal multipliers and focuses on the question at which level of government different expansionary fiscal measures yield the largest aggregate output effect. Germany, in particular, is suited to this kind of analysis for two reasons: First, Germany is politically and economically highly decentralised consisting of three layers of government (federal level, states and municipalities) and an extensive social insurance system.[2] Second, the constitution puts fiscal policy in the hands of the federal and state level, giving social insurances and municipalities a subordinate role. This division leads to a delimitation of tasks, which grants us insights into what government expenditure, broken down by area of activity, is the most effective in terms of its GDP impact.

[1] For a general discussion on local multipliers and a review of the research, see Chodorow-Reich (2017).

[2] Time series based studies on general government fiscal multipliers for Germany have been conducted by Hayo and Uhl (2014), Tenhofen, Wolff, and Heppke-Falk (2010), Marcellino (2006) as well as Perotti (2005). In qualitative terms, the findings of these studies largely concur with those for the United States or individual countries in the euro area (see, inter alia, Giordano, Momigliano, Neri, and Perotti (2007) and Castro and de Cos (2008)).

Our analysis relies on sequentially and independently estimated VAR models that encompass all general government revenue and expenditure affecting the budget. Each model distinguishes between the government expenditure categories of consumption, investment and monetary social benefits and between the revenue categories of taxes and social security contributions as well as all other net receipts. The sectoral distribution of the variables included in the model changes according to the fiscal variable and sub-sector under review.

In principle, there are a variety of ways to identify exogeneous fiscal policy shocks (see Caldara and Kamps (2017)). A series of analyses makes specific assumptions regarding the short-term responses of selected variables to fiscal policy shocks (see, inter alia, Blanchard and Perotti (2002) or Fatas and Mihov (2001)). Other studies use detailed information on the tax system or detailed information on specific policy decisions derived from quasi-experiments to ensure identification (see, inter alia, Ramey (2011) or Romer and Romer (2010)). A third group of studies, by contrast, imposes qualitative restrictions on the impulse response functions with a view to ensuring that certain variables respond a priori to specific shocks with plausible signs (see Mountford and Uhlig (2009)). For a given purpose, one identification strategy can be preferable to another. While quasi-experiments are more suitable for addressing potential endogeneity than traditional SVAR approaches (see Riera-Crichton, Vegh, and Vuletin (2016)), the downside to this identification strategy is, in our case, that such exogenous shock series are not available for specific revenue and expenditure categories and, above all, not for disaggregated levels of government. The main advantage of the sign restriction approach is that theoretical assumptions are reconciled with empirical analyses. However, as we are interested in the effects of fiscal policy across sub-sectors it would not be an innocuous assumption to impose the same qualitative response of the same fiscal variable on all government levels. This is why we opt for an approach that enables us to identify comparable shocks across government sub-sectors and directly compare the effectiveness of various fiscal measures employed by different levels of government. This can only be achieved by the contemporaneous identification approach of Blanchard and Perotti (2002), using, for each government sub-sector, exogenous institutional information about the tax and transfer system.

We find that, in particular, government investment has a significantly positive effect on output with a general government impact multiplier in our baseline model of roughly 3.5. The effects of monetary social benefits, government consumption as well as taxes and social contributions are, with an estimated baseline multiplier of around 2.0, 0.8 and 0.6 significant, lower.[3] It is only for government consumption that no robust statistically significant relationship with regard to GDP development is established.

The GDP effects in response to fiscal policy measures implemented at the different levels of government turn out to be very heterogeneous across government sub-sectors and policy instruments. Investment expenditures at all public authorities (central, state and local) trigger positive and statistically significant output effects on impact. The initial positive effect, however, decreases over time and even becomes statistically signifcantly negative at state government level. Furthermore, it is only government consumption at

[3]For Germany only the study by Tenhofen et al. (2010) analyses the GDP effects of comparable disaggregated fiscal policy measures. Much as in our analysis, the authors provide evidence that in particular, spending involving direct government purchases produces a stronger GDP response than less direct expenditure, such as personnel expenses.

state government level and monetary benefits at state government and social security level that induce statistically significant and positive effects on economic activity. Overall, the disaggregated results suggest that besides investment, it is chiefly expenditure with a large share of personnel-related outlays that can have positive effects on aggregate output. With respect to the revenue side, our result suggests that, in particular, changes in social contributions seem to be effective, while the aggregate output effects of tax shocks are considerably smaller.
This paper is structured as follows: first of all, section 2 provides a description of the statistical model. This is followed by the description of the data in section 3, while the identification assumptions for the derivation of fiscal policy shocks are discussed in section 4. The results of the baseline scenario are presented in section 5. The results are discussed in section 6 with respect to aggregation, estimation assumptions and data specifications. Section 7 concludes and puts our findings into perspective.

2 Methodology

Our analysis relies on a VAR model that maps all general government revenue and expenditure affecting the budget. The general government baseline model comprises six variables and, in addition to having GDP as the target variable, distinguishes between general government consumption expenditure, investment expenditure and monetary transfers on the expenditure side and between taxes and social security contributions (referred to collectively as levies) and all other net receipts on the revenue side. The data used are defined in detail and described in the next section.
In order to examine the GDP effects of the various fiscal policy measures implemented by the different government sub-sectors (central government, state government, local government and the social security funds) in Germany, our analysis builds upon the general government model for the aforementioned fiscal variables and for the different government sub-sectors by estimating an individual VAR with an additional seventh variable in each case. The additional seventh variable is the respective fiscal variable as defined by the government sub-sector under review. In order to ensure that all general government revenue and expenditure affecting the budget are captured in the models and there is no duplication of general government revenue and expenditure, the fiscal variable of the other government sub-sectors contained in the model changes according to the fiscal variable and sub-sector under review. The advantage of this type of modeling is that, as well as providing a complete picture of all government revenue and expenditure, the interaction between fiscal variables (for example, the response of general government levies to an increase in consumption in a government sub-sector) across the government sub-sectors is taken into account when analysing the GDP impact.
In all estimates, the reduced form of the VAR models is assumed to follow the stochastic process

$$Z_t = \Gamma_0 + \Gamma_1(L, p)Z_{t-1} + E_t \tag{1}$$

where the vector Γ_0 contains a constant and a trend in each case. The expression $\Gamma_1(L, p)$ describes a 'lag polynomial', which, in all estimates in the baseline scenario, takes into account the impact of the values going back up to four periods of vector Z_t on the

current values of the individual variables (i.e. $p = 4$ in the baseline).[4] In the model for general government, the vector $Z_t = (y_t, c_t^T, i_t^T, s_t^T, a_t^T, r_t^T)$ consists of the logs of the variables GDP (y_t), government consumption expenditure (c_t^T), government investment expenditure (i_t^T), monetary social benefits (s_t^T), taxes and social security contributions (referred to collectively as levies; a_t^T) and all other net receipts (r_t^T), where the superscript index T stands for general government.
In the models analysing the GDP impact of different fiscal measures implemented by government sub-sectors, the index $k = B, L, G, SV$, with central government (B), state government (L), local government (G) and the social security funds (SV), describes the sectoral definition of fiscal variable $x_t^k = c_t^k, i_t^k, s_t^k, a_t^k$, where the sum of fiscal variable x_t across all government sub-sectors k corresponds to the fiscal variable of general government ($x_t^T = \sum_k x_t^k$). Thus, the composition of vector Z_t is described in generalised terms in all models as

$$\begin{aligned} &Z_t(x^k) = \left(y_t, x_t^T - f^c(x_t^k), i_t^T - f^i(x_t^k), s_t^T - f^s(x_t^k), a_t^T - f^a(x_t^k), r_t^T, x_t^k\right) \\ &with \quad f^X(x_t^k) = \begin{cases} x_t^k, & \text{if x=X} \quad \text{for X,x = c,i,s,a} \\ 0, & else \end{cases} \end{aligned} \tag{2}$$

where an individual VAR model is estimated for all combinations of x and k. Thus, for instance, when analysing a local government investment shock ($x_t^k = i_t^G$), vector $Z_t(i^G)$ consists of the variables GDP (y_t), general government consumption expenditure (c_t^T), general government investment less local government investment ($i_t^T - i_t^G$), general government monetary social benefits (s_t^T), general government levies (a_t^T), general government other net receipts (r_t^T) and local government investment (i_t^G). The composition of vectors $Z_t(x^k)$ is determined in the same way for the remaining fiscal variables and sub-sectors under review. Vectors $E_t^T = (e_t^y, e_t^{c^T}, e_t^{i^T}, e_t^{s^T}, e_t^{a^T}, e_t^{r^T})$ in the general government model and $E_t(x^k) = (e_t^y, e_t^{c^T - f^c(x_t^k)}, e_t^{i^T - f^i(x_t^k)}, e_t^{s^T - f^s(x_t^k)}, e_t^{a^T - f^a(x_t^k)}, e_t^{r^T}, e_t^{x^k})$ in the models analysing the fiscal measures of the government sub-sectors describe the forecast errors, whose disturbance terms have a normal distribution of white noise, are intertemporally uncorrelated and have a constant contemporaneous covariance matrix. We estimate all models using the frequentist approach and obtain confidence bands by asymptotic distributions.

3 Definitions of variables and description of data

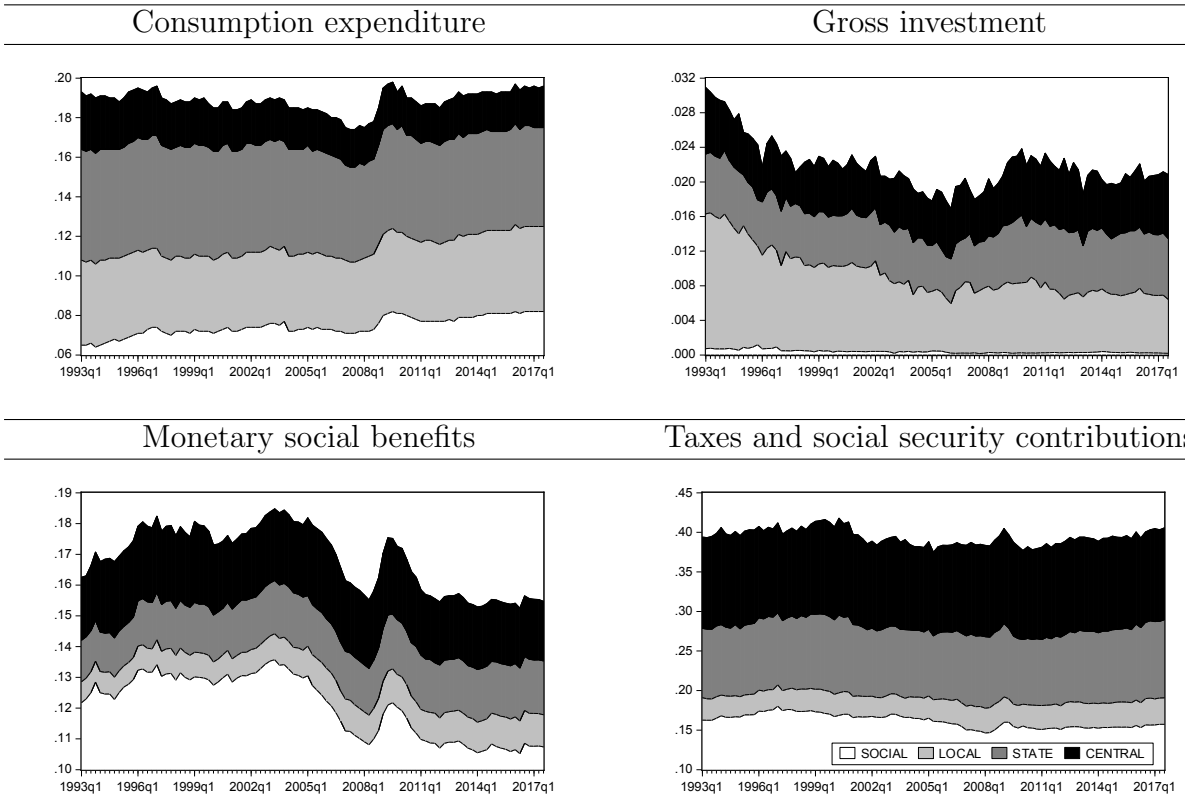
In this analysis all VAR models are estimated using seasonally and price-adjusted quarterly data from $1993Q1$ to $2017Q3$ based on the accounting system of the national accounts.[5] Each model includes the variables GDP, government consumption, government investment, monetary social benefits, social contributions and taxes as well as all other net receipts. For a detailed overview of the data underlying the estimation, see Table 5

[4] Results derived from alternative model structures are discussed in section 6.3.

[5] The seasonal adjustment of the data was carried out using the standard X-13-ARIMA-SEATS procedure. Government consumption was adjusted using the deflator for government consumption, public investment is adjusted using the deflator for public investment and all other variables using the GDP deflator. Estimations performed with alternative deflators and with nominal variables are discussed in section 6.3.

in the Appendix. The fiscal variables always comprise the entire government sector and show all receipts and expenditure affecting the budget. The variable 'other net receipts' correspondingly acts as a residual and is composed of net property income, other current net transfers (especially current transfers in the context of international cooperation and current transfer payments to the EU), net capital transfers and subsidies.[6]

Figure 1: Development of revenue and expenditure broken down by government sub-sector (as a percentage of GDP)



Note: Receipts and expenditure according to the System of National Accounts.

Figure 1 shows the development of the various receipts and expenditure components of general government as a percentage of GDP, as well as their distribution across central, state and local government and social security funds over time. From a general government perspective, it is evident that, with the exception of the crisis years 2008 and 2009, consumption expenditure, taxes and social security contributions, in particular, have expanded in line with GDP. Regarding consumption expenditure, an increase in social transfers (health and care insurance, in particular) was offset by a considerable decline in the compensation of employees (staff cuts). What is striking is that both consumption expenditure and the levies ratio have returned to a constant, slightly upward trajectory since 2011. However, in the period under review, general government investment fell in relation to GDP, the decline being mainly attributable to a sustained slowdown in the construction boom and to the normalisation process following German reunification in the 1990s. From the introduction of the labour market reform and the upswing which

[6]Given that 'other net receipts' are only of secondary importance to discretionary fiscal policy, no further consideration is given to them as we proceed with our analysis.

began in 2005, the ratio of monetary social benefits, which was increasing steadily up to the early 2000s, saw a decline that lasted until the crisis years 2009 and 2010. Since 2011, social benefits have essentially grown in parallel with GDP.

A breakdown of general government consumption expenditure and monetary social benefits into the various government sub-sectors shows that the percentage share of expenditure is particularly high in social security funds.[7] Consumption expenditure at the level of social security funds primarily consists of social transfers relating to health and care, and monetary social benefits essentially comprise spending on pension insurance schemes and short-term unemployment benefits (Arbeitslosengeld I). Consumption expenditure by central, state and local government, too, varies considerably between the different levels in terms of the general government share as well as the composition. While consumption expenditure at the state government level (around 30% of general government consumption expenditure) predominantly comprises expenditure on wages (around 80%), central and local government, besides wages (around 50%), exhibit a significant amount of expenditure on intermediate consumption (around 40%) (see Figure 8 in the Appendix). With regard to investment, it is evident that, proportionately, local government, at around 39%, currently invests somewhat more than both central government (around 30%) and state government (around 30%); by comparison, investment by social security funds, with a share of around 1% of late, is negligible at the general government level. The breakdown of general government taxes and social security contributions among central, state and local government and social security funds has barely changed since 1993. All receipts from taxes go to central, state and local government (percentage share of 57.8% in general government levies on average over the period reviewed here), whereas receipts from actual social security contributions are solely at the disposal of the social security funds.[8]

Overall, the vertical breakdown of the levels of fiscal variables therefore makes it possible not only to quantify the effects that certain receipt and expenditure categories of central, state and local government as well as social security funds have on GDP, but also, given the varied composition of government sub-sectors' receipts and expenditure, allows the extraction of detailed information on the GDP effect of certain receipt and expenditure categories. For example, GDP's reaction to a levy-related shock to social security funds reflects GDP's reaction to a shock to aggregate actual social security contributions. The different areas of responsibility regarding investment by central, state and local government, too, make it possible to draw tentative conclusions about the GDP effect of certain investments by area of responsibility. For instance, a large part of investment at central government level is attributable to defense (around 36%) and economic affairs (around 39%), while investment at state government level is predominantly made in education (around 25%) and in general public administration (around 30%). Figure 9 in the Appendix contains a breakdown of consumption and investment expenditure by

[7] Regarding consumption expenditure, in particular, the share of social security funds in general government expenditure has risen considerably over time, whereas the shares of central and state government have fallen somewhat. Monetary social benefits, on the other hand, paint a somewhat different picture. Here, the share of social security funds in overall expenditure has decreased slightly, while the local government share has increased. A chart showing how the different shares have evolved may be found in Figure 10 of the Appendix.

[8] Note that in the system of national accounts imputed social contributions are recorded as revenues of central, state and local governments. Due to the low proportion, however, they are not considered further in the subsequent analysis.

area of responsibility.

