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Tax and spending shocks in the open economy: are the deficits twins?

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Abstract: We present evidence on the open economy consequences of US fiscal policy shocks identified through proxy-instrumental variables. Tax shocks and government spending shocks that raise the government budget deficit lead to persistent current account deficits. In particular, the negative response of the current account to exogenous tax reductions through a surge in the demand for imports is among the strongest and most precisely estimated effects. Moreover, we find that the reduction of the current account is amplified when the tax reduction is due to lower personal income taxes and when the government increases its consumption expenditures. Historically, a much larger share of current account dynamics has been due to tax shocks than to government spending shocks.

Keywords: Tax policy, government spending, proxy-vector autoregressions, current account, twin deficits.

JEL: E32, E62, F41.

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1 Introduction

The observation that government budget deficits and current account deficits are often positively correlated has received considerable attention both in policy debates and in academic macroeconomics. In policy discussions, there is often an associated notion that fiscal deficits might be the causal reason for external deficits, which is called the 'twin deficits' hypothesis. For example, some commentators have referred to recent tax legislation decisions in the US as 'Trump's deficit gamble' by highlighting the apparent connection between debt-financed tax cuts and reductions of the trade balance.[2] Outside the US, a recurrent topic of policy debate is the large recent German current account surplus that is often described as a counterpart to the relatively restrictive fiscal stance of the government, and higher government budget deficits are frequently suggested as a remedy for the perceived problem of international imbalances.

Of course, even if government budget and current account deficits appear to move together sometimes, this correlation says nothing about causality, since both are endogenous variables that are driven by a variety of economic shocks. Hence, the question is whether fiscal policy shocks that cause budget deficits also tend to produce a current account deficit. In other words, possible unconditional correlations between the two notwithstanding, is there a conditional correlation between the budget deficit and the current account in the case of fiscal shocks?

The existing empirical evidence appears mixed, with some studies finding that fiscal shocks indeed produce twin deficits, but others pointing to the opposite result of 'twin divergence', i.e. opposite signs of the responses of the government budget and the current account deficit conditional on fiscal shocks. One reason for differing results is that identification of fiscal shocks is difficult, in particular in the case of tax shocks because tax revenues in large part respond endogenously to business cycle movements. From the theoretical perspective, predictions about the current account response to an exogenous increase in the fiscal deficit are also ambiguous. As shown by Enders et al. (2011) and Müller (2008) a standard open economy model can produce both twin deficits and twin divergence depending on the assumption about trade price elasticities. Taken together, neither the empirical nor the theoretical literature has reached a consensus on how fiscal deficits shape external deficits.

In this paper, we use recently developed proxy-vector autoregressions (Stock and Watson 2012, 2018, Mertens and Ravn 2013) that identify structural shocks through instrumental variables that are arguably correlated with a particular economic shock. Specifically, we use proxy-VARs to estimate the effects of US tax shocks and government spending shocks on the current account and the government budget deficit. We follow Mertens and Ravn (2013) and use the narrative tax shock measure by Romer and Romer (2010) to proxy-identify tax

[2] See e.g. the discussion at https://www.project-syndicate.org/bigpicture/ trump-s-deficit-gamble, or Paul Krugman speaking of 'Trump's twin deficits' in his column at https://www.nytimes.com/2019/03/07/opinion/trump-deficit.html.

shocks, and follow Hall (2009), Barro and Redlick (2011) and Miyamoto et al. (2019) to use military spending changes as proxies for government spending shocks.

The key result is that both types of fiscal shocks that raise the government budget deficit, i.e. tax reductions or spending increases, tend to produce pronounced and long-lasting current account deficits. In particular, there is strong and robust evidence that exogenous tax reductions lead to a persistent and statistically significant negative response of the current account, or net exports, that is driven mostly by a surge in import demand. Though tax reductions are associated with a short-run increase in private savings, they also tend to be accompanied by a short-run decline in public savings and a medium-run increase in private investment, resulting in a negatively hump-shaped current account response. When differentiating between the specific type of the fiscal intervention, we find that a tax reduction that is due to lower personal income taxes induces a larger current account decline compared to lower corporate income taxes. Government spending increases also tend to produce current account deficits in most specifications, but in contrast to tax shocks they do not appear to have contributed more than a very small fraction of movements in external balances historically, and the estimated responses to spending shocks seem to be influenced more strongly by the data from the aftermath of the Great Recession. Moreover, the fall in the current account is amplified (reduced) when a rise in government spending is driven by higher public consumption (investment) expenditures. Overall, our empirical results are in line with the twin deficits hypothesis.

In the previous empirical literature, several studies have found that US fiscal shocks produce twin divergence. Kim and Roubini (2008) use a VAR identified through short-run restrictions and find that the current account increases when the government spends more or lowers tax rates. Other studies find similar results with respect to government spending using a recursive identification scheme (Corsetti et al. 2012) or sign restrictions (Enders et al. 2011). Contrary, Monacelli and Perotti (2010) and Ravn et al. (2012) provide evidence in favor of twin deficits. Concerning tax changes, Bouakez et al. (2014) find mixed current account effects for four countries using heteroscedasticity for identification, while Boileau and Normandin (2012) find that recursively identified tax shocks generate twin deficits in the data for 16 industrialized countries.

There is more limited evidence on the open economy effects of fiscal shocks identified by proxy-instruments or narrative measures. Relying on panel data, Miyamoto et al. (2019) use military expenditures as an instrument for exogenous government spending changes and find that an increase in public expenditures leads to a decrease in the current account. However, because a valid tax shock instrument is not available for a large number of countries, they do not study how tax policy interventions affect the current account. Bluedorn and Leigh (2011) find that fiscal consolidations identified through the narrative accounts introduced by Devries et al. (2011) increase current account balances in a panel of 17 OECD countries. However, it is not possible to distinguish between tax and spending shocks with these

measures, and the data are only available annually. In contrast, using proxy-VARs we can make use of narrative information for identification and at the same time analyze the differences between the macroeconomic effects of tax and spending shocks.

Concerning tax shocks, our approach closely follows Mertens and Ravn (2013) who also use a narrative measure for US tax shocks as instruments in a proxy-VAR, but do not present evidence on the current account. Concerning government spending shocks, we follow previous authors (Hall 2009, Barro and Redlick 2011) and use military expenditures for identification, though in contrast to these we do not require that military spending is identical to structural fiscal spending shocks. Since the proxy-VAR methodology only requires the weaker assumption that the proxy is correlated with the fiscal spending shock only, it should be robust to certain types of measurement error in the proxy variable as pointed out by Mertens and Ravn (2013). Importantly, we verify that the instruments we use appear strong in the sense that they imply first stage F-statistics well above 20, such that weak instruments should not be a concern for our analysis.

The rest of the paper is organized as follows. Section 2 describes our econometric approach, whereupon section 3 presents empirical results. Specifically, section 3.1 discusses our baseline specification and data and section 3.2 presents the central results concerning the effects of tax and government spending shocks on the current account and the budget deficit. The key result is shown to hold up to a number of robustness checks in section 3.3. Section 3.4 presents a historical decomposition to depict the estimated contribution of the fiscal shocks to the movements in fiscal and external balances over the sample. Finally, section 4 concludes.

2 Econometric method

Consider a VAR with reduced form

$$x_t = \sum_{i=1}^{n} A_i x_{t-i} + u_t \tag{1}$$

where x_t is a $k \times 1$ vector of variables observed at time t, the A_i, $i = 1, ..., n$ are $k \times k$ parameter matrices, n is the number of lagged variables considered (assumed to be known here, and empirically determined based on information criteria below), and u_t is a vector of random one-period ahead forecast errors, which are assumed *i.i.d.* with contemporaneous covariance matrix $E(u_t u_t') = \Sigma$. We aim at (partly) identifying the corresponding structural VAR model (SVAR)

$$B^{-1} x_t = \sum_{i=1}^{n} C_i x_{t-i} + e_t \tag{2}$$

where the C_i and B are parameter matrices, and e_t is the vector of structural, economically interpretable *i.i.d.* shocks assumed to be mutually uncorrelated having a diagonal covariance matrix $E(e_t e_t') = \Omega$. The columns of the matrix B are the impact effects of the structural shocks, such that e.g. the j-th column of B contains the contemporaneous responses of the

variables in x_t to the j-th shock.