4 Identifying Discretionary Fiscal Policy Shocks at General Government and Government Sub-Sector Level

4.1 Structural model for general government

This section sets out the identification of the discretionary fiscal policy shocks in all the models that we estimate. As shocks are correlated with each another, they cannot necessarily be traced back to a policy measure, but may be directly linked to a shock to GDP via the automatic stabilisers. However, if the main focus is on policy measures, such effects must first be separated from each other. The starting point for the structural identification in our analysis is the AB model by Amisano and Giannini (1997), according to which the reduced equation systems in Equation (1) may also be illustrated by the structural model

$$Az_t = \Theta_0 + \Theta_1 Z_{t-1} + B\epsilon_t \tag{3}$$

with $\Theta_0 = A\Gamma_0, \Theta_1 = A\Gamma_1$ and $B\epsilon_t = AE_t$ being equivalent. Besides unexpected contemporaneous reactions (A matrix), reactions to structural shocks (B matrix) can also be depicted in this way. We will first take a look at the general government baseline model, in which the following correlations between the structural and the reduced form residuals are assumed.

$$\begin{aligned}
e_t^y &= a_{11}e_t^{c^T} + a_{12}e_t^{i^T} + a_{13}e_t^{s^T} + a_{14}e_t^{a^T} + a_{15}e_t^{r^T} + \epsilon_t^y && (4)\\
e_t^{c^T} &= a_{21}e_t^y + b_{22}\epsilon_t^{i^T} + b_{23}\epsilon_t^{s^T} + b_{24}\epsilon_t^{a^T} + b_{25}\epsilon_t^{r^T} + \epsilon_t^{c^T} && (5)\\
e_t^{i^T} &= a_{31}e_t^y + b_{32}\epsilon_t^{c^T} + b_{33}\epsilon_t^{s^T} + b_{34}\epsilon_t^{a^T} + b_{35}\epsilon_t^{r^T} + \epsilon_t^{i^T} && (6)\\
e_t^{s^T} &= a_{41}e_t^y + b_{42}\epsilon_t^{c^T} + b_{43}\epsilon_t^{i^T} + b_{44}\epsilon_t^{a^T} + b_{45}\epsilon_t^{r^T} + \epsilon_t^{s^T} && (7)\\
e_t^{a^T} &= a_{51}e_t^y + b_{52}\epsilon_t^{c^T} + b_{53}\epsilon_t^{i^T} + b_{54}\epsilon_t^{s^T} + b_{55}\epsilon_t^{r^T} + \epsilon_t^{a^T} && (8)\\
e_t^{r^T} &= a_{61}e_t^y + b_{62}\epsilon_t^{c^T} + b_{63}\epsilon_t^{i^T} + b_{64}\epsilon_t^{s^T} + b_{65}\epsilon_t^{a^T} + \epsilon_t^{r^T} && (9)
\end{aligned}$$

with coefficients a_{ij} representing the unexpected contemporaneous reactions, while coefficients b_{ij} depict the structural correlations between the shocks. Equation (4) states that an unexpected change in GDP may be triggered contemporaneously within a quarter by unexpected changes in government consumption, government investment, monetary social expenditure, receipts from taxes and social security contributions, other receipts and a structural GDP shock. Equation (5) states that unexpected changes in government consumption may be triggered by unexpected GDP changes as well as by structural shocks to investment expenditure, monetary social benefits, receipts from social security contributions and tax, other net receipts, and structural shocks to government consumption itself. Correspondingly, Equations (6) to (9) can be interpreted in the same way.
In order to completely identify the equation system of the six-variable VAR with 25 parameters which are to be freely determined, it is necessary to place a total of 15 restrictions on the system. In principle, we follow the procedure adopted by Blanchard and Perotti

(2002) here. By using quarterly data, it is plausible to assume that intra-period GDP shocks have no repercussions for government consumption ($a_{21} = 0$), government investment ($a_{31} = 0$), and other net receipts ($a_{61} = 0$), given that fiscal policy decision-makers are probably not able to respond to a GDP shock with a discretionary impulse within the space of one quarter. By contrast, the response to a GDP shock by taxes and social security contributions (a_{51}) as well as monetary social benefits (a_{41}) primarily reflects the impact of the automatic stabilisers, which can be determined exogenously through information on the tax and transfer system (see also section 4.3). With regard to the contemporaneous correlation of structural shocks (equations (5) to (9)) any sequence of shocks is conceivable, as a general rule. In the baseline scenario, we decided to let expenditure-side measures react before receipts-side measures ($b_{24} = b_{25} = b_{34} = b_{35} = b_{44} = b_{45} = 0$), consumption and monetary social benefits to react before investment ($b_{22} = b_{43} = 0$), consumption to react before monetary social benefits ($b_{23} = 0$), and other net receipts to react before levies ($b_{65} = 0$).

4.2 Structural models for government sub-sectors

In order to analyse separately the fiscal shocks of the government sub-sectors, an individual VAR model is estimated for each sub-sector and each fiscal variable, with the fiscal variable in question (consumption, investment, monetary social benefits and levies) being broken down to the relevant government sub-sector to be analysed (central, state and local government or social security funds) and a residual (shares of the remaining government sub-sectors). The general government model is thus supplemented by an additional variable but continues to include all general government receipts and expenditure in aggregate. Based on the structural model for general government, the relationships between structural and reduced residuals can then be generalised as follows.

$$
\begin{aligned}
e_t^y &= a_{11}^{x^k} e_t^{c^T - f^c(x_t^k)} + a_{12}^{x^k} e_t^{i^T - f^i(x_t^k)} + a_{13}^{x^k} e_t^{s^T - f^s(x_t^k)} + a_{14}^{x^k} e_t^{a^T - f^a(x_t^k)} \\
&\quad + a_{15}^{x^k} e_t^{r^T} + a_{16}^{x^k} e_t^{x^k} + \epsilon_t^y && (10) \\
e_t^{c^T - f^c(x_t^k)} &= a_{21}^{x^k} e_t^y + b_{22}^{x^k} \epsilon_t^{i^T - f^i(x_t^k)} + b_{23}^{x^k} \epsilon_t^{s^T - f^s(x_t^k)} + b_{24}^{x^k} \epsilon_t^{a^T - f^a(x_t^k)} \\
&\quad + b_{25}^{x^k} \epsilon_t^{r^T} + b_{26}^{x^k} \epsilon_t^{x^k} + \epsilon_t^{c^T - f^c(x_t^k)} && (11) \\
e_t^{i^T - f^i(x_t^k)} &= a_{31}^{x^k} e_t^y + b_{32}^{x^k} \epsilon_t^{c^T - f^c(x_t^k)} + b_{33}^{x^k} \epsilon_t^{s^T - f^s(x_t^k)} + b_{34}^{x^k} \epsilon_t^{a^T - f^a(x_t^k)} \\
&\quad + b_{35}^{x^k} \epsilon_t^{r^T} + b_{36}^{x^k} \epsilon_t^{x^k} + \epsilon_t^{i^T - f^i(x_t^k)} && (12) \\
e_t^{s^T - f^s(x_t^k)} &= a_{41}^{x^k} e_t^y + b_{42}^{x^k} \epsilon_t^{c^T - f^c(x_t^k)} + b_{43}^{x^k} \epsilon_t^{i^T - f^i(x_t^k)} + b_{44}^{x^k} \epsilon_t^{a^T - f^a(x_t^k)} \\
&\quad + b_{45}^{x^k} \epsilon_t^{r^T} + b_{46}^{x^k} \epsilon_t^{x^k} + \epsilon_t^{s^T - f^s(x_t^k)} && (13) \\
e_t^{a^T - f^a(x_t^k)} &= a_{51}^{x^k} e_t^y + b_{52}^{x^k} \epsilon_t^{c^T - f^c(x_t^k)} + b_{53}^{x^k} \epsilon_t^{i^T - f^i(x_t^k)} + b_{54}^{x^k} \epsilon_t^{s^T - f^s(x_t^k)} \\
&\quad + b_{55}^{x^k} \epsilon_t^{r^T} + b_{56}^{x^k} \epsilon_t^{x^k} + \epsilon_t^{a^T - f^a(x_t^k)} && (14) \\
e_t^{r^T} &= a_{61}^{x^k} e_t^y + b_{62}^{x^k} \epsilon_t^{c^T - f^c(x_t^k)} + b_{63}^{x^k} \epsilon_t^{i^T - f^i(x_t^k)} + b_{64}^{x^k} \epsilon_t^{s^T - f^s(x_t^k)} \\
&\quad + b_{65}^{x^k} \epsilon_t^{a^T - f^a(x_t^k)} + b_{66}^{x^k} \epsilon_t^{x^k} + \epsilon_t^{r^T} && (15) \\
e_t^{x^k} &= a_{71}^{x^k} e_t^y + b_{72}^{x^k} \epsilon_t^{c^T - f^c(x_t^k)} + b_{73}^{x^k} \epsilon_t^{i^T - f^i(x_t^k)} + b_{74}^{x^k} \epsilon_t^{s^T - f^s(x_t^k)} \\
&\quad + b_{75}^{x^k} \epsilon_t^{a^T - f^a(x_t^k)} + b_{76}^{x^k} \epsilon_t^{r^t} + \epsilon_t^{x^k} && (16)
\end{aligned}
$$

with the superscript indices representing the sectoral definition of the fiscal variable as a function of x and k and the definition of $f^X(x_t^k)$ given by equation (2). Given that individual VAR models are estimated for all combinations of $x = c, i, s, a$ and $k = B, L, G, SV$, the discretionary shocks of the fiscal variable x and government sub-sector k can be viewed in isolation, with the general government fiscal sector continuing to be shown in the models. Besides the fiscal variable x, the interpretation of Equations (10) through (16) also depends on sub-sector k. For instance, in the model analysing a consumption shock ($x = c$) at central government level ($k = B$) in Equation (10), parameter $a_{16}^{c^B}$ denotes the contemporaneous reaction of GDP to an unexpected shock in government consumption at central government level, and parameter $a_{11}^{c^B}$ the contemporaneous reaction of GDP to a shock in government consumption at the level of the remaining government sub-sectors (in this case, state and local government and social security funds). As in equation (4) of the general government model, the remaining parameters in Equation (10) now reflect the GDP's contemporaneous reaction to unexpected shocks in general government investment, general government social security benefits, general government levies and remaining general government net receipts. Correspondingly, Equations (11) to (14) can be interpreted in the same way, with $e_t^{C^T - C^B}$ now showing the structural and $e_t^{C^T - C^B}$ the reduced form shocks of general government consumption net of government consumption at central government level as well as $e_t^{C^B}$ the structural and $e_t^{c^B}$ the reduced form shocks of government consumption at central government level.

The difficulty in identifying these shocks is that the variables in the model differ depending on the fiscal variable x and sub-sector k being analysed. The result is that identification assumptions vary from model to model. The additional seventh variable means that, compared with the general government model, a further six restrictions are now required. As in the general government model, all models are based on the assumption that, irrespective of a variable's sectoral definition k, shocks in GDP have no repercussions within one period on government consumption ($a_{21}^{x^k} = 0$), government investment ($a_{31}^{x^k} = 0$) and other net receipts ($a_{61}^{x^k} = 0$), and that the reaction of taxes, social security contributions ($a_{51}^{x^k}$) and monetary social benefits ($a_{41}^{x^k}$) to a GDP shock is essentially evidence of the automatic stabilisers taking effect. These stabilisers are, as in the general government model, determined via exogenous information and regressions, with the elasticity varying between models depending on the fiscal variable x and sub-sector k being analysed.[9] Interpreting and thus also determining parameter $a_{71}^{x^k}$ varies from model to model and depends on the fiscal variable x. In the case of $x = c$ and $x = i$, the parameter reflects the contemporaneous reaction of government consumption or investment of sub-sector k to changes in GDP; this reaction is assumed to be zero. In the case of $x = s$ and $x = a$, the parameter shows the contemporaneous reaction of monetary social benefits or levies of sub-sector k to changes in GDP; this reaction is determined by means of an exogenously calculated elasticity (see section 4.3).

The contemporaneous correlation of the structural shocks, too, uses the general govern-

[9] Given that the sectoral definition of the variables contained in the model varies with each k, it is necessary to calculate different elasticities for the various sectoral definitions of levies and monetary social benefits in order to identify shocks to levies and monetary social benefits. In the model for analysing levy-related shocks to social security funds, parameter $a_{71}^{a_{SV}}$, for instance, denotes the contemporaneous reaction of levies from social security funds to a change in GDP, whereas parameter $a_{51}^{a_{SV}}$ illustrates the reaction of the aggregated levies of the remaining sub-sectors, namely central, state and local government.

ment model as a blueprint, due to which it was assumed in the baseline scenario that expenditure-side measures would react before receipts-side measures ($b_{24}^{x^k} = b_{25}^{x^k} = b_{34}^{x^k} = b_{35}^{x^k} = b_{44}^{x^k} = b_{45}^{x^k} = 0$), consumption and monetary social benefits would react before investment ($b_{22}^{x^k} = b_{43}^{x^k} = 0$), consumption before monetary social benefits ($b_{23}^{x^k} = 0$), and other net receipts before levies ($b_{65}^{x^k} = 0$). In turn, the restrictions of parameters $b_{26}^{x^k}$, $b_{36}^{x^k}$, $b_{46}^{x^k}$, $b_{56}^{x^k}$, $b_{66}^{x^k}$ as well as $b_{72}^{x^k}$, $b_{73}^{x^k}$, $b_{74}^{x^k}$, $b_{75}^{x^k}$ and $b_{76}^{x^k}$ depend on the fiscal variable x. Where $x = a$, parameters $b_{26}^{x^k}$, $b_{36}^{x^k}$, $b_{46}^{x^k}$ and $b_{66}^{x^k}$ are set at zero, as expenditure-side measures react before receipts-side measures, and other net receipts before levies. With regard to the sequence of the sectoral shocks, it was assumed that the shocks in the fiscal variable x of the government sub-sector k react before the shocks x in the remaining sub-sectors T-k. Hence, where $x = a$, parameter $b_{75}^{x^k}$ is set at zero. The restrictions in the case of $x = c$, $x = i$ and $x = s$ can be derived in the same way if it is assumed that expenditure-side measures react before receipts-side measures, consumption and monetary social benefits before investment, and that the fiscal variables of the government sub-sectors k react before those of the remaining sub-sectors T-k. The sensitivity of the results regarding alternative identification assumptions in the sub-sector models as well as in the general government model is addressed in section 6.2. For a better visualisation of the identification of fiscal shocks both of the general government shocks as well as for the sub-sectors see also the matrix representation in Section A.3 of the Appendix.

4.3 Exogeneous elasticities

As outlined in the previous section, in order to identify shocks it is necessary to distinguish the impact of automatic stabilisers from discretionary fiscal policy responses to unexpected (exogenous) changes in macroeconomic activity. To achieve this, we first identify - in the context of the tax and transfer system in Germany - which revenue and expenditure categories may respond automatically in the same quarter to GDP changes. Next, we quantify this response using simple regressions.

In view of the tax and transfer system in Germany, it is plausible to assume that, on the expenditure side, only unemployment insurance benefit payments made when unemployment commences (unemployment benefit I) will be affected contemporaneously in the same quarter by GDP changes. Other spending categories that generally also depend on macroeconomic developments, such as basic allowance benefits (such as unemployment benefit II) or pension insurance expenditure, respond with something of a lag (the latter with a lag of more than a year, via the pension adjustment formula).[10] While expenditure-side developments within a quarter are thus largely independent of GDP changes, the response on the revenue side via the automatic stabilisers in the economy is much more sensitive. Alongside wage tax, profit-related taxes (assessed income tax, corporation tax, local business tax and investment income tax), consumption taxes (including vehicle tax) and value added tax, receipts from social security contributions (pension insurance, health insurance, long-term care insurance and accident insurance), in particular, are likely to react automatically to changes in economic output. By contrast, developments in revenue from real estate transfer tax, real estate tax and inheritance tax

[10] It can also be assumed that interest expenditure, capital transfers and subsidies do not respond in the same quarter to GDP changes.

tend to be largely independent of cyclical influences.[11]

Next, we use econometric equations to calculate the cyclical responsiveness of the various revenue and expenditure categories ($\gamma_{gdp,fiscal}$); there is no distinction between general government and the government sub-sectors (central government, state governments, local authorities, social security funds). The elasticity of a revenue or expenditure category is the product of the elasticities of the macroeconomic bases to GDP ($\gamma_{gdp,base}$), and of the elasticity of revenue and expenditure to the respective macroeconomic base ($\gamma_{base,fiscal}$), which are each estimated using dynamic individual equations in difference form. The left-hand column of Table 1 shows the estimation results for the various partial elasticities of the individual revenue and expenditure categories, and the macroeconomic bases assumed for the revenue and expenditure developments.[12] Aside from motor vehicle taxes, which are not very significant in quantitative terms, profit-related taxes were the only category for which no statistically significant relationship could be identified between revenue developments and the macroeconomic reference variable (in this case: corporate and property income). Indeed, a quarterly elasticity of zero for profit-related taxes does not, in principle, appear implausible, as the size of the advance payments made by taxpayers is based on past corporate earnings and there is usually a lag of more than one quarter before the final tax liability is fixed and any back payments from or refunds to taxpayers are made.

In the literature, the calculated responses of revenue and expenditure categories to GDP changes generally differ widely. This is due not only to differing definitions of cyclically sensitive revenue and expenditure and to varying observation periods and data definitions but also to the method of calculating the partial elasticities. For example, in Tenhofen et al. (2010), the elasticity of revenue and expenditure to the relevant macroeconomic base is derived from institutional data. The advantage of their method is that changes in tax legislation, which are difficult to control for in empirical estimates, do not influence the results. The disadvantage, however, is that the institutionally derived elasticities provide a very oversimplified picture of the tax and transfer system: advance payments and lags, which are likely to particularly affect the quarterly elasticities of profit-related taxes, are not adequately taken into account. Similarly, expectations effects of future tax changes that might alter the consumption behavior of households before the tax is ultimately changed, cannot be captured by this identification either.[13] The sensitivity of the results to alternative elasticity assumptions is addressed in section 6.2.

In order to identify the automatic responses of revenue and expenditure in the various government sub-sectors according to the data definition relevant to the VAR model estimation, we then weight the elasticities calculated for the individual categories by the revenue share in total taxes and social security contributions - or, for spending on unemployment benefit I, by the expenditure share in total monetary social benefits - and add them up. In the models analysing the shocks to taxes and social security contributions

[11] This also applies to several 'minor' taxes and various public levies or contributions, such as air travel duties or radio and television license fees (largely booked as direct household taxes in the national accounts), which are therefore omitted from the calculation of automatic stabilisers within a quarter.

[12] As in the case of the estimated VAR models, the data used to calculate the elasticities are based on the national accounts calculation system and likewise span the period from 1993Q1 to 2017Q3. See the comments beneath Table 1 for details on the data and the econometric estimation models.

[13] See the fiscal foresight literature and potential biases that arise if expectation effects are omitted, for example Leeper, Walker, and Yang (2013)

Table 1: Quarterly Fiscal-to-GDP elasticities of the various government sectors

Macro and fiscal elasticities of individual revenue and expenditure categories					Share of individual revenue/expend categories in taxes and social sec contributions/monetary social benefits in the government sector (k)					Quarterly Fiscal-to-gdp elasticities of the various government sectors (k)				
Rev/epend category	Macro base	$\gamma_{gdp,base}$	$\gamma_{base,fiscal}$	$\gamma_{gdp,fiscal}$	General gov	Central gov	State gov	Local gov	Social sec	General gov(T)	Central gov(B)	State gov(L)	Local gov(G)	Social sec(SV)
Taxes and social security contributions										**0.481**	**0.594**	**0.525**	**0.239**	**0.408**
of which:		(A)	(B)	(AxB)	(C)	(D)	(E)	(F)	(G)	(AxBxC)	(AxBxD)	(AxBxE)	(AxBxF)	(AxBxG)
Value added tax	Private consumption + residental investment	0.710	1.170	0.831	0.172	0.317	0.358	0.036	0.000	0.143	0.263	0.297	0.030	0.000
Excise tax	Private consumption	0.610	1.120	0.683	0.080	0.261	0.015	0.000	0.000	0.055	0.178	0.010	0.000	0.000
Wage tax	Gross wages and salaries per employee	0.300	1.790	0.537	0.186	0.256	0.363	0.351	0.000	0.100	0.138	0.195	0.189	0.000
	Employees	0.060	1.000	0.060						0.011	0.015	0.022	0.021	0.000
Corporation tax	Entrepreneurial and propterty income (EPI)	2.610	0.000	0.000	0.020	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Local business tax	EPI	2.610	0.000	0.000	0.035	0.006	0.009	0.401	0.000	0.000	0.000	0.000	0.000	0.000
Assessed income tax	EPI	2.610	0.000	0.000	0.024	0.037	0.046	0.034	0.000	0.000	0.000	0.000	0.000	0.000
Investment income tax	EPI	2.610	0.000	0.000	0.021	0.036	0.045	0.014	0.000	0.000	0.000	0.000	0.000	0.000
Motor vehicle tax	Private consumption	0.610	0.000	0.000	0.007	0.006	0.026	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Social sec. contributions	Gross wages and salaries per employee	0.300	1.170	0.351	0.419	0.000	0.000	0.000	0.993	0.147	0.000	0.000	0.000	0.349
	Employees	0.060	1.000	0.060						0.025	0.000	0.000	0.000	0.060
Others	—	0.000	0.000	0.000	0.035	0.050	0.137	0.160	0.007	0.000	0.000	0.000	0.000	0.000
Memo item:														
Aggregated elasticity of taxes and social sec. contributions in the sub-sectors T-k*										**na**	**0.426**	**0.426**	**0.494**	**0.525**
Monetary social benefits										**-0.056**	**0.000**	**0.000**	**0.000**	**0.000**
of which:		(A)	(B)	(AxB)	(C)	(D)	(E)	(F)	(G)	(AxBxC)	(AxBxD)	(AxBxE)	(AxBxF)	(AxBxG)
Unemployment benefits I	Unemployed persons	-0.860	1.130	-0.972	0.058	0.000	0.000	0.000	0.080	-0.056	0.000	0.000	0.000	-0.078
Others	-	0.000	0.000	0.000	0.942	1.000	1.000	1.000	0.920	0.000	0.000	0.000	0.000	0.000
Memo item:														
Aggregated elasticity of monetary benefits in the sub-sectors T-k*										**na**	**-0.065**	**-0.065**	**0.065**	**0.000**

*Note: We calculated the elasticities of the macroeconomic reference variables to GDP ($\gamma_{gdp,base}$) and the elasticities of the fiscal variables to the macroeconomic reference variable ($\gamma_{base,fiscal}$) using the linear regression $\Delta U_t = c + \alpha \Delta V_t + \epsilon_t$. For both the fiscal and the macroeconomic variables, only data from the national accounts for the period from 1993Q1 to 2017Q3 were used in the regressions and the weighting. In the case of a statisitcally insignificant coefficient α (10% significance level), an elasticity of zero was assumed. * The aggregated elasticity of the sub-sectors T-k describes the automatic response of the variables excluding sub-sector k. To calculate this, we weighted the elasticities of the individual revenue and expenditure categories by the revenue or expenditure share in aggregated taxes and social security contributions or monetary social benefits in the sub-sectors T-k (not shown in the table).*

or monetary social benefits in the government sub-sectors, it is necessary to calculate not only the fiscal-GDP quarterly elasticity for sub-sector k but also, in each case, the contemporaneous response of taxes and social security contributions or monetary social benefits in the other sub-sectors (T-k).[14] We perform the weighting separately for each government sub-sector in order to take account of the different proportional composition of revenue and expenditure in the government sub-sectors. The elasticities need to be placed in overarching national accounts categories so as to ensure that the identification of shocks and the data used for the VAR estimation is consistent.
The results (see the right-hand column of Table 1) show that a GDP change of 1% leads to an increase of 0.48% in general government taxes and social security contributions in the same quarter. At the central and state government level, the elasticity of taxes and social security contributions is slightly higher than this, at 0.59 and 0.53, respectively, whereas that calculated for local government is lower, at 0.24. The main reason for this difference in sensitivity is the variation in the proportional composition of tax revenue in relation to total tax revenue[15] for each of the government sectors. For example, at the central government level, indirect taxes that are particularly cyclically sensitive within the same quarter account for a relatively large share of total tax revenue, which results in a higher quarterly elasticity. The tax and contribution elasticity of the social security funds is around 0.41 and is determined entirely by the automatic response of revenue from social security contributions. For general government, the automatic response of monetary social benefits is around -0.06 and is thus relatively low. This is due to the assumption that only expenditure on unemployment benefits for the short-term unemployed responds in the same quarter to GDP changes. For central, state and local government, the quarterly elasticity is zero, as the cyclically sensitive expenditure on short-term unemployed benefits only affects the social security funds. As the relative share of expenditure on short-term unemployment benefits in total monetary social benefits is larger for the social security funds than for general government, the sensitivity of the social security funds is slightly higher (elasticity of -0.08) than that of general government.

5 Results of the baseline scenario

This section presents the results of the baseline scenario, describing and analysing first the impulse responses and then the cumulated multipliers of the various fiscal policy shocks. We initially look at the impact of general government fiscal measures before turning our attention to fiscal shocks in individual sub-sectors.

5.1 Impulse response analysis

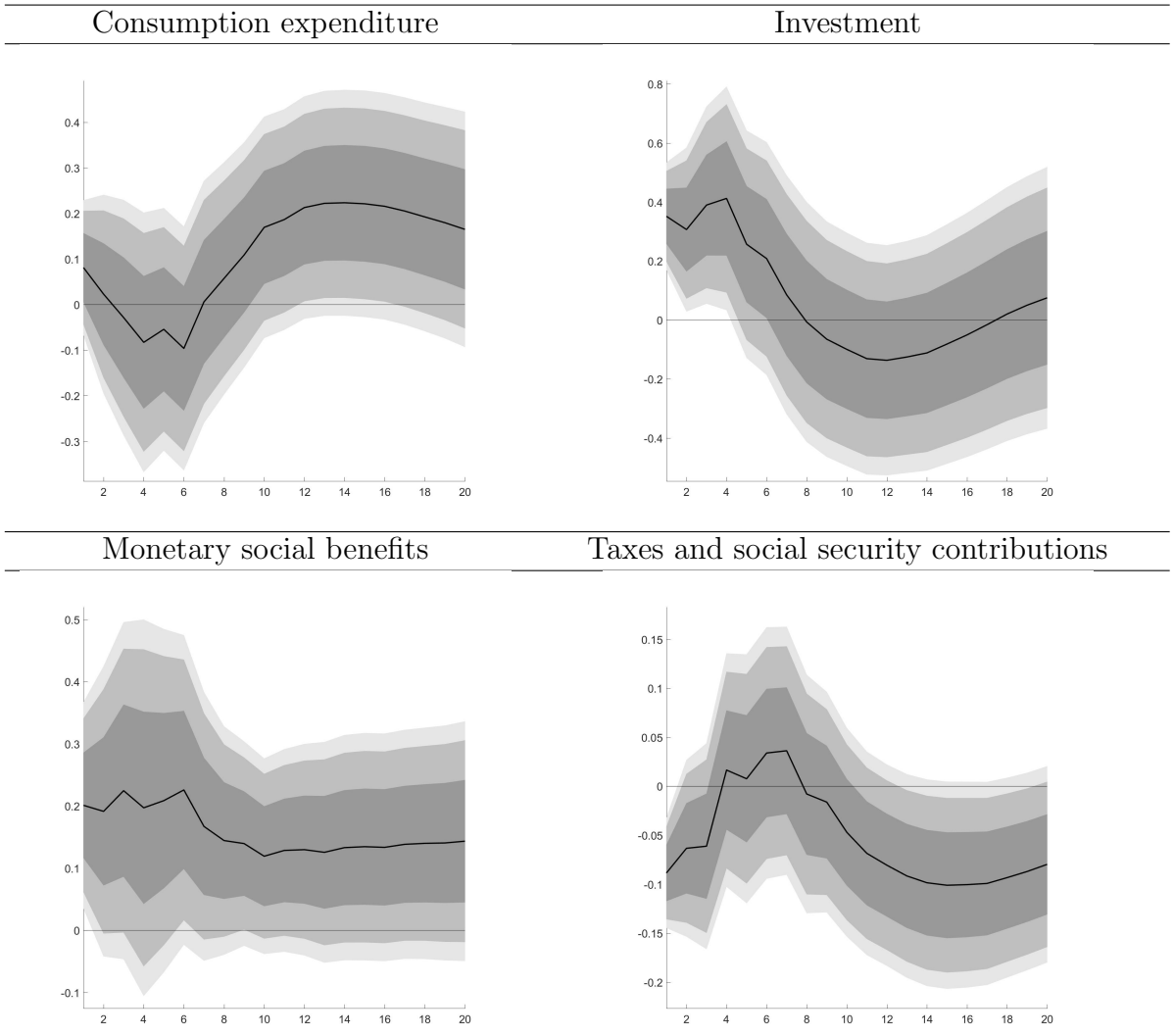
Figure 2 shows the percentage response of GDP to a rise of 0.1% of GDP in the respective general government fiscal variables, with the solid line indicating the mean estimated

[14] To calculate the elasticities for taxes and social security contributions and for monetary social benefits in the sub-sectors T-k, we weight the elasticities of the individual revenue and expenditure categories by the revenue or expenditure share in aggregated taxes and social security contributions or monetary social benefits in the sub-sectors T-k.

[15] Receipts from actual social security contributions are available to the social security funds only and do not affect central, state and local government.

GDP response and the gray-shaded areas showing the 68%, 90% and 95% confidence interval of the point estimator. Overall, for all fiscal shocks, the GDP response is in line with the theory. On the basis of a 5% significance level, an expansion of government investment and monetary social benefits leads to a positive and statistically significant impact on GDP after one quarter, while an increase of taxes and social contributions has a statistically significant negative effect. For government consumption a statistically significant relationship with regard to GDP development could only be detetected at a 32% significance level.

Figure 2: GDP response to a positive general government fiscal shock



Note: The impulse response functions show the percentage change in GDP in response to an increase in the respective revenue and spending categories amounting to 0.1% *of GDP. The gray-shaded areas around the point estimator indicate the* 68%, 90% *and* 95% *confidence intervals.*

The largest GDP effect in quantitative terms in the first period is triggered by government investment with an impact on GDP of around 0.35%, followed by monetary social benefits at around 0.20% and consumption expenditure at around 0.08%. A change in taxes and social security contributions has the lowest GDP impact in comparative terms; an increase amounting to 0.1% of GDP leads to an initial decline in GDP of around

0.09%.[16] In addition to differences in the initial size of the GDP reaction, there are also significant variations in the dynamic response. At its peak, the impact of a rise in investment, with a GDP effect of around 0.41% (period 4), is twice that of an increase in consumption expenditure (0.22% in period 14) or in monetary social benefits (0.23% in period 6). In comparison with the expenditure-side shocks, changes in taxes and social security contributions prove to be the least significant in quantitative terms. At its peak, the GDP effect of a rise in taxes and social security contributions amounting to 0.1% of GDP is a decline of 0.10% (period 15).
Overall, the results of the general government model are qualitatively comparable to those of other studies (see Gechert (2015)), i.e. investment expenditure provides the strongest stimulus for economic activity, while revenue-side shocks tend to trigger smaller GDP responses than expenditure side measures.[17] Looking specifically at Germany, only the study by Tenhofen et al. (2010) disaggregates fiscal measures. The authors conclude that, in particular, spending involving direct government purchases leads to a stronger GDP response than less direct expenditure, such as personnel expenses. Unlike in our study, however, the authors find that investment affects GDP only with a certain time lag. Presumably, this lagged impact is attributable to the use of cash fiscal data, while the national account data used in this study is recorded on an accrual basis.

GDP response to expenditure-side shocks in the government sub-sectors

Next, we analyse the impact of the fiscal measures separately for the individual levels of government (central, state and local government) and for the social security funds. Figure 3 shows that only consumption expenditure at state and local government level leads to positive and statistically significant GDP effects. The positive impact, however, takes effect only with a certain time lag. Quantitatively speaking, this means that an increase in public consumption by 0.1% of GDP at state and local government level yields, at its peak, an increase in GDP of 0.43% (period 11) and 0.50% (period 14), respectively. By contrast, an expansion of investment at all public authorities (central, state and local government) triggers postive and statistically significant output effects only in the short run. The peak impact at 0.70% (period 1) is particularly pronounced at state government level. The initial positive effect, however, decreases over the course of time and even becomes statistically significantly negative. Furthermore, monetary social benefits turn out to be effective only at state government and social security level. The peak GDP effect at 1.15% (period 1) is much higher at state government level than in response to an expansion of monetary social benefits at social security level (peak GDP impact of 0.24%

[16] The initial GDP response to a levy shock depends on the quarterly elasticity assumed in the identification of the shocks. The initial GDP effect is all the larger, the larger is the assumed automatic response of taxes and social security contributions to GDP changes. However, for taxes and social security contributions to trigger a GDP response that is comparable in quantitative terms to that caused by consumption expenditure or monetary social benefits, the assumed quarterly elasticity would need to be more than twice as high, which seems rather implausible in view of the points outlined in section 4.3. The significance of the automatic response of taxes and social security contributions for the results is discussed in detail in section 6.2.

[17] However, it is important to note that in studies with narrative approaches (such as Romer and Romer (2010) or Hayo and Uhl (2014)) the GDP response to a tax shock tends to be larger than in studies which derive shocks via contemporaneous elasticities. Nonetheless, for Germany, Gechert, Paetz, and Villanueva (2017) show that tax shocks trigger only a small GDP response irrespective of the identification strategy.