The identification problem consists of the fact that while the reduced form parameters in the A_i and Σ are readily estimable, these do not uniquely pin down the parameters in the C_i matrices and in $\Omega = B^{-1}\Sigma B^{-1'}$. Traditionally, many authors have used theory-inspired restrictions on the B (or B^{-1}) matrix, or on the long-run impulse response matrix, to achieve identification. Here, we will follow Stock and Watson (2012, 2018) and Mertens and Ravn (2013) and use external instruments to identify columns of B of particular interest, which is the so-called proxy-VAR approach. In particular, we are interested in identifying the impulse response of x_t to particular structural shocks in the elements of e_t. The structural impulse responses are given by the coefficients of the structural vector moving average

$$x_t = \sum_{i=0}^{\infty} R_i B e_{t-i} \tag{3}$$

where R_i are the reduced form vector moving average matrices that can be estimated by inverting the reduced form autoregressive lag polynomial $(I_k - A_1 L - ... - A_n L^n)$, with L being the lag operator and I_k the k-dimensional identity matrix; note that $R_0 = I_k$ by construction, such that B contains the contemporaneous, or impact, effects of the structural shocks.

Since we are interested in the effects of tax and government spendings shocks, we normalize the coefficients in the respective columns of B, following Stock and Watson (2012, 2018). Thus, if for example taxes are the h-th element in the vector x_t, and we (arbitrarily) assign the tax shock as the j-th element in the structural disturbance vector e_t, we normalize $B_{hj} = 1$. In this way, the responses are calculated as pertaining to a shock that has an impact effect of 1 on the tax variable.

Suppose further that we have proxy variables for tax and spending shocks, $z_{\tau t}$ and z_{gt} respectively. In the following, we demonstrate the general shock identification method (due to Stock and Watson, 2012) for the example of identifying tax shocks through $z_{\tau t}$; identification of government spending shocks through z_{gt} proceeds analogously. Suppose that the tax shock pertains to the j-th column of B, henceforth B_j. The identifying assumption is that $z_{\tau t}$ is correlated with the structural tax shock e_{jt} (relevance condition), but uncorrelated with all other shocks (exclusion restriction). Formally, the requirement is that

$$E(z_{\tau t} e_{jt}) = a \neq 0 \text{ and } E(z_{\tau t} e_{it}) = 0 \quad \text{for } i = 1, ..., k \text{ when } i \neq j. \tag{4}$$

Since the (estimable) reduced form VAR disturbances u_t satisfy $u_t = Be_t$, we have that $E(u_t z_{\tau t}) = BE(e_t z_{\tau t}) = B_j a$. Assuming without loss of generality that the tax variable τ_t is the first element of the data vector x_t and thus normalizing the first element of the vector B_j to be one, this states that $E(u_{\tau t} z_{\tau t}) = a$ (where $u_{\tau t}$ is the reduced form residual for the VAR equation with τ_t on the left side) and $E(u_{it} z_{\tau t}) = B_{ij} a$ for $i = 2, ..., k$ (where u_{it} is the reduced form VAR residual of the i-th equation). The elements of the impact vector B_j

are thus given as

$$B_{ij} = \frac{E(u_{it} z_{\tau t})}{E(u_{\tau t} z_{\tau t})}, \quad i = 2, ..., k. \tag{5}$$

Consequently, under the stated assumptions the B_{ij} can consistently be estimated by replacing the expectations in the above expression by sample moments. This amounts to estimating B_{ij} by an instrumental variable regression of u_{it} on $u_{\tau t}$ using $z_{\tau t}$ as instrument. With the impact vector B_j thus identified, impulse responses to structural tax shocks can then be estimated using (3). Proceeding analogously for another column of B using the government spending instrument z_{gt} then allows to estimate responses to identified fiscal spending shocks.