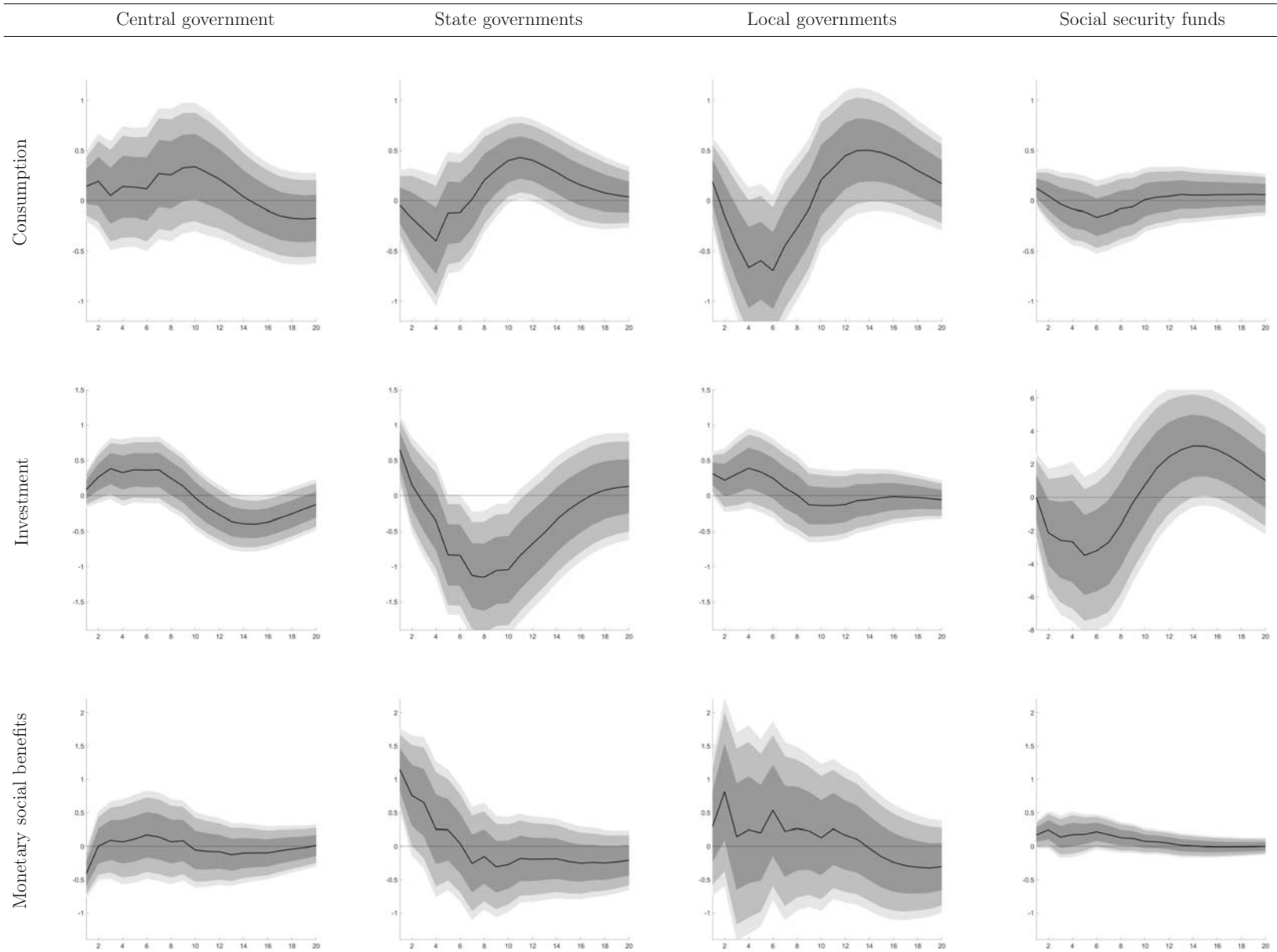
in period 2).

Overall, the results show that the aggregate GDP response to expenditure-side measures in the various government sub-sectors is very heterogeneous. However, it is noticeable that investment expenditure leads to positive GDP reactions primarily in the first few periods, while this effect diminishes over time. Consumption expenditure, however, has an impact on GDP only with a certain time lag. Above all expenditure that comprises a large share of personnel-related outlays are effective. In this vein, especially expenditure of the states (whose consumption and monetary social benefits largely consist of compensation of employees and provisions for civil servants benefits) as well as monetary social benefits of the social security (comprise especially expenditure for pensions) produce positive GDP effects. There are a number of reasons for the heterogeneous effects of the expenditure-side measures by the government sub-sectors. First, the composition of the expenditure categories as well as the government sub-sectors' various areas of activity play a key role. Second, the dynamic progression of the GDP reaction is crcially affected by its interrelationship with other fiscal measures at the same government level as well as by fiscal measures in other government sub-sectors. The data show, for example, an increase in investment at central or state government level to be accompanied by a decrease in monetary social benefits at all government levels over time as well as by a decrease in consumption expenditure at all government levels, which dampens the dynamic GDP effect of the increase in investment at central government level.

GDP reaction to tax and social security contribution shocks in the government sub-sectors

While the central, state and local governments as well as the social security funds are essentially able to determine their expenditure freely and independently, the individual levels of government have limited autonomy in collecting revenue. As a result, the revenues of central, state and local governments largely consist of joint taxes, meaning that an isolated increase in tax receipts at a particular level of government is often accompanied by a change in tax receipts at the other levels. For this reason, an isolated analysis of tax and social security contribution shocks at each individual level of government is not particularly meaningful. Separate analyses of aggregate central, state and local government levies, on the one hand, and social security fund levies, on the other, seem much more appropriate, as these allow a distinction to be made between the GDP effects of increases in taxes and the GDP effects of increases in actual social security contributions. Overall, Figure 4 shows that an increase in social security contributions by 0.1% of GDP (shock to the social security funds) leads to a noticeably, at all significance levels statistically significant, negative GDP effect of up to 0.49% of GDP, whereas an increase in tax receipts (shock to central, state and local governments) causes a considerably smaller GDP reaction of only -0.06% of GDP at most. A number of other studies on Germany (see Tenhofen et al. (2010) as well as Gechert et al. (2017)) also present empirical evidence showing that tax changes affect GDP to no more than a very limited extent. Gechert et al. (2017) also find that changes to social security contributions have a comparatively greater impact on economic activity, although this effect is not as pronounced quantitatively as in our study.

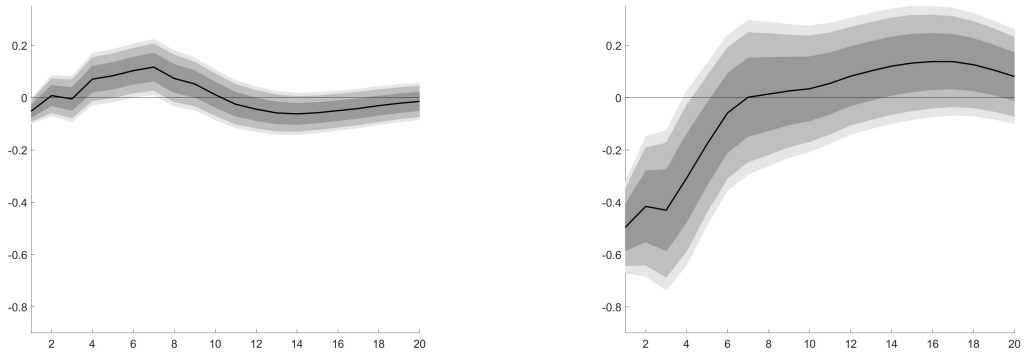
Figure 3: GDP reaction to a positive fiscal shock on the expenditure side (divided by government sub-sector)



Note: The impulse response functions show the percentage GDP response to an increase in the respective spending categories by 0.1% *of GDP. The gray-shaded areas around the point estimator indicate the* 68%, 90% *and* 95% *confidence intervals.*

Figure 4: GDP reaction to a positive tax or social security contribution shock

Taxes	Social security contributions



Note: The impulse response functions show the percentage GDP response to an increase in the respective taxes and social security contributions by 0.1% *of GDP. The gray-shaded areas around the point estimator indicate the* 68%, 90% *and* 95% *confidence intervals.*

5.2 Cumulative fiscal multipliers

One major disadvantage of the impulse response analysis in the previous chapter is that, from the GDP reactions shown, it is not apparent how the initial fiscal shock affects the fiscal variable itself in the subsequent periods (for example, taking into account feedback effects in the case of a tax shock via the automatic stabilisers) or how this reaction, in turn, influences GDP development over the dynamic period. The cumulative multipliers shown in the following section control for this effect, thereby allowing for better comparability of the fiscal measures' effectiveness. However, it should be noted that no other interrelationships between the variables included in the model (such as the discretionary reaction of taxes and social security contributions to an investment shock) are controlled for, and that this can have a decisive impact on the multipliers.[18]
We calculate cumulative multipliers (CMs), where the impulse response function is divided by the autoregressive reaction of the fiscal variable (Δx_t) itself, weighted with the relative percentage of total GDP and cumulated across the periods.[19]

$$CM = \frac{\sum_{t=0}^{T} \Delta y_t}{\sum_{t=0}^{T} \Delta x_t} \tag{17}$$

In order to account for the statistical significance of the GDP reaction as well as the autoregressive reaction of the fiscal variable, only reactions statistically different from zero are included in the calculations. In this regard, we distinguish, as in the impulse response analysis, between the 32%, 10% and 5% significance levels.
Table 2 presents the cumulative multipliers of the various measures on both the revenue

[18] An empirical paper on VAR-based fiscal multipliers which discusses this counterfactual experiment is Kuckuck and Westermann (2014).

[19] Unlike the studies by Ilzetzki et al. (2013) or Mountford and Uhlig (2009), we do not apply a discount factor when calculating the multiplier due to its low quantitative relevance at present.

and the expenditure sides for general government. The results show that an increase in investment by one unit leads on impact to an increase in GDP by 3.5 units. Depending on the significance level the multiplier after five years ranges between 4.5 and 6.4. The impact multiplier of monetary social benefits is at 2.0 and with a dynamic multiplier in a range of 0.3 and 3.8 after five years significant lower. For government consumption a statistically significant GDP effect on impact is detected only at the 32% significance level, denoting an impact multiplier of 0.8. On the revenue side, in particular, changes in social contributions seem to be effective. A reduction by one unit results on impact in a GDP effect of 4.6 units. The effects are considerably lower after a negative tax shock with an impact multiplier of 0.5 and a dynamic multiplier in a range of -0.1 and 0.6 after five years.

Table 2: Cumulative multipliers of general government

	Consumption			Investment			Social benefits		
Significance level	*32%*	*10%*	*5%*	*32%*	*10%*	*5%*	*32%*	*10%*	*5%*
Impact	0.8	-	-	3.5	3.5	3.5	2.0	2.0	2.0
after 1 year	0.3	-	-	7.3	7.3	8.2	3.0	0.7	0.7
after 2 years	0.2	-	-	6.6	5.0	6.4	3.6	1.0	0.5
after 3 years	1.0	0.3	-	5.4	4.5	6.4	3.4	0.9	0.3
after 4 years	1.9	1.4	-	5.3	4.5	6.4	3.5	0.8	0.3
after 5 years	2.3	1.1	-	5.3	4.5	6.4	3.8	0.7	0.3
$\sum_{i=1}^{20} y_i$ (in €bn)	14.0	6.8	-	11.9	9.0	9.0	19.5	3.5	1.2
$\sum_{i=1}^{20} x_i$ (in €bn)	6.0	6.0	5.7	2.2	2.0	1.4	5.1	4.7	4.4

	Taxes			Social Contributions		
Significance level	*32%*	*10%*	*5%*	*32%*	*10%*	*5%*
Impact	0.5	0.5	0.5	4.6	4.6	4.6
after 1 year	0.2	0.2	0.2	10.5	10.0	8.1
after 2 years	-0.4	-0.1	-0.1	6.4	5.3	4.3
after 3 years	-0.3	-0.1	-0.1	3.9	4.6	3.7
after 4 years	0.3	-0.1	-0.1	2.2	4.6	3.7
after 5 years	0.6	-0.2	-0.1	1.2	4.6	3.7
$\sum_{i=1}^{20} y_i$ (in €bn)	0.8	-0.3	-0.3	6.6	10.2	8.3
$\sum_{i=1}^{20} x_i$ (in €bn)	-1.4	-2.0	-2.4	-5.3	-2.2	-2.2

Note: The cumulative multipliers indicate the change in GDP by x units if consumption expenditure, investment, or monetary social benefits are increased by one unit, or if taxes or social security contributions are reduced by one unit. The numbers below the dotted line show the cumulative absolute change in the shocked fiscal variable (x_t) and the cumulative absolute change in GDP (y_t) after five years in euro billions.

Overall, the results largely reflect the findings of the impulse response analysis in the previous chapter. In particular, the multipliers of consumption and taxes are very similar to the findings of other VAR-based studies (see Table 3). The larger dynamic tax multipliers in Mountford and Uhlig (2009) and Hayo and Uhl (2014) are primarily attributable to differences in the identfication strategy. Public investment generally displays larger effects in comparison to the other instruments. VAR-based analyses that study the effects of monetary social benefits and social security contributions and show not only impulse responses but also multipliers along the definition above, do not exist yet, as far as we

know.

Table 3: Overview and comparison with other VAR-based multiplier studies

Author and date	Country (Period)	Impact	Dynamic
Consumption shock			
Giordano et al. (2007)	IT (1982Q1 - 2004Q4)	1.3	2.0 (4 years)
de Castro et al. (2008)	ES (1980Q1 - 2004Q4)	-	-8.7 (5 years)
Auerbach and Gorodnichenko (2012)	US (1947Q1 - 2008Q4)	-	1.2 (5 years)
Hollmayr and Kuckuck (2018)*	DE (1993Q1 - 2017Q3)	0.8	2.3 (5 years)
Investment shock			
de Castro et al. (2008)	ES (1980Q1 - 2004Q4)	-	0.7 (5 years)
Heppke-Falk et al. (2010)	DE (1974Q1 - 2008Q4)	0.1	3.4 (3 years)
Auerbach and Gorodnichenko (2012)	US (1947Q1 - 2008Q4)	-	2.4 (5 years)
Hollmayr and Kuckuck (2018)	DE (1993Q1 - 2017Q3)	3.5	5.3 (5 years)
Tax shock			
Mountford and Uhlig (2009)**	US (1955Q1 - 2000Q4)	0.3	5.3 (3 years)
Heppke-Falk et al. (2010)***	DE (1974Q1 - 2008Q4)	0.8	0.4 (3 years)
Hayo and Uhl (2014)	DE (1974Q1 - 2010Q2)	<0.5	2.4 (3 years)
Hollmayr and Kuckuck (2018)	DE (1993Q1 - 2017Q3)	0.5	0.6 (3 years)

Multiplier at 32% significance level; **Present value multiplier after a debt-financed tax reduction; * Multiplier after a reduction of direct taxes.*

Also, the multipliers on the expenditure side of the various public sectors in Table 4 mirror the results of the impulse response analysis in the last section. Consumption expenditure yields robust statistically significant GDP effects only at state government level, the GDP impact, however, takes effect only with a certain time lag. After five years, the consumption multiplier at state government level ranges between 2.8 and 0.8, depending on the significance level. Furthermore, investment expenditures at all public authorities (central, state and local) trigger positive and statistically significant output effects at least in the short run. The estimated multipliers after one year lie between 6.7 (32% significance level) at central government level and 1.7 (10% and 5% significance level) at local government level.[20] In the longer term, however, the positive GDP effect in response to investment shocks at central and state government level goes into reverse, leading to negative multipliers (which are particularly pronounced for investment at state government level). Further, the multipliers show that monetary social benefits are effective in terms of GDP stimulation particularly at state government level.
Generally, the size of multipliers, especially dynamically, should be interpreted with caution as they are influenced by the interdependencies in the model. If fiscal instruments are disaggregated and potentially also along a further dimension such as the sectors, it seems probable that those multipliers increase. The reason for this phenomenon is that, besides the interdependencies of all variables in the model, the GDP effect of variables with a small GDP weight may be econometrically overestimated. This study uses, in both these dimensions, the most disaggregated available time series for Germany. A further

[20]Due to its low proportion, investment expenditures of social security funds are of limited relevance. They account for only 1.8% of general government investment.

explanation for elevated multipliers could be the neglect of the expectations channel. It appears likely that, in reality, private consumption and private investment are smoothed upon an anticipated shock. In contrast, in a purely backward-looking VAR this anticipation effect is hard to capture and distorts results by putting too much emphasis on the time period when the shock occurs (see Mertens and Ravn (2010)).