Of course, the crucial requirement is that the instruments are only correlated with the shock that they are intended to identify, and that they are strong instruments in the sense that they are strongly correlated with the reduced form VAR residuals. While the first requirement cannot be tested directly, we only rely on instruments that have also been used in previous studies and are thus well established in the fiscal policy literature. To address the second, we verify that the instruments are strong by using first stage F tests which yield test statistics well above 20 in all cases and thus suggest that our instruments are reasonably strong.

Concerning inference, there has been a recent debate about the appropriate way to construct bootstrap confidence bands around impulse responses identified by proxy-VARs. While Mertens and Ravn (2013) use a wild bootstrap procedure, this has been criticized by Jentsch and Lunsford (2018) in that it does not take into account the uncertainty about the instrument and is therefore inconsistent. Instead, Jentsch and Lunsford (2018) show that a moving blocks bootstrap yields consistent inference, but renders many of the results in Mertens and Ravn (2013) statistically insignificantly different from zero at usual significance levels. In this paper, we use a moving blocks bootstrap as recommended by Jentsch and Lunsford (2018).[3] In particular, this takes the uncertainty of the relation between the structural shocks and the proxy instruments into account. We do find that our confidence intervals are relatively wide using this procedure, in line with the argument by Jentsch and Lunsford (2018), such that many impulse responses appear insignificantly different from zero at the 90% significance level, though most are significant at the 68% level that is also often used in the VAR literature. Most importantly for our purposes, however, the responses of the current account and the fiscal deficit are relatively precisely estimated and appear significant even at the 90% level. In sum, while we acknowledge a high degree of uncertainty around many of the impulse responses, this does not negatively affect our main object of study, since the twin deficits feature turns out to be the most robust and significant result that we find. Appendix A1 describes the bootstrap procedure in more detail.

[3] We follow Jentsch and Lunsford (2018) and use as block length $\kappa T^{1/4}$ rounded to the next integer, where $\kappa = 5.03$ and T is the sample size, which for our baseline specification results in a block length of 17.

3 Empirical results

In this section, we present our estimates of the effects of proxy-identified tax and spending shocks on quarterly US macroeconomic data. We proceed in the following steps. First, we describe our baseline empirical specification in section 3.1, and discuss the data and proxy-instruments used. Second, in section 3.2 we present the main result by showing the impulse responses of the variables in this specification to the identified fiscal policy shocks. Additionally, we show evidence on various components of the current account to shed more light on underlying the transmission channel. Third, we discuss various robustness checks in section 3.3. Fourth, we give a historical decomposition to depict the actual in-sample contribution of the two fiscal shocks to the dynamics of the fiscal and current account deficit.

3.1 Baseline specification

In our baseline model, the vector x_t consists of the following seven variables: g_t which is the log of real government spending per head of population, taxes τ_t (the log of real tax and social security receipts deflated with the GDP deflator, per head of population), log real GDP per head of population y_t, the fiscal deficit d_t (the difference between government expenditures and receipts as a fraction of nominal GDP), the current account balance ca_t (as a fraction of nominal GDP), a short-run nominal interest rate r_t, and the log of the GDP price level p_t. In constructing the short-run nominal interest rate r_t, we use quarterly averages of the monthly Federal Funds Rate, except for the zero lower bound period from January 2009 to November 2015 where we use the Wu and Xia (2016) shadow rate. Thus, the nominal interest rate r_t controls for the influence of monetary policy, both in its conventional form of targeting the Federal Funds Rate that has been used for most of the sample, as well as for the influence of unconventional monetary policies that have been used during the zero lower bound episode and that are reflected in the shadow rate. In this way, we avoid to erroneously attribute the part of the fluctuation in the data that is due to either conventional or unconventional monetary policies to fiscal shocks. Following the argument by Forni and Gambetti (2010), we include the price level in the baseline model to ensure that our VAR is informationally sufficient.[4] Appendix A2 gives a more detailed description of the data series used and their sources.