Table 4: Cumulative expenditure multipliers of the government sub-sectors

	Central			State			Local			Social security		
Significance level	*32%*	*10%*	*5%*	*32%*	*10%*	*5%*	*32%*	*10%*	*5%*	*32%*	*10%*	*5%*
Consumption												
Impact	-	-	-	-	-	-	-	-	-	1.2	-	-
after 1 year	-	-	-	-1.9	-	-	-3.9	-	-	0.4	-	-
after 2 years	-	-	-	-1.2	-	-	-8.2	-	-	0.3	-	-
after 3 years	-	-	-	2.6	2.8	1.0	-7.2	-	-	0.3	-	-
after 4 years	-	-	-	3.2	2.9	0.8	-2.2	-	-	0.3	-	-
after 5 years	-	-	-	2.8	2.5	0.8	-0.4	-	-	0.3	-	-
$\sum_{i=1}^{20} y_i$ (in €bn)	-	-	-	10.9	9.7	2.6	-1.0	-	-	0.8	-	-
$\sum_{i=1}^{20} x_i$ (in €bn)	1.5	1.1	1.1	3.9	3.9	3.5	2.3	2.1	1.8	2.5	2.4	2.0
Investment												
Impact	-	-	-	6.5	6.5	6.5	3.1	3.1	3.1	-	-	-
after 1 year	6.7	3.0	-	3.3	3.3	3.3	4.9	1.7	1.7	-35.4	-	-
after 2 years	15.9	3.0	-	-15.9	-17.4	-8.4	5.7	1.7	1.7	-67.1	-	-
after 3 years	14.0	3.0	-	-33.4	-33.4	-19.3	5.7	1.7	1.7	-57.3	-	-
after 4 years	3.4	-8.9	-6.2	-35.9	-32.2	-19.3	5.7	1.7	1.7	-9.6	-	-
after 5 years	-2.8	-11.4	-6.2	-35.9	-32.2	-19.3	5.7	1.7	1.7	8.6	-	-
$\sum_{i=1}^{20} y_i$ (in €bn)	-2.5	-9.1	-4.9	-46.0	-38.6	-23.0	8.2	1.9	1.9	13.2	-	-
$\sum_{i=1}^{20} x_i$ (in €bn)	0.9	0.8	0.8	1.3	1.2	1.2	1.4	1.1	1.1	1.5	1.4	1.3
Monetary social benefits												
Impact	-4.1	-4.1	-4.1	11.5	11.5	11.5	-	-	-	1.7	-	-
after 1 year	-1.2	-1.2	-1.2	13.7	10.2	6.1	3.2	-	-	1.4	0.8	-
after 2 years	-1.1	-1.1	-1.1	13.7	10.2	6.1	2.2	-	-	2.0	0.4	-
after 3 years	-1.1	-1.1	-1.1	13.7	10.2	6.1	2.2	-	-	1.5	0.3	-
after 4 years	-1.1	-1.1	-1.1	13.7	10.2	6.1	2.2	-	-	1.1	0.2	-
after 5 years	-1.1	-1.1	-1.1	12.3	10.2	6.1	2.2	-	-	1.0	0.2	-
$\sum_{i=1}^{20} y_i$ (in €bn)	-2.5	-2.5	-2.5	14.2	11.7	7.1	5.0	-	-	7.5	1.5	-
$\sum_{i=1}^{20} x_i$ (in €bn)	2.3	2.3	2.3	1.2	1.2	1.2	2.3	2.1	1.8	7.7	6.9	6.6

Note: The cumulative multipliers indicate the change in GDP by x units if consumption expenditure, investment, or monetary social benefits are increased by one unit. The numbers below the dotted line show the cumulative absolute change in the shocked fiscal variable (x_t) and the cumulative absolute change in GDP (y_t) after five years in euro billion.

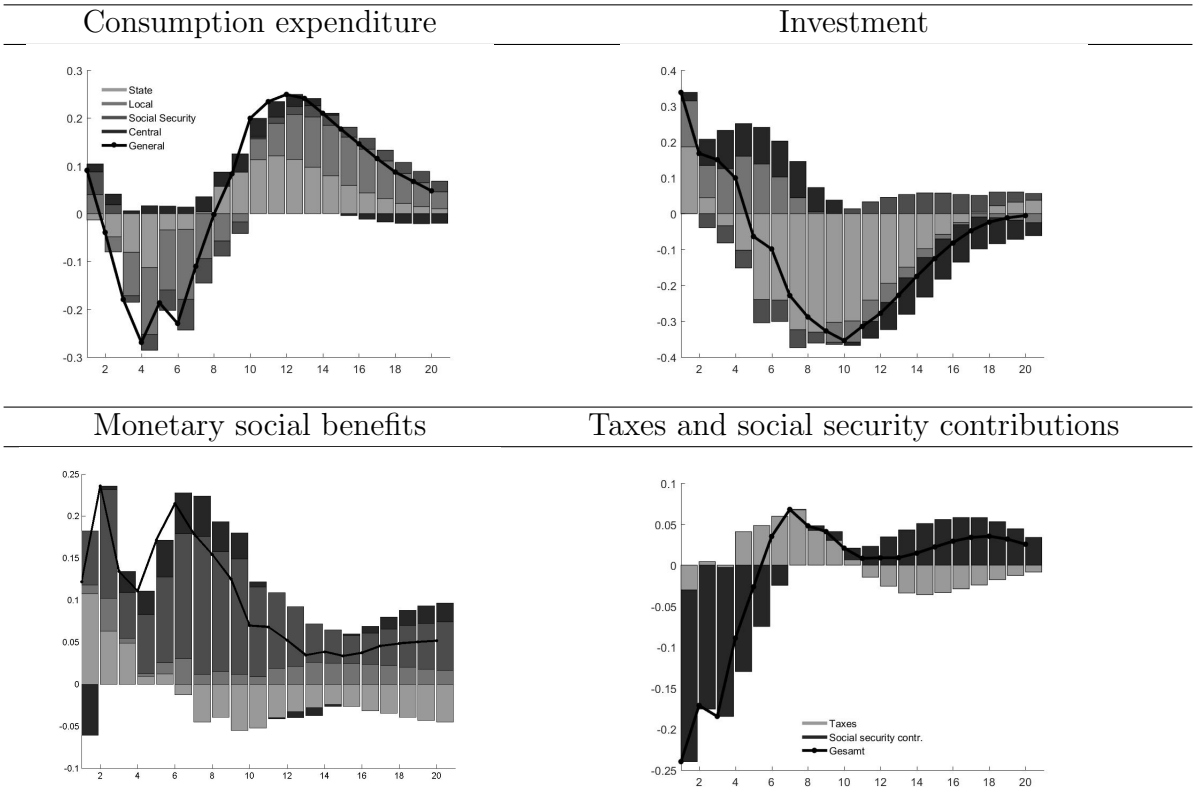
6 Discussion of results

This section serves two purposes. First, we will show which government sector contributes the most to the aggregate effect for each fiscal instrument. Second, the aim is to show that the base results are highly robust. We will therefore alter some model specifications and demonstrate that the most important results can be qualitatively replicated.

6.1 General government estimate: bottom-up vs. aggregate approach

Figure 5 illustrates the influence of the individual levels of government on the weighted average. In this bottom-up approach, the GDP impulse responses following a shock to the various fiscal instruments (see Figure 3) across all levels of government are weighted and totaled with the respective revenue to overall GDP. While the aggregate impulse response is depicted as a black line, the contributions of central, state and local governments are shown as bars in various shades of gray over the impulse response horizon.

Figure 5: Contributions of the government sub-sectors to the GDP effect

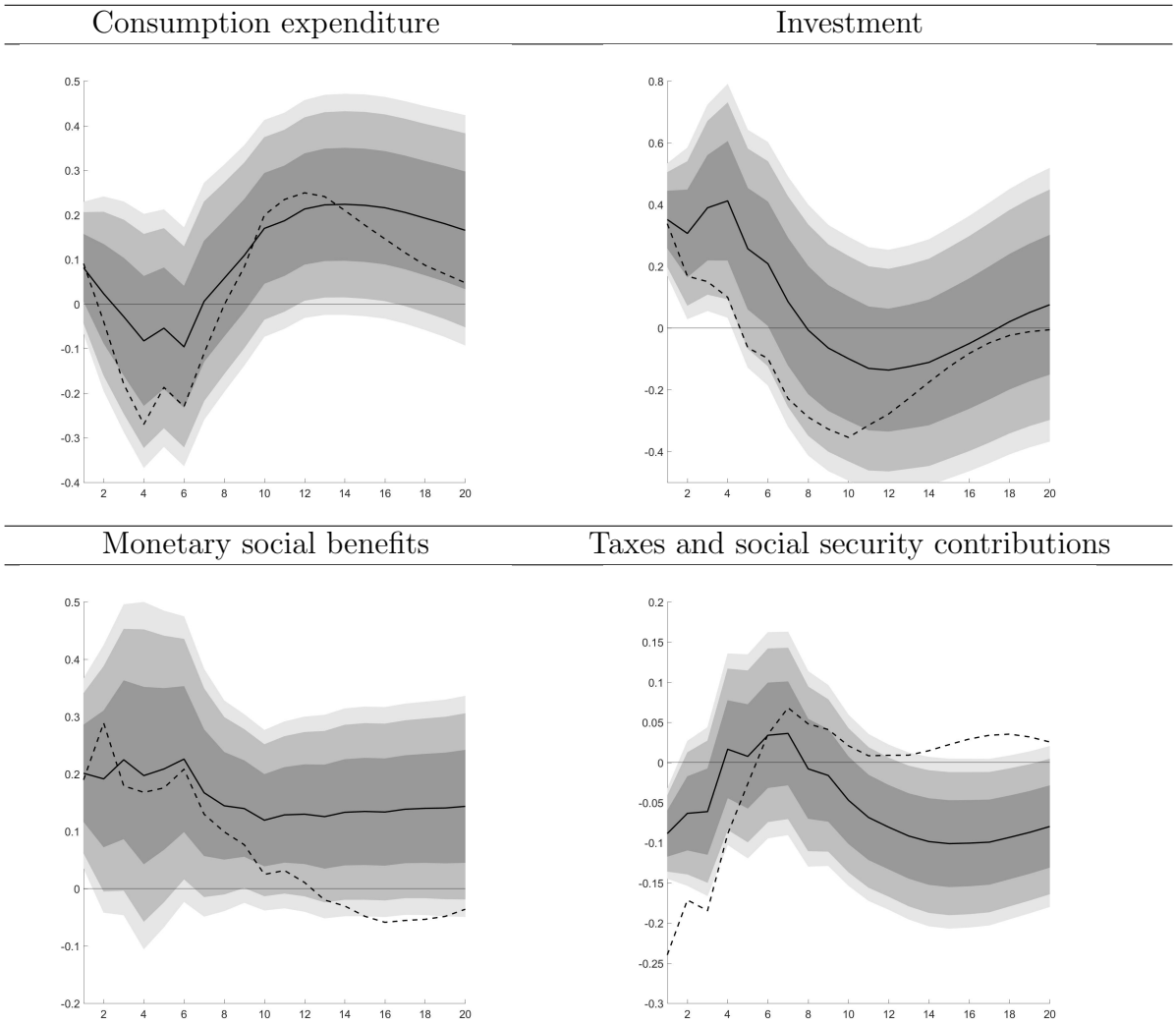


Note: The dashed lines show the weighted average of the impulse responses for the central, state and local governments over the impulse response horizon as a bottom-up impulse response in each case. The bars in each period represent the proportions for each level of government.

Above all, government consumption is driven quantitatively by state and local governments. With respect to investment, the relatively persistent negative response between periods five and 20 is due primarily to the influence of state governments, while local governments make positive contributions throughout. The consistently positive overall GDP response due to monetary social benefits is largely sustained by the social security funds and central government. State governments still make positive contributions in the first few periods but also have a substantial negative effect on the overall development thereafter. Finally, with regard to taxes and social security contributions, it is apparent that social security contributions lead to the highly negative GDP reaction in the first ten periods in particular, while taxes are almost entirely responsible for the negative GDP

response in the second half of the impulse response horizon.

Figure 6: GDP reaction to a positive shock to the general government (bottom-up vs aggregate approach)



Note: Both the dashed and the solid lines represent the percentage GDP reaction to an increase in the respective revenue and expenditure categories by 0.1% *of GDP at all government levels. On the one hand, the impulse response function was derived as a sum of the weighted impulse response functions of the government sub-sectors (dashed line, bottom-up approach) and, on the other hand, estimated directly from the general government data (solid line, aggregate approach). The gray-shaded areas indicate the* 68%, 90% *and* 95% *confidence intervals of the aggregate approach.*

This decomposition leads to two questions. The first is whether the weighted average corresponds to the estimation of the aggregate response and the second is which approach is more suitable for deriving the impact of the general government on GDP. In order to address the first question we contrast the two responses in Figure 6. There, we compare the reactions of the macroeconomy calculated using the bottom-up approach with the aggregate impulse responses that have been estimated based on the general government data (from Figure 2). This GDP response is represented by a dashed line. It is apparent that, for the expenditure side, this weighted average derived from disaggregated data is within the confidence intervals of the aggregated value estimated from aggregated data

for every variable and at all times of the impulse response horizon. This means that, at first glance, it is statistically equivalent. On the revenue side, with regard to taxes and social security contributions, the two approaches differ only for the first few periods .[21] The normative question of which approach gives the more precise analysis or is generally more suitable to derive the 'true' multiplier is more difficult to answer, however. The advantage of the disaggregate estimation is to include more data and have responses on all government levels, which the aggregate estimation simply cannot produce. Measuring whether the weighted average is better able to match the real multiplier than the estimation with data on general government is impossible, as we lack the metric to which we could relate both approaches.

6.2 The importance of identification assumptions

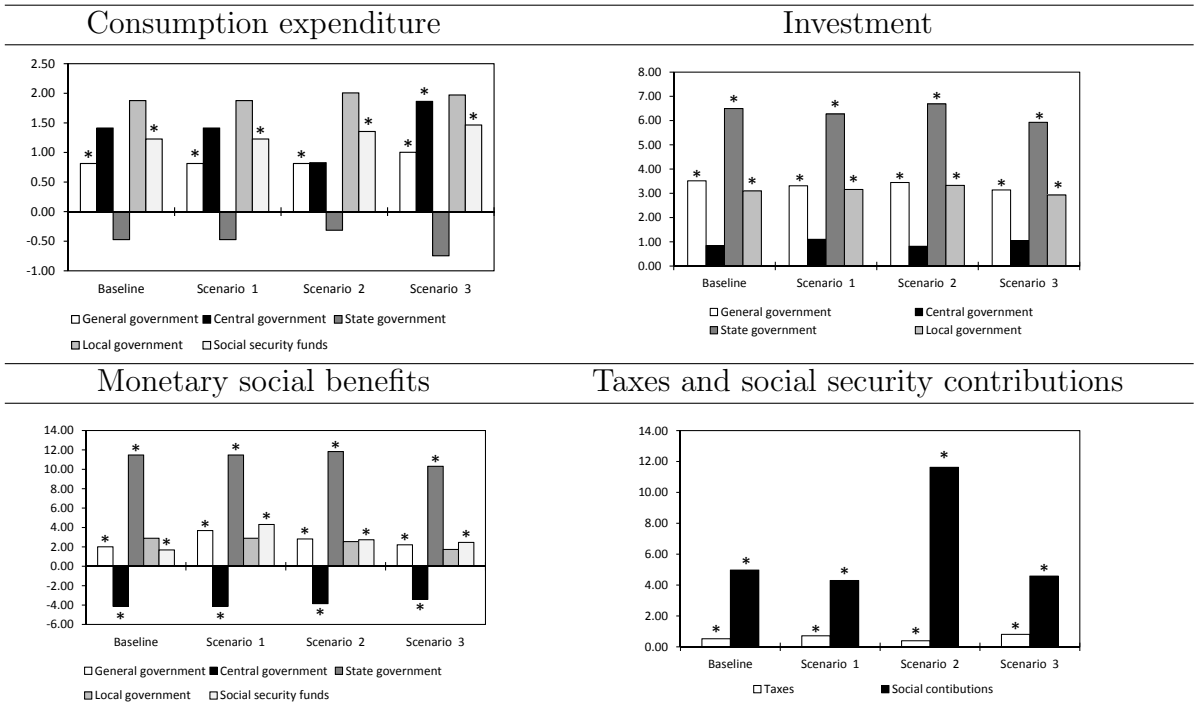
The results of VAR-based studies on the effectiveness of fiscal policy measures are crucially dependent on the identification of discretionary fiscal shocks. In addition to the quarterly elasticities used, the sequence of the structural shocks can also play a decisive role in this context. In the following section the results of the baseline scenario are discussed against the backdrop of alternative identification assumptions and checked for robustness.

Alternative fiscal-to-base elasticities: As explained in section 4.3, the quarterly elasticities assumed in the baseline scenario are based entirely on econometric estimates, the results of which may become distorted as a result of changes in tax legislation in particular. In an alternative scenario, we therefore assume elasticities in which the response of income and expenditure to the respective macroeconomic assessment basis (hereinafter referred to as 'fiscal-to-base elasticity') is derived entirely from institutional information. Thus, for the revenue resulting from value added tax, profit-related taxes and social security contributions, we assume a proportional development in relation to the macro reference variable owing to the levy schedule, whereas for wage tax a fiscal base elasticity of 1.8 is assumed due to its progressiveness and 0.8 for consumption tax (including motor vehicle tax). On the basis of the quarterly cyclicality of profit-dependent taxes that is now assumed, the quarterly elasticity of taxes is markedly higher on the whole (0.86 compared with 0.53 in the baseline scenario). By contrast, the elasticity of the social security contributions decreases slightly (from 0.41 in the baseline scenario to 0.36) as the assumed proportional elasticity with regard to per capita income is slightly lower than the estimated elasticity of 1.17. The response of expenditure on unemployment benefit I to a change in the unemployment figures can likewise be determined on the basis of institutional regulations. Here, we now assume that each unemployed person receives the average level of unemployment benefit I, which, when compared with the empirically determined expenditure base elasticity in the baseline scenario of 1.13, leads to a noticeably higher elasticity of 4.3. As a result, the general government's quarterly elasticity of monetary social benefits

[21] There are two different reasons why disaggregation and aggregation may not always result in exactly the same reaction. First, it is identified in the same way economically at every level, but this does not mathematically represent a linear transformation when aggregating the levels. Thus, the initial value of the impulse response is skewed and the overall impulse response is consequently shifted. This holds especially true for taxes and social security contributions. Second, the reaction also ceases to be linear by the second period of the impulse response at the latest. For a formal analysis of this result and an exemplification for the conditions to be identical between both approaches see also A.2.

rises from -0.06 to -0.21.

Figure 7: Sensitivity of the results towards alternative identification assumptions



*Note: The bars indicate the impact multiplier of each fiscal instrument for the baseline and the alternative identification scenarios: alternative fiscal-to-base-elasticities (scenario 1), alternative base-to-GDP elasticites (scenario 2), alternative sequence of structural shocks (scenario 3)). The symbol * on top of the bar indicates whether the impact multiplier is statistically significant at the* 32% *significance level.*

Alternative base-to-GDP elasticities: Similarly, alternative assumptions can also be made for the response of the macroeconomic assessment basis to fluctuations in GDP (hereinafter referred to as 'base-to-GDP elasticity'). For example, instead of applying econometric regressions, the base GDP elasticities can also be derived using a macroeconomic shock scenario according to Bouthevillain, Cour-Thimann, du Van den Dool, de Cos, Langenus, Mohr, Momigliano, and Tujala (2001). This scenario assumes a proportional shock to domestic income subject to domestic taxes and deductions (gross wages and salaries as well as corporate and property income) and domestic private demand (consumption and investment); the elasticities are then derived almost entirely using simple identity equations from the national accounts.[22] As a result, the base GDP elasticities of the various macroeconomic reference variables rise significantly. The gross wages and salaries per employee now develop almost proportionately to GDP with an elasticity of 0.9, whereas for private consumption and the unemployed a progressive elasticity of 1.1

[22]The shock scenario is based somewhat more formally on five key assumptions: 1-3) the current account balance, write-downs and labour supply are not affected by the shock, 4) operating surpluses grow at the same rate as private wages and 5) private demand grows at the same rate as private consumption. With these assumptions, the elasticities can be very largely derived from the national accounts using simple identity equations (for example, the elasticity of private consumption in relation to GDP is derived from the inverse of private demand in relation to GDP). In contrast to Bouthevillain et al. (2001), we assume that the variables in the government sector can likewise fluctuate in line with economic activity.

and -2.0 respectively is assumed. The quarterly elasticities of taxes, social security contributions and monetary social benefits used to identify the shocks therefore rise significantly compared with the baseline scenario (1.08, 1.15 and -0.13 compared with 0.53, 0.41 and -0.06 in the baseline scenario). Against the backdrop of the development of revenue in Germany, however, it is extremely questionable to what extent a quarterly elasticity of taxes and social security contributions in terms of GDP fluctuations greater than one is a reflection of reality. Rather, the quarterly elasticities derived using the shock scenario are to be interpreted as a kind of upper limit in order to check the sensitivity of the results of the baseline scenario to alternative identification assumptions.

Alternative sequence of structural shocks: In addition to the assumptions regarding the automatic reaction of revenue and expenditure to changes in GDP, the sequence of the structural shocks can also have a decisive impact on the estimated GDP effect of the fiscal measures. While in the baseline scenario we have assumed that measures on the expenditure side react before measures on the revenue side (for further details, see section 4.1), in an alternative scenario we investigate a reverse sequence of the shocks, i.e. with revenue-side measures reacting before expenditure-side measures.

Comparison of results: The impact of the different identification scenarios on the impact multiplier are shown in Figure 7. Overall, it can be seen that, on the expenditure side, consumption and investment multipliers for all government levels and, on the revenue side, the tax multiplier are barely influenced by the different identification assumptions. By contrast, the estimated impact multipliers for monetary social benefits and social security contributions are much more sensitive with regard to the identification strategy. It is above all the alternative assumptions with regard to the quarterly elasticities which lead to different results. Since the estimated impact multipliers increase with the assumed automatic response of the fiscal variable to changes in GDP, it is not surprising that monetary social benefits in the scenario of alternative fiscal-to-base elasticities and social security contributions in the scenario of the alternative base-to-GDP elasticities now have a perceptibly bigger GDP effect when compared with the baseline scenario. It should be noted, however, that the assumed quarterly elasticities have roughly tripled when compared with the baseline scenario, in terms of both the monetary social benefits and the social security contributions. It is questionable, in particular with regard to the social security contributions, to what extent this now very high level of quarterly elasticity is a reflection of reality, as even an elasticity estimated by the OECD based on annual data is only about half as large with a value of 0.6 (see Price, Thai-Thanh, and Guillemette (2014)). Thus, it can be assumed that the calculated GDP response with the alternative base GDP elasticities is significantly overestimated.

6.3 Alternative data and model specifications

In a concluding section, we now have to examine to what extent different data and model specifications influence the results of the baseline scenario. In addition to model estimates based on nominal variables and alternative assumptions relating to the deflators of the individual revenue and expenditure categories, we also examine estimation models with alternative lag lengths and different observation periods. The respective results are shown in Tables 6 to 10 in the Appendix.

The results of all the robustness checks for each fiscal instrument with regard to general government are listed in Table 6. It becomes apparent that the scope of impulse responses is both on impact and dynamically relatively small (for a comparison of the baseline results with the average of all model specifications see the graph in the right-hand column of the table). Only monetary social benefits show bigger deviations in the first periods. The reason for this difference lies in the lower starting values that result from the estimation with a different lag structure and also with different deflators. It is striking that VARs with a lag length of eight display the biggest variation from the baseline results, which is most pronounced in the case of revenue-based shocks.
All robustness checks with respect to expenditure based shocks of fiscal sectors as well as of social security (see Tables 7 to 8) point to the fact that the results of the baseline basically correspond to the average of the different model specifications. Especially the first periods of the impulse response horizon of the baseline and the average of robustness checks are quite similar for the majority of fiscal shocks. Results of single specifications do differ from the baseline, however. In this context, it is striking that similarly to the results for the general government, estimations with alternative lag structure generate, above all, dynamically different impulse responses. A greater lag length generally leads to larger GDP effects in comparison to the results of the baseline. The fewer lags in the estimation, the smoother are the impulse responses. The choice of different deflators and the use of different starting points for the estimation has only limited influence on the results.

7 Conclusion

According to Musgrave (1959), public measures should pursue an efficient use of resources (allocation policy), systematically correct the distribution of income and wealth according to a set of distribution principles (distribution policy), and ensure a stable macroeconomic equilibrium (stabilisation policy). Many studies on fiscal multipliers focus exclusively on the success of the fiscal sector in terms of short-run stabilisation and stimulation. Our study also contributes to this literature and draws on data for Germany. For this purpose, we use a modern time series method and a detailed data set for all government sectors. The well-known caveats are that this methodology does not consider time or state dependence and is only capable of analysing unexpected fiscal policy shocks.
All in all, this paper tends to confirm the results of other studies: fiscal effects are largest (and statistically significant) on impact, with public investment as the instrument that generates the largest effect. Public consumption and monetary social benefits exhibit a weaker influence on GDP. On the government revenue side, fiscal measures generally lead to weaker effects, while taxes increase GDP by less than social security contributions. This study further shows that the GDP effect of fiscal measures is heterogeneous among government sectors. Overall, the disaggregated results suggest that besides investment, particularly expenditure that comprises a large share of personnel-related outlays cause positive effects on aggregate output.

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A Appendix

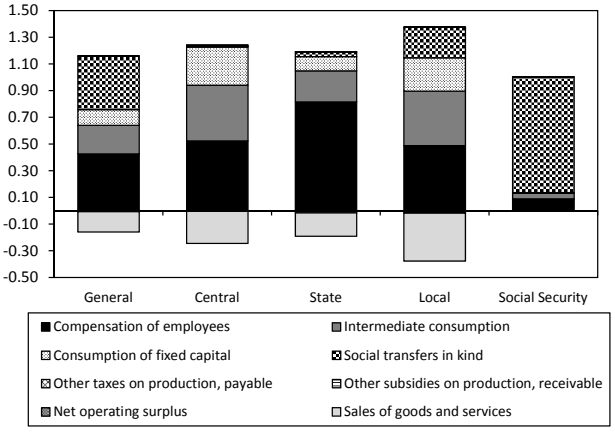
A.1 Data and alternative model specifications

Table 5: Data definition in baseline

Variable		Definition [Price deflator]	SNA code
Government consumption		Government final consumption expenditure [Deflator of government final consumption expenditure]	P. 3
Government investment		Government gross capital formation (incl. economic disappearance of non-produced assets*) [Deflator of government gross capital formation]	P.5 + K.2
Monetary social benefits		Social benefits other than social transfers in kind [GDP deflator]	D.62
Taxes and social security contributions		Current taxes on income, wealth, etc. [GDP deflator]	D.5
	+	Taxes on production and imports [GDP deflator]	D.2
	+	Net social contributions [GDP deflator]	D.61
Other net revenue		Net property income [GDP deflator]	D.4R - D.4U
	+	Other current net transfers [GDP deflator]	D.7R - D.7U
	+	Net capital transfers** [GDP deflator]	D.9R - D.9U
	-	Subsidies [GDP deflator]	D.3
GDP		Gross Domestic Product [GDP deflator]	B1GQ

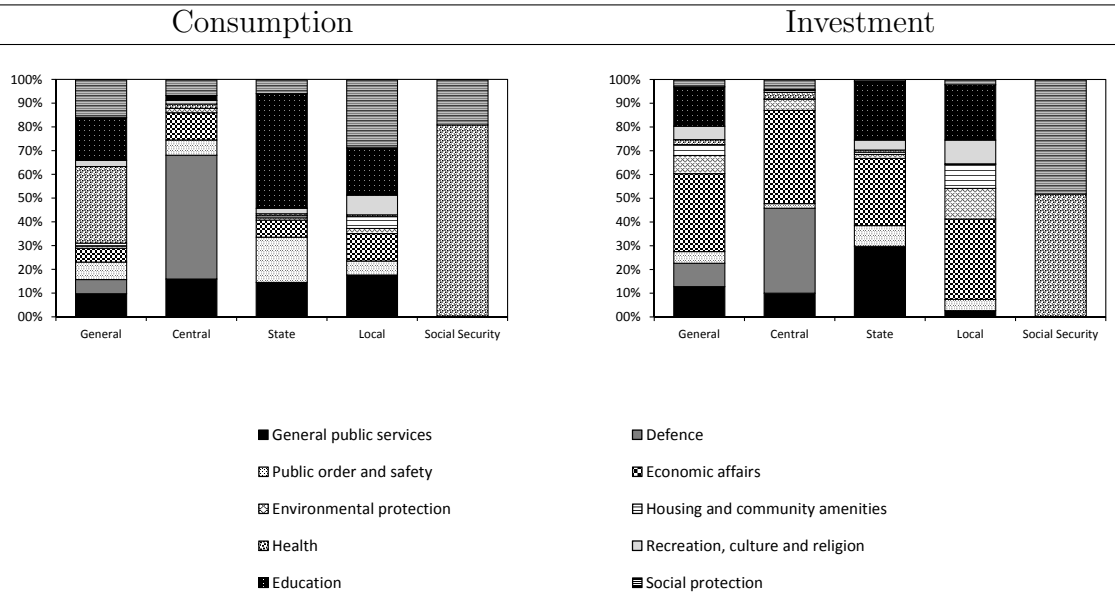
*Data according to the System on National Accounts (SNA). *The economic disappearance of non-produced assets is adjusted by the revenues from the auctioning of mobile phone licenses (€50.8 billion in 2000Q3 and €4.4 billion in 2010Q3 at central government level). ** The capital revenues are adjusted on the revenue side by the transfers of financial assets to the 'Deutsche Kreditbank' (€2.9 bn in 1995Q1 at central government level) and on the expenditure side by the debt assumption by the 'Treuhandanstalt (Trust agency)' as well as the 'Ostdeutsche Wohnungswirtschaft (East German housing industry)' (€107.6 billion in 1995Q1 as well as €14.9 billion in 1995Q3 at central government level) and by financial markets assistance measures (€33.7 billion in 2010Q3 with €32.5 billion at central government and €1.2 billion at state government level).*

Figure 8: Composition of government consumption for all sectors (% of consumption)



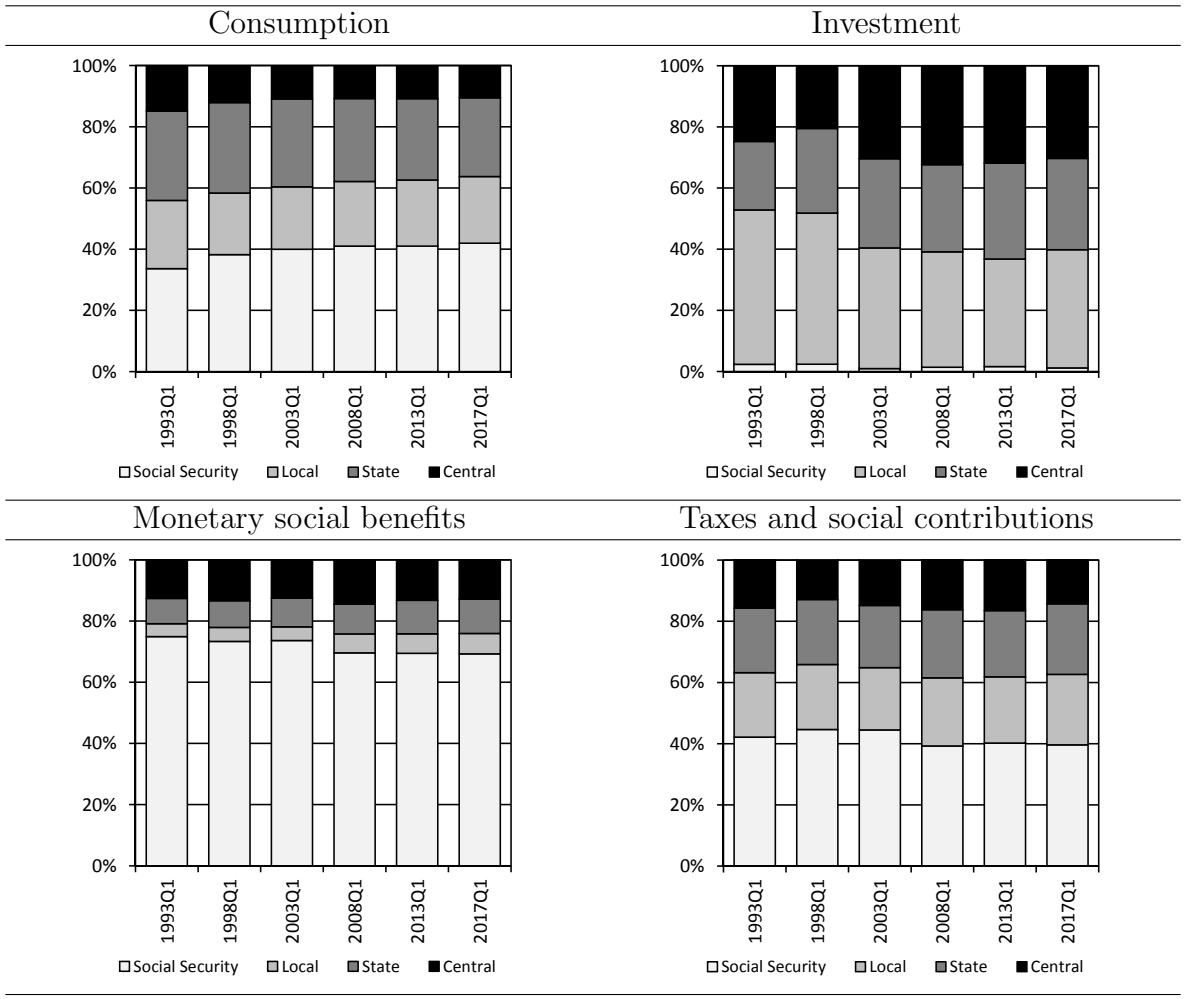
Shares of government consumption of general government and the sectors calculated as the mean over the time horizon 1993 to 2017.

Figure 9: Government consumption and investment for sectors according to their fields of activities (% of consumption/investment)



Shares of field of activities as mean over the time horizon 1993 to 2016. Data taken from the German statistical office (Destatis).