We estimate the model on quarterly US data over the period 1983Q1 to 2017Q2, using a VAR specification with three lags and allowing for a constant. The choice of three lags is recommended by the Akaike information criterion, whereas the Schwarz and Hannan-Quinn criteria recommend the use of two lags. However, the results do not change much quantitatively, and all qualitative conclusions remain unaltered, if we alternatively use two or four lags (or if we additionally include a linear time trend). We follow Corsetti et al. (2012) and choose 1983Q1 as the starting date to exclude the turbulent pre-Volcker period from the sample. Thus, the sample choice has the advantage that we focus on a period

[4]Thanks are due to the associate editor for pointing this out.

in which the policy framework was relatively stable. Notably, several studies detect a change in the fiscal transmission mechanism at the beginning of the 1980s (e.g., Bilbiie et al. 2008, Perotti 2005). More specifically, Bilbiie et al. (2008) find that in the post Volcker period a fiscal stimulus was more debt-financed compared to pre 1980, suggesting that the conditional comovement between fiscal shocks and budget deficits may have changed. Focusing just on the post 1983 period, Corsetti et al. (2012) find that a fiscal stimulus leads to a persistent increase in government debt suggesting a rise in the government deficit following expansionary fiscal policy during the period of consideration. However, we show that our key results concerning the comovement between budget deficits and the current account in response to fiscal shocks are robust to starting the sample in 1975, and most of the results are similar if we exclude the turbulent period subsequent to the onset of the Great Recession in 2008.

To instrument exogenous changes in tax revenues, we rely on the narrative series provided by Romer and Romer (2010). To achieve identification the authors exploit the narrative information in official historical documents in two ways. First, they verify that the policy documents do not discuss a desire to respond to current or prospective economic conditions and return growth to normal. Second, within the set of policy changes not motivated by the near-term economic outlook, they focus on tax changes motivated either by a desire to reduce the budget deficit or by raising long-run growth. Thus, the identified tax shocks measure changes in the tax system that are not related to the state of the economy and thereby offer a valid instrument for studying the macroeconomic effects of tax changes. Although the tax instrument is just available up until 2007Q4, we follow Stock and Watson (2018) and Gertler and Karadi (2015) by estimating the VAR coefficients on the longer sample (until 2017Q2) and the impact vector of an exogenous tax shock by using information on the instrument for the shorter sample. As shown by Stock and Watson (2018), using the longer sample for the VAR estimation improves estimation efficiency. Between 1983Q1 and 2007Q4, Romer and Romer (2010) identify 21 exogenous tax shocks out of which 12 correspond to an exogenous tax increase and the remaining 9 innovations measure exogenous tax cuts. The average size of these tax changes is 0.4 percent of GDP.

As an instrument for exogenous changes in government spending we use the growth rate of military spending per head of population. Hall (2009), Barro and Redlick (2011), and Miyamoto (2019), amongst others, also use military spending data to identify exogenous government spending shocks. Changes in military spending are often large and regularly respond to foreign policy developments, suggesting that these changes are exogenous in the sense that they are less likely to be driven by domestic cyclical forces. In particular, military spending is not correlated with the state of the economy like the state of the business cycle, the monetary policy stance or financial conditions of the private sector. Moreover, military spending is closely associated with the wasteful spending assumed in many macroeconomic models implying that our empirical findings can be used to test predictions of competing

theoretical models.[5] Note that the narrative defense news series provided by Ramey (2011) and Ramey and Zubairy (2018) is not an appropriate instrument for our application because it measures future changes in government spending whereas we have to rely on an instrument that affects government spending contemporaneously.

It is important to notice that both for tax and government shocks, we appear to have rather strong instruments, as judged by the first stage F-statistic. As shown in Table 1, in both cases the respective values are well above 20. This suggests that weak instruments are unlikely to be a concern for our analysis. In all impulse response figures displayed below, the lightly shaded areas indicate 90% confidence bands obtained from 10,000 bootstrap repetitions, and the darker shaded areas indicate 68% confidence bands.

	Tax shock	**Spending shock**
First-stage F-statistic	24.58	78.56
Sample	1983Q1-2007Q4	1983Q1-2017Q2

Table 1: Instrument relevance.

3.2 Main result: the twin deficits

Figure 1 shows impulse responses for both shocks from the estimate of the baseline specification. For better readability, throughout we display the results for a negative tax shock (left column) and a positive government spending shock (right column).

To interpret the scale of the responses, note that we normalize the shock size to one in each case. This amounts to a tax reduction of one percent of tax revenues, and a fiscal spending increase of one percent of government spending. As can be seen from the figure, the estimated shocks trigger persistent responses of taxes and spending, respectively. The output responses are persistently positive and significant at the 68% level in each case at least. Whereas tax shocks appear to have, if anything, a delayed positive effect on government spending, increases in the latter appear to be followed by declining taxes in the short run.

The interest rate shows no clear reaction to the tax shock, and the response is imprecisely estimated throughout. There seems to be a moderately negative response of the interest rate to government spending shocks, which while not easy to reconcile with standard theoretical models of government spending expansions, is well in line with other empirical studies (most recently Jørgensen and Ravn 2018 and D'Alessandro et al. 2019), and is actually theoretically expected in some models such as Corsetti et al. (2012). The price level shows no clearly measurable response to either of the shocks in the short run, but a moderate

[5]Our main findings change only marginally when the proxy is constructed as the change in military spending relative to lagged GDP as proposed by Barro and Redlick (2011).

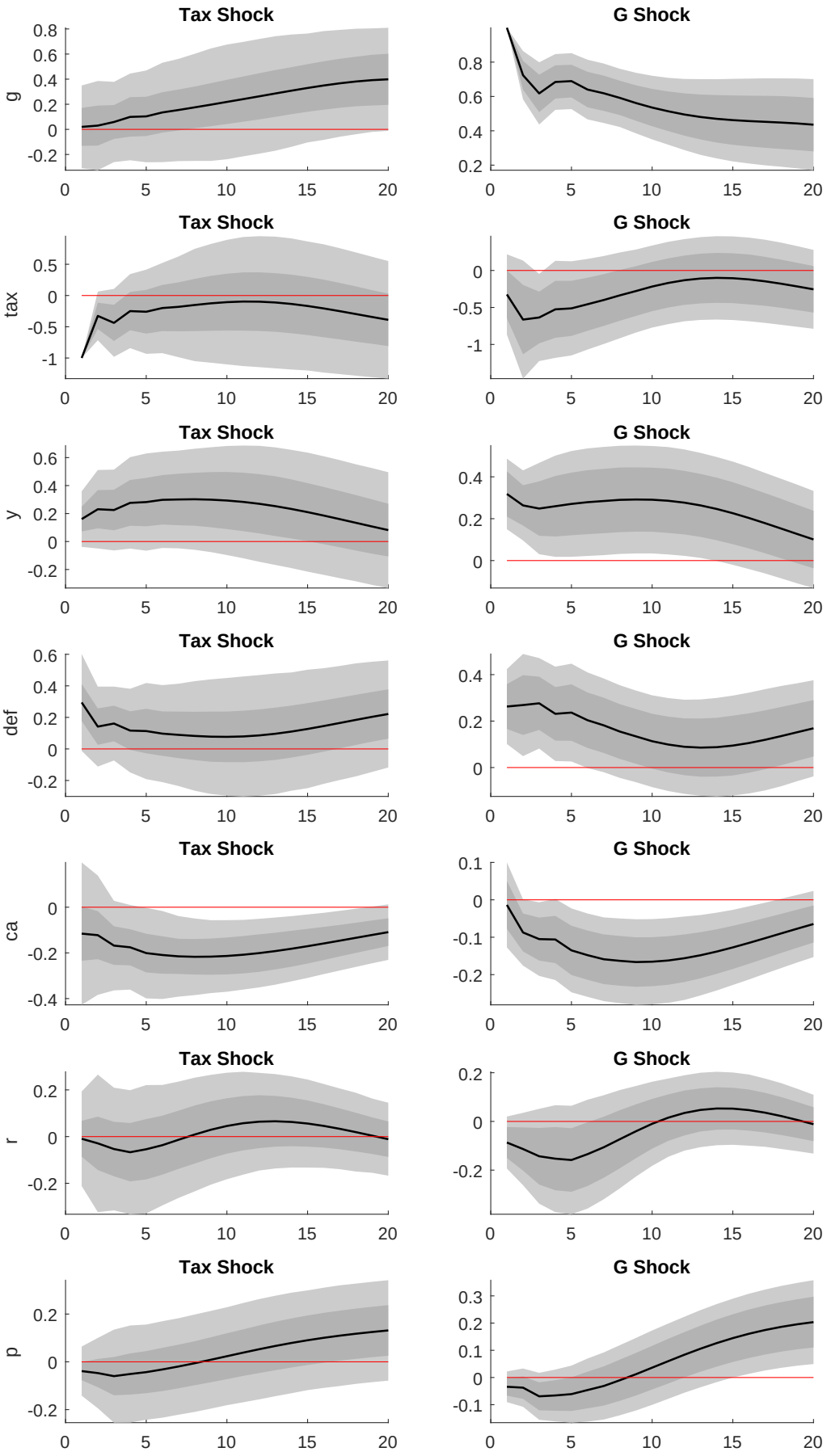


Figure 1: baseline results.

Notes: Solid lines show point estimates. Shaded areas indicate 68% and 90% bootstrapped confidence intervals.

increase after several quarters.

In response to both shocks, the fiscal deficit increases, as would be expected, and the increase is statistically more strongly signficant in the case of government spending. This indicates that fiscal shocks are mostly deficit financed in the post-Volcker period, which supports the evidence presented by Bilbiie et al. (2008), Perotti (2005) and Corsetti et al. (2012). In both cases, the deficit response peaks on impact.

Most important for our question is the response of the external deficit, measured by the current account balance. In response to both shocks, we estimate a persistent decrease in the current account. Thus, we indeed find a twin deficits property in the sense that the fiscal shocks that move the government budget into deficit also trigger a current account deficit. For both types of fiscal shocks, the effect on the current account is markedly negative along the whole impulse response, strongly persistent and hump-shaped, and highly statistically significant if not on impact, but from about four to five quarters after the shock until several years later.