Figure 10: Sub-sectors' share of general government income and expenditure categories



A.2 Analytical explanation of the difference between the bottom-up and the aggregate approach

Let x_t be a vector of N variables which are aggregated. A simple VAR(1) is then given by

$$x_t = \Omega x_{t-1} + u_t$$

Let then the variables in x_t be disaggregated in two parts $x_{1,t}$ and $x_{2,t}$ such that

$$x_t = \omega x_{1,t} + (1-\omega) x_{2,t}$$

The VAR(1) on the disaggregated data looks like:

$$\begin{pmatrix} x_{1,t} \\ x_{2,t} \end{pmatrix} = \begin{pmatrix} \Gamma_1 & 0 \\ 0 & \Gamma_2 \end{pmatrix} \begin{pmatrix} x_{1,t-1} \\ x_{2,t1} \end{pmatrix} + \begin{pmatrix} u_{1,t-1} \\ u_{2,t1} \end{pmatrix}$$

The dynamic responses for the disaggregated VARs are then given by[23]

$$\begin{aligned} x_{1,t|t-1} &= \Gamma_1 x_{1,t-1} \\ x_{2,t|t-1} &= \Gamma_2 x_{2,t-1} \end{aligned}$$

and for the aggregate data where we can make use of the fact that the data can be disaggregated:

$$x_{t|t-1} = \Omega \left(\omega x_{1,t-1} + (1-\omega) x_{2,t-1} \right).$$

It follows that $\Omega\omega = \Gamma_1$ and $\Omega(1-\omega) = \Gamma_2$, or written differently:

$$\Omega = \frac{\Gamma_1}{\omega} = \frac{\Gamma_2}{1-\omega}$$

The coefficients estimated on the aggregated data must correspond to the weighted (by the aggregation weights) coefficients of the disaggregated estimation.

[23] Without loss of generalization the additional aspect of identification is left out of this simple analytical example

A.3 Exemplification of identification in matrix notation

For the purpose of clarification we show the identification strategy in matrix form. First, for general government the identification (and estimation) is carried out for six variables.

$$\underbrace{\begin{bmatrix} 1 & na & na & na & na & na \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ a_{41} & 0 & 0 & 1 & 0 & 0 \\ a_{51} & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}}_{\textbf{A - Contemporaneous effects}} \underbrace{\begin{bmatrix} u_{GDP} \\ u_{Cons.} \\ u_{Inv.} \\ u_{Mon.SocialBen.} \\ u_{Taxes} \\ u_{Other} \end{bmatrix}}_{Reduced \quad shock} = \underbrace{\begin{bmatrix} na & 0 & 0 & 0 & 0 & 0 \\ 0 & na & 0 & 0 & 0 & 0 \\ 0 & na & na & na & 0 & 0 \\ 0 & na & 0 & na & 0 & 0 \\ 0 & na & na & na & na & na \\ 0 & na & na & na & 0 & na \end{bmatrix}}_{\textbf{B - Reaction to structural shocks}} \underbrace{\begin{bmatrix} \epsilon_{GDP} \\ \epsilon_{Cons.} \\ \epsilon_{Inv.} \\ \epsilon_{Mon.SocialBen.} \\ \epsilon_{Taxes} \\ \epsilon_{Other} \end{bmatrix}}_{Struct. \quad shock}$$

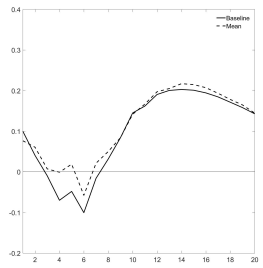
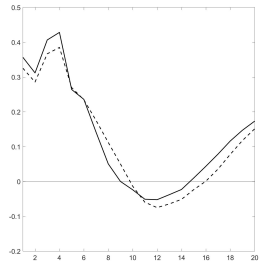
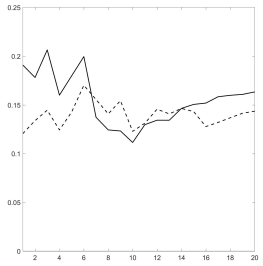
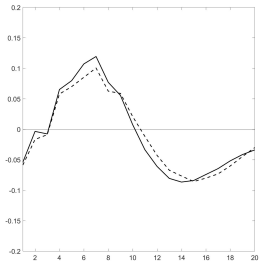
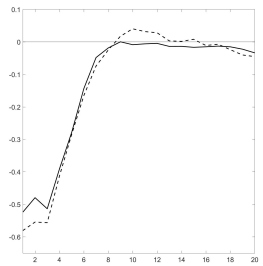
The two elasticities a_{41} and a_{51} are estimated in a different step and imposed as are all zeros and ones in both matrices. The na's are estimated freely.

It is impossible to show the matrix forms for each model that we estimate (where we include different subnational fiscal instruments). For the purpose of illustration the following matrices therefore show the model where state investment is included. The rest of all the different models work in a similar fashion.

$$\underbrace{\begin{bmatrix} 1 & na & na & na & na & na & na \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ a_{41} & 0 & 0 & 1 & 0 & 0 & 0 \\ a_{51} & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ a_{71} & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}}_{\textbf{A - Contemporaneous effects}} \underbrace{\begin{bmatrix} u_{GDP} \\ u_{Cons.} \\ u_{Inv.} \\ u_{Mon.SocialBen.} \\ u_{Taxes} \\ u_{Other} \\ u_{Inv.State} \end{bmatrix}}_{Reduced \quad shock} = \underbrace{\begin{bmatrix} na & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & na & 0 & 0 & 0 & 0 & 0 \\ 0 & na & na & na & 0 & 0 & 0 \\ 0 & na & 0 & na & 0 & 0 & 0 \\ 0 & na & na & na & na & na & na \\ 0 & na & na & na & 0 & na & na \\ 0 & na & na & na & 0 & 0 & na \end{bmatrix}}_{\textbf{B - Reaction to structural shocks}} \underbrace{\begin{bmatrix} \epsilon_{GDP} \\ \epsilon_{Cons.} \\ \epsilon_{Inv.} \\ \epsilon_{Mon.SocialBen.} \\ \epsilon_{Taxes} \\ \epsilon_{Other} \\ \epsilon_{Inv.State} \end{bmatrix}}_{Struct. \quad shock}$$

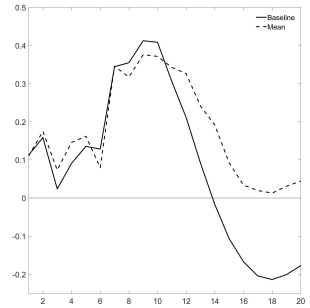
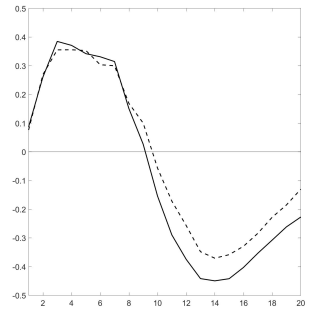
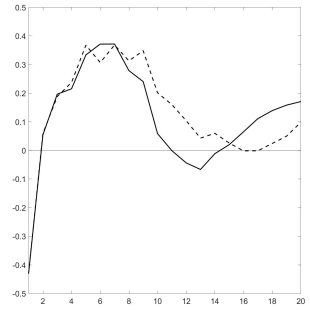
In this case the elasticity a_{71} is set to zero (this holds for consumption and investment at all subnational levels), whereas it is calculated for monetary social benefits as shown in section 4.3. The ordering in the B-matrix is also different according to the fiscal instrument under consideration

Table 6: GDP reaction to a fiscal shock of general government

	Q1	Q2	Q3	Q4	Q6	Q8	Q12	Q20	Comparison baseline and mean
GDP reaction to a positive consumption shock									
Baseline	0.08*	0.02	-0.03	-0.08	-0.10	0.06	0.21**	0.17*	
Deflators:									
GDP deflator	0.10*	0.15*	0.08	0.20*	0.17*	0.22**	0.26***	0.32***	
Various deflators[1)]	0.10*	0.02	-0.05	-0.10*	-0.15*	-0.01	0.18*	0.14*	
Nominal values	0.10*	0.14*	0.08	0.19*	0.13*	0.19**	0.26***	0.23*	
Lag length:									
p=2	0.10*	0.08	0.06	0.10	0.15*	0.19*	0.24***	0.27***	
p=6	0.03	0.04	-0.01	-0.06	-0.21*	-0.06	0.17*	0.08	
p=8	-0.05	-0.03	-0.09	-0.18*	-0.34***	-0.18	0.07	-0.07	
Sample periods:									
1991Q1-2017Q3	0.08*	0.01	-0.04	-0.09	-0.09	0.07	0.23**	0.16*	
1995Q1-2017Q3	0.09*	0.03	-0.02	-0.08	-0.10	0.05	0.20*	0.13	
Mean	**0.08**	**0.06**	**0.01**	**0.00**	**-0.06**	**0.05**	**0.20**	**0.15**	
GDP reaction to a positive investment shock									
Baseline	0.35***	0.31***	0.39***	0.41***	0.21***	-0.01	-0.14	0.08	
Deflators:									
GDP deflator	0.35***	0.32***	0.37***	0.38***	0.18	-0.03	-0.18	0.06	
Various deflators[1)]	0.37***	0.33***	0.41***	0.44***	0.21*	-0.01	-0.14	0.08	
Nominal values	0.28***	0.23**	0.22*	0.23*	0.11	-0.01	-0.04	0.12	
Lag length:									
p=2	0.33***	0.24**	0.27**	0.27*	0.22*	0.17	0.16	0.20	
p=6	0.32***	0.29***	0.37***	0.41***	0.18	0.07	-0.23*	0.11	
p=8	0.24***	0.27**	0.27*	0.30*	0.26*	0.35*	-0.44**	-0.08	
Sample periods:									
1991Q1-2017Q3	0.30***	0.25**	0.36***	0.32***	0.17	-0.01	-0.12	0.05	
1995Q1-2017Q3	0.36***	0.32***	0.42***	0.48***	0.26***	0.07	-0.05	0.21	
Mean	**0.32**	**0.28**	**0.34**	**0.36**	**0.20**	**0.07**	**-0.13**	**0.09**	
GDP reaction to a positive monetary benefits shock									
Baseline	0.20***	0.19*	0.23*	0.20*	0.23**	0.14*	0.13*	0.14*	
Deflators:									
GDP deflator	0.15**	0.14*	0.15*	0.12	0.26***	0.19**	0.14*	0.14*	
Various deflators[1)]	0.04	-0.00	0.03	0.09	0.19*	0.19**	0.14**	0.07	
Nominal values	0.11*	0.14*	0.16*	0.13	0.20**	0.16**	0.19***	0.18**	
Lag length:									
p=2	0.07*	-0.00	0.05	0.08	0.13*	0.14*	0.14*	0.11	
p=6	0.09*	0.25**	0.24*	0.22*	0.22*	0.23*	0.18*	0.13*	
p=8	0.12*	0.21*	0.18*	0.14	0.13	0.14	0.17	0.14	
Sample Periods:									
1991Q1-2017Q3	0.19***	0.17*	0.20*	0.20*	0.26***	0.18**	0.13*	0.12*	
1995Q1-2017Q3	0.22***	0.20*	0.23*	0.18*	0.19*	0.11*	0.13*	0.20*	
Mean	**0.13**	**0.14**	**0.16**	**0.15**	**0.20**	**0.16**	**0.15**	**0.14**	
GDP reaction to a positive tax shock									
Baseline	-0.05*	0.01	-0.01	0.07*	0.10*	0.07*	-0.04*	-0.01	
Deflators:									
GDP deflator	-0.06*	0.00	-0.01	0.06*	0.09*	0.09*	-0.03	-0.02	
Various deflators[1)]	-0.04*	0.02	0.01	0.08*	0.11*	0.08*	-0.03	-0.03	
Nominal values	-0.06*	-0.01	-0.03	0.04	0.07*	0.06	-0.03	0.01	
Lag length:									
p=2	-0.03*	0.06*	0.07*	0.08*	0.06*	0.04	0.01	0.01	
p=6	-0.08*	-0.03	0.00	0.08*	0.08*	0.10*	-0.04	-0.02	
p=8	-0.11*	-0.11*	-0.05	0.04	0.05	0.00	-0.06	-0.02	
Sample periods:									
1991Q1-2017Q3	-0.05*	0.02	0.02	0.09*	0.10*	0.06*	-0.04	-0.01	
1995Q1-2017Q3	-0.07*	0.00	-0.01	0.08*	0.12*	0.08*	-0.06*	-0.04	
Mean	**-0.06**	**-0.00**	**-0.00**	**0.07**	**0.09**	**0.06**	**-0.04**	**-0.02**	
GDP reaction to a positive social security contr. shock									
Baseline	-0.50***	-0.42***	-0.43***	-0.31**	-0.06	0.01	0.08	0.08	
Deflators:									
GDP deflator	-0.60***	-0.57***	-0.58***	-0.45***	-0.03	0.10	0.14*	0.08	
Various deflators[1)]	-0.47***	-0.44***	-0.44***	-0.28**	-0.06	0.06	0.13*	0.10*	
Nominal values	-0.63***	-0.58***	-0.54***	-0.39***	-0.05	0.06	0.07	-0.01	
Lag length:									
p=2	-0.28***	-0.18*	-0.13*	-0.02	0.08	0.09*	0.07*	0.05*	
p=6	-0.65***	-0.61***	-0.59***	-0.43***	-0.11	0.04	0.13	0.14	
p=8	-0.80***	-0.54***	-0.47**	-0.29*	0.00	0.13	-0.01	0.13	
Sample periods:									
1991Q1-2017Q3	-0.49***	-0.44***	-0.44***	-0.25*	-0.05	-0.00	0.10	0.05	
1995Q1-2017Q3	-0.72***	-0.59***	-0.56***	-0.43**	-0.07	0.06	0.14	0.04	
Mean	**-0.57**	**-0.49**	**-0.46**	**-0.31**	**-0.04**	**0.06**	**0.10**	**0.07**	

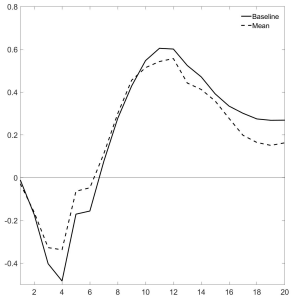
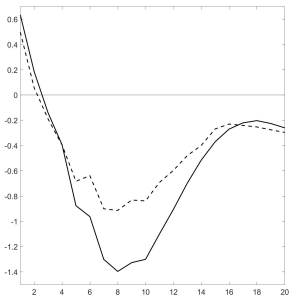
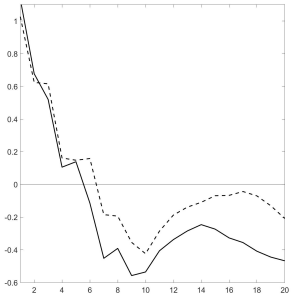
The table shows the percentage change in GDP in response to an increase in the respective revenue and spending categories amounting to 0.1% of GDP. The symbols ∗, ∗∗ , and ∗∗∗ indicate significance at the 32%, 10%, and 5% level respectively. 1) Government consumption is adjusted using the deflator for government consumption, public investment with the deflator for public investment, monetary benefits as well as social contributions with the deflator of private consumption and all other variables with the GDP deflator.