To put the results in perspective, while the existing empirical literature has provided evidence supporting both twin deficits (Monacelli and Perotti 2010, Ravn et al. 2012) and twin divergence (Kim and Roubini 2008, Corsetti et al. 2012, Forni and Gambetti 2016), our results clearly favor the twin deficits hypothesis. These results are also of interest from a theoretical point of view, because standard open economy models can produce both results. As shown by Enders et al. (2011) and Müller (2008) the assumption about the trade price elasticity determines whether the current account increases or falls after a fiscal policy shock. Thus, our empirical twin deficits finding might serve as a target for theoretical work on the open economy effects of fiscal policy.

In terms of magnitudes, we find that both shocks trigger a reduction in the current account of similar size, with the response to tax shocks marginally more negative if measured at the trough about eight quarters after the shock. Both shocks lead to roughly a 0.3 percentage point increase in the fiscal deficit on impact, and to about a 0.15 to 0.2 percentage point reduction in the current account between one and two years afterwards.

To summarize, we find that both types of fiscal shocks generate twin deficits. While the estimation uncertainty concerning the effects of the proxy-identified tax shocks is rather large, as recently pointed out for their output response by Jentsch and Lunsford (2018) in their discussion of Mertens and Ravn (2013), this does not appear to afflict the current account response in our data. In fact, the negative current account reaction to tax reductions and spending increases can be seen as the most clear-cut among the results, as the responses of this variable are estimated to be significantly negative for the larger part of the 20 quarters response horizon shown in Figure 1. In the next section, we will discuss the robustness of these results with respect to changes in the specification, sample, and data used.

To see more clearly what drives the external deficit response, note that the current account in the framework of national income accounting can be viewed from two sides. From