Table 7: GDP reaction to a fiscal shock of central government

	Q1	Q2	Q3	Q4	Q6	Q8	Q12	Q20	Comparison baseline with mean
GDP reaction to a positive consumption shock									
Baseline	0.14	0.19	0.05	0.14	0.12	0.26	0.21	-0.17	
Deflators:									
GDP deflator	0.12	0.28*	0.17	0.32	0.21	0.23	0.04	-0.05	
Various deflators[1)]	0.05	-0.01	-0.17	-0.13	-0.13	0.18	0.47*	0.02	
Nominal values	0.11	0.28*	0.14	0.25	0.30	0.33*	0.18	0.05	
Lag length:									
p=2	0.06	0.09	0.02	0.04	0.11	0.15	0.14	0.08	
p=6	0.24*	0.45**	0.22	0.40*	-0.03	0.32	0.26	0.01	
p=8	0.39***	0.62***	0.43*	0.56*	-0.05	0.24	0.32	0.25	
Sample periods:									
1991Q1-2017Q3	0.16	0.14	0.08	0.12	0.15	0.26	0.24	-0.18	
1995Q1-2017Q3	0.14	0.18	0.01	0.07	-0.01	0.12	0.30	-0.09	
Mean	**0.16**	**0.25**	**0.11**	**0.20**	**0.07**	**0.23**	**0.24**	**-0.01**	
GDP reaction to a positive investment shock									
Baseline	0.08	0.26*	0.38**	0.33*	0.36*	0.24*	-0.27*	-0.13	
Deflators:									
GDP deflator	0.10	0.27*	0.34*	0.29*	0.34*	0.20	-0.22*	-0.11	
Various deflators[1)]	0.07	0.25*	0.38**	0.34*	0.41**	0.25*	-0.26*	-0.14	
Nominal values	0.04	0.17	0.14	0.05	0.07	0.07	-0.16	-0.07	
Lag length:									
p=2	0.04	0.16	0.24*	0.30*	0.24*	0.11	-0.03	-0.04	
p=6	0.02	0.29*	0.40**	0.38*	0.30*	0.29*	-0.22	-0.19	
p=8	-0.05	0.29*	0.30*	0.40*	0.40*	0.47*	-0.32	-0.30	
Sample periods:									
1991Q1-2017Q3	0.13	0.24*	0.41**	0.31*	0.35*	0.16	-0.22*	-0.10	
1995Q1-2017Q3	0.10	0.29*	0.37*	0.28*	0.19	0.02	-0.35*	-0.02	
Mean	**0.06**	**0.25**	**0.33**	**0.30**	**0.30**	**0.20**	**-0.23**	**-0.12**	
GDP reaction to a positive monetary benefits shock									
Baseline	-0.41***	0.00	0.09	0.06	0.17	0.07	-0.08	0.01	
Deflators:									
GDP deflator	-0.40***	-0.03	-0.03	0.13	0.10	0.07	0.17	-0.03	
Various deflators[1)]	-0.52***	-0.15	-0.11	-0.06	0.15	0.21	0.16	-0.04	
Nominal values	-0.30*	0.13	0.26	0.17	0.32*	0.17	0.09	0.07	
Lag length:									
p=2	-0.30**	-0.10	-0.02	0.12	0.17	0.13	0.05	0.04	
p=6	-0.57***	-0.19	0.03	0.04	-0.20	0.00	0.13	-0.07	
p=8	-0.52***	0.19	0.22	0.17	-0.36	-0.34	-0.23	0.01	
Sample periods:									
1991Q1-2017Q3	-0.37***	-0.04	0.07	-0.01	0.08	0.00	0.02	-0.01	
1995Q1-2017Q3	-0.33**	0.15	0.26	0.29	0.40*	0.33*	-0.04	-0.25*	
Mean	**-0.41**	**-0.01**	**0.09**	**0.07**	**0.09**	**0.07**	**0.03**	**-0.03**	

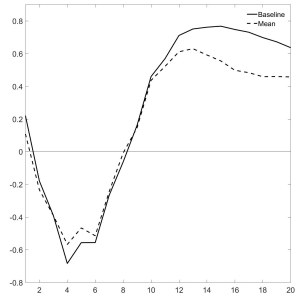
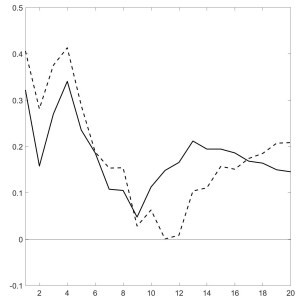
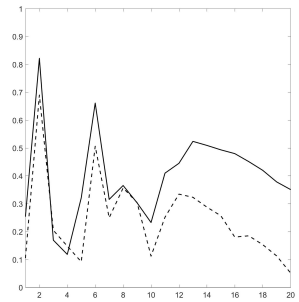
The table shows the percentage change in GDP in response to an increase in the respective revenue and spending categories amounting to 0.1% of GDP. The symbols ∗, ∗∗ , and ∗ ∗ ∗ indicate significance at the 32%, 10%, and 5% level respectively. 1) Government consumption is adjusted using the deflator for government consumption, public investment with the deflator for public investment, monetary benefits as well as social contributions with the deflator of private consumption and all other variables with the GDP deflator.

Table 8: GDP reaction to a fiscal shock of state government

	Q1	Q2	Q3	Q4	Q6	Q8	Q12	Q20	Comparison baseline with mean
GDP reaction to a positive consumption shock									
Baseline	-0.05	-0.17	-0.29	-0.40*	-0.12	0.20	0.40**	0.04	
Deflators:									
GDP deflator	-0.15	-0.10	-0.13	-0.07	0.22	0.34*	0.28*	0.04	
Various deflators[1)]	-0.01	-0.10	-0.26	-0.35*	-0.18	0.07	0.23*	0.09	
Nominal values	-0.01	-0.09	-0.07	-0.01	0.27	0.48**	0.44***	0.14	
Lag length:									
p=2	-0.01	-0.10	-0.07	0.06	0.16	0.19*	0.15*	0.10	
p=6	-0.16	-0.27	-0.30	-0.36	-0.03	0.18	0.71***	-0.13	
p=8	-0.01	-0.39*	-0.40	-0.65*	-0.33	0.05	0.39	-0.25	
Sample periods:									
1991Q1-2017Q3	-0.10	-0.16	-0.30*	-0.26	-0.07	0.26*	0.24*	0.05	
1995Q1-2017Q3	-0.01	-0.14	-0.22	-0.33	0.02	0.41*	0.47**	-0.05	
Mean	**-0.06**	**-0.17**	**-0.22**	**-0.26**	**-0.01**	**0.24**	**0.37**	**0.00**	
GDP reaction to a positive investment shock									
Baseline	0.65***	0.16	-0.12	-0.36	-0.84**	-1.15***	-0.68*	0.13	
Deflators:									
GDP deflator	0.61***	0.09	-0.17	-0.38	-0.83**	-1.02***	-0.62*	0.03	
Various deflators[1)]	0.67***	0.26	0.03	-0.17	-0.64*	-0.98***	-0.60*	-0.16	
Nominal values	0.61***	0.04	-0.31	-0.52*	-0.92***	-1.03***	-0.42	0.01	
Lag length:									
p=2	0.55***	0.07	-0.31	-0.37	-0.42*	-0.35*	-0.24*	-0.12	
p=6	0.01***	0.12*	0.08*	0.04**	0.02	0.05*	0.06	0.02	
p=8	0.16	-0.72**	-0.39	-0.53*	0.46	0.20	0.20	-0.83*	
Sample periods:									
1991Q1-2017Q3	0.64***	0.16	-0.14	-0.37	-0.71*	-0.92***	-0.41*	0.16	
1995Q1-2017Q3	0.80***	0.22	-0.05	-0.43	-0.96***	-1.33***	-0.80*	0.20	
Mean	**0.52**	**0.04**	**-0.15**	**-0.34**	**-0.54**	**-0.73**	**-0.39**	**-0.06**	
GDP reaction to a positive monetary benefits shock									
Baseline	1.15***	0.76**	0.65*	0.25	0.04	-0.16	-0.20	-0.21	
Deflators:									
GDP-deflator	0.71***	0.43	0.33	0.09	0.25	0.08	-0.20	-0.20*	
Various deflators[1)]	0.78***	0.40	0.43	0.29	0.28	0.17	-0.12	-0.20	
Nominal values	0.70***	0.43*	0.35	-0.06	-0.24	-0.40	-0.26	-0.26*	
Lag length:									
p=2	0.62***	0.16	-0.09	-0.13	-0.13	-0.12	-0.14	-0.14	
p=6	1.10***	0.95**	1.26***	0.53	0.82*	-0.02	-0.17	-0.20	
p=8	1.41***	0.90***	1.33***	0.26	0.69*	-0.05	0.04	-0.06	
Sample periods:									
1991Q1-2017Q3	1.17***	0.74**	0.75*	0.27	0.03	-0.08	-0.01	-0.14	
1995Q1-2017Q3	1.22***	0.78*	0.63*	0.03	-0.34	-0.56*	-0.26	0.07	
Mean	**1.00**	**0.62**	**0.63**	**0.17**	**0.16**	**-0.13**	**-0.15**	**-0.15**	

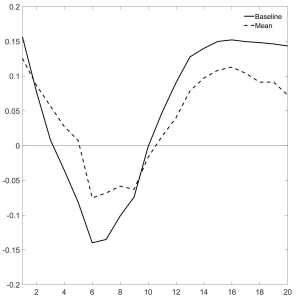
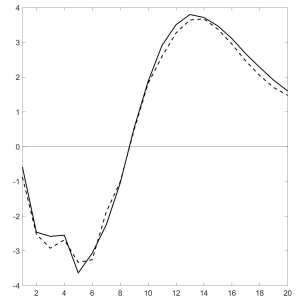
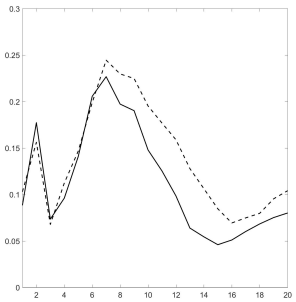
The table shows the percentage change in GDP in response to an increase in the respective revenue and spending categories amounting to 0.1% of GDP. The symbols ∗, ∗∗ , and ∗ ∗ ∗ indicate significance at the 32%, 10%, and 5% level respectively. 1) Government consumption is adjusted using the deflator for government consumption, public investment with the deflator for public investment, monetary benefits as well as social contributions with the deflator of private consumption and all other variables with the GDP deflator.

Table 9: GDP reaction to a fiscal shock of local government

	Q1	Q2	Q3	Q4	Q6	Q8	Q12	Q20	Comparison baseline and mean
GDP reaction to a positive consumption shock									
Baseline	0.19*	-0.15	-0.43	-0.67	-0.70**	-0.27	0.45	0.17	
Deflators:									
GDP deflator	0.24*	0.07	-0.14	-0.31	-0.40	-0.18	0.23	0.15	
Various deflators[1)]	0.25*	-0.22	-0.57	-0.82***	-0.98***	-0.44	0.51	0.28	
Nominal values	0.40**	0.26	0.12	0.01	-0.02	0.24	0.48***	0.30	
Lag length:									
p=2	0.17	-0.15	-0.23	-0.32	-0.29	-0.16	0.03	0.11	
p=6	-0.17	-0.48	-0.75**	-0.78**	-0.83**	-0.14	0.44	0.08	
p=8	-0.47***	-0.61	-0.93***	-0.95**	-0.86*	-0.13*	0.77	0.05	
Sample periods:									
1991Q1-2017Q3	0.05*	-0.19	-0.39	-0.50	-0.55**	-0.16	0.33	0.11	
1995Q1-2017Q3	0.29*	-0.06	-0.26	-0.52	-0.59	-0.04	0.56	-0.03	
Mean	**0.10**	**-0.17**	**-0.40**	**-0.54**	**-0.58**	**-0.14**	**0.42**	**0.14**	
GDP reaction to a positive investment shock									
Baseline	0.31***	0.22*	0.30*	0.39*	0.25*	0.01	-0.13*	-0.06	
Deflators:									
GDP deflator	0.39***	0.34	0.42*	0.43*	0.29*	-0.04	-0.29*	-0.06	
Various deflators[1)]	0.34***	0.27*	0.37*	0.42*	0.17*	-0.04	-0.07*	0.04	
Nominal values	0.33***	0.30	0.44	0.44	0.32	-0.01	-0.24*	0.12	
Lag length:									
p=2	0.41***	0.35	0.46**	0.40*	0.20	0.03	-0.04	0.00	
p=6	0.56***	0.48*	0.50*	0.59**	0.17*	0.15	-0.32*	0.12	
p=8	0.53***	0.58**	0.33	0.33	-0.04*	0.38	-0.85***	0.06	
Sample periods:									
1991Q1-2017Q3	0.36***	0.34	0.44*	0.48*	0.21*	-0.04	-0.23	-0.01	
1995Q1-2017Q3	0.29**	0.22*	0.32*	0.37	0.27	-0.01	-0.38*	0.08	
Mean	**0.39**	**0.34**	**0.40**	**0.43**	**0.20**	**0.05**	**-0.28**	**0.03**	
GDP reaction to a positive monetary benefits shock									
Baseline	0.29*	0.81*	0.14	0.24	0.53*	0.26*	0.16	-0.31	
Deflators:									
GDP deflator	-0.09*	0.26*	-0.37	-0.15*	0.38*	0.35	0.31	-0.51	
Various deflators[1)]	-0.20	0.14	-0.57	-0.24	0.39*	0.52*	0.57*	-0.23	
Nominal values	-0.11*	0.16*	-0.17*	-0.12*	0.36*	0.30	0.60	0.07	
Lag length:									
p=2	0.17	0.43	0.07	0.20	0.29	0.38	0.34	0.12	
p=6	0.45*	1.16*	0.91	0.70	0.91	0.19*	-0.14*	-0.25	
p=8	0.20*	1.55*	1.02	0.86	-0.13	-0.29	-0.03	-0.14	
Sample periods:									
1991Q1-2017Q3	0.12*	0.58*	-0.12*	0.08*	0.00*	-0.12	0.14	-0.19	
1995Q1-2017Q3	0.30*	0.92*	0.18	0.17*	0.26*	0.09*	0.32	-0.43	
Mean	**0.13**	**0.67**	**0.12**	**0.19**	**0.33**	**0.19**	**0.25**	**-0.21**	

The table shows the percentage change in GDP in response to an increase in the respective revenue and spending categories amounting to 0.1% of GDP. The symbols ∗, ∗∗ , and ∗ ∗ ∗ indicate significance at the 32%, 10%, and 5% level respectively. 1) Government consumption is adjusted using the deflator for government consumption, public investment with the deflator for public investment, monetary benefits as well as social contributions with the deflator of private consumption and all other variables with the GDP deflator.

Table 10: GDP reaction to a fiscal shock of social security funds

	Q1	Q2	Q3	Q4	Q6	Q8	Q12	Q20	Comparison baseline with mean
GDP reaction to a positive consumption shock									
Baseline	0.12*	0.05	-0.04	-0.09	-0.17	-0.08	0.04	0.06	
Deflators:									
GDP deflator	0.13*	0.10	0.03	0.03	-0.02	0.02	0.05	-0.01	
Various deflators[1)]	0.12*	0.03	-0.03	-0.07	-0.11	-0.07	-0.09	0.04	
Nominal values	0.13*	0.13	0.16	0.15	-0.02	-0.05	0.05	0.05	
Lag length:									
p=2	0.08	0.02	-0.07	-0.05	-0.06	-0.05	-0.01	0.02	
p=6	0.07	0.04	-0.01	-0.05	-0.27*	-0.16	0.12	-0.08	
p=8	0.02	-0.08	-0.10	-0.22*	-0.38*	-0.26*	0.03	-0.14	
Sample periods:									
1991Q1-2017Q3	0.09*	0.04	0.01	-0.10	-0.15	-0.05	0.03	0.03	
1995Q1-2017Q3	0.13*	0.11	0.05	0.05	0.03	0.01	-0.10	0.05	
Mean	**0.10**	**0.05**	**0.00**	**-0.04**	**-0.13**	**-0.08**	**0.01**	**0.00**	
GDP reaction to a positive investment shock									
Baseline	-0.02	-2.12*	-2.58*	-2.67*	-3.21*	-1.65	2.45*	1.02	
Deflators:									
GDP deflator	0.56	-1.97	-2.48*	-3.30*	-4.04**	-2.09	2.87*	1.10	
Various deflators[1)]	-0.19	-2.39*	-3.06*	-3.41*	-3.80*	-1.94	3.30*	1.90	
Nominal values	0.73	-0.76	-1.95	-2.46	-2.70	-0.80	2.66*	-0.47	
Lag length:									
p=2	0.69	-1.35	-1.48	-2.30*	-2.11	-1.21	0.13	0.50	
p=6	-3.01***	-4.70***	-5.31***	-4.18*	-5.88***	-0.55	3.07*	1.13	
p=8	-2.01*	-3.30*	-2.94	-0.61	-3.52*	-1.77	4.32*	1.18	
Sample periods:									
1991Q1-2017Q3	-0.25	-1.89	-2.86*	-3.25*	-3.49*	-1.77	1.71	1.15	
1995Q1-2017Q3	-0.39	-2.57*	-2.89*	-2.41	-2.03	-0.21	2.96*	0.36	
Mean	**-0.43**	**-2.34**	**-2.84**	**-2.73**	**-3.42**	**-1.33**	**2.61**	**0.98**	
GDP reaction to a positive monetary benefits shock									
Baseline	0.17*	0.24**	0.14	0.17	0.21*	0.13*	0.05	0.00	
Deflators:									
GDP deflator	0.16*	0.21*	0.12	0.20*	0.25***	0.10	-0.03	0.00	
Various deflators[1)]	-0.01	-0.01	-0.08	0.02	0.12**	0.17**	0.17**	0.03	
Nominal values	0.24***	0.25**	0.18*	0.21*	0.21*	0.06	-0.09	-0.03	
Lag length:									
p=2	0.05	0.04	0.02	0.04	0.06	0.04	0.02	-0.01	
p=6	0.16*	0.24*	0.15	0.15	0.12	0.19*	0.18*	-0.02	
p=8	0.26***	0.22*	-0.01	0.16	0.21	0.18	-0.01	-0.05	
Sample periods:									
1991Q1-2017Q3	0.21***	0.20*	0.17*	0.20*	0.16*	0.05	0.00	0.01	
1995Q1-2017Q3	0.28***	0.38**	0.23	0.26*	0.24*	0.18*	0.09	0.00	
Mean	**0.17**	**0.20**	**0.10**	**0.16**	**0.18**	**0.12**	**0.04**	**-0.01**	

The table shows the percentage change in GDP in response to an increase in the respective revenue and spending categories amounting to 0.1% of GDP. The symbols ∗, ∗∗ , and ∗ ∗ ∗ indicate significance at the 32%, 10%, and 5% level respectively. 1) Government consumption is adjusted using the deflator for government consumption, public investment with the deflator for public investment, monetary benefits as well as social contributions with the deflator of private consumption and all other variables with the GDP deflator.