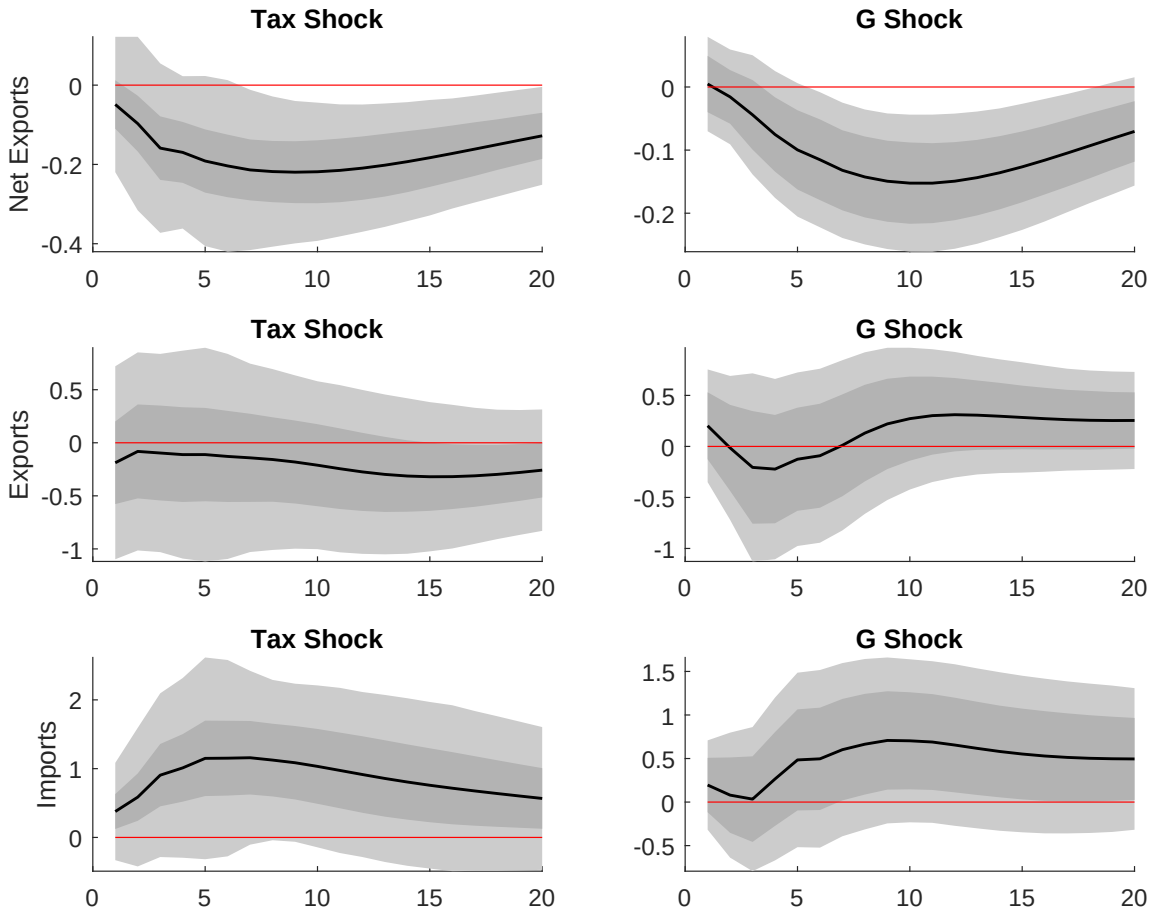


Figure 2: Net exports, exports and imports.

Notes: Solid lines show point estimates. Shaded areas indicate 68% and 90% bootstrapped confidence intervals.

a production account perspective, it consists mainly of net exports of goods and services, with international factor income payments and transfers quantitatively far less important. From an income and savings perspective, on the other hand, the current account reflects the sum of private and public differences between gross savings and investment.[6] In the following, we show the results from two additional specifications each highlighting one of these perspectives, to see more clearly which of the components drives the above results.

In Figure 2, we first replace the current account balance by net exports as a fraction of GDP, shown in the first row in the figure, and then replace the net export variable by log real exports and log real imports (both in per capita terms) entered separately, shown in the second and third row. As can be seen from Figure 2, the strongly negative effect of both fiscal shocks on the external imbalance is very comparable if we use net exports as opposed to the current account balance, confirming the view that the latter is largely driven by the dynamics of trade in goods and services. If we enter exports and imports separately, as shown in the second and third rows of Figure 2, the reaction of exports is small and mostly statistically insignificant. This is different with respect to imports, which react positively in both cases. The strongest response is the one of imports to a tax reduction shock,

[6]Thanks are due to an anonymous referee for pointing this out.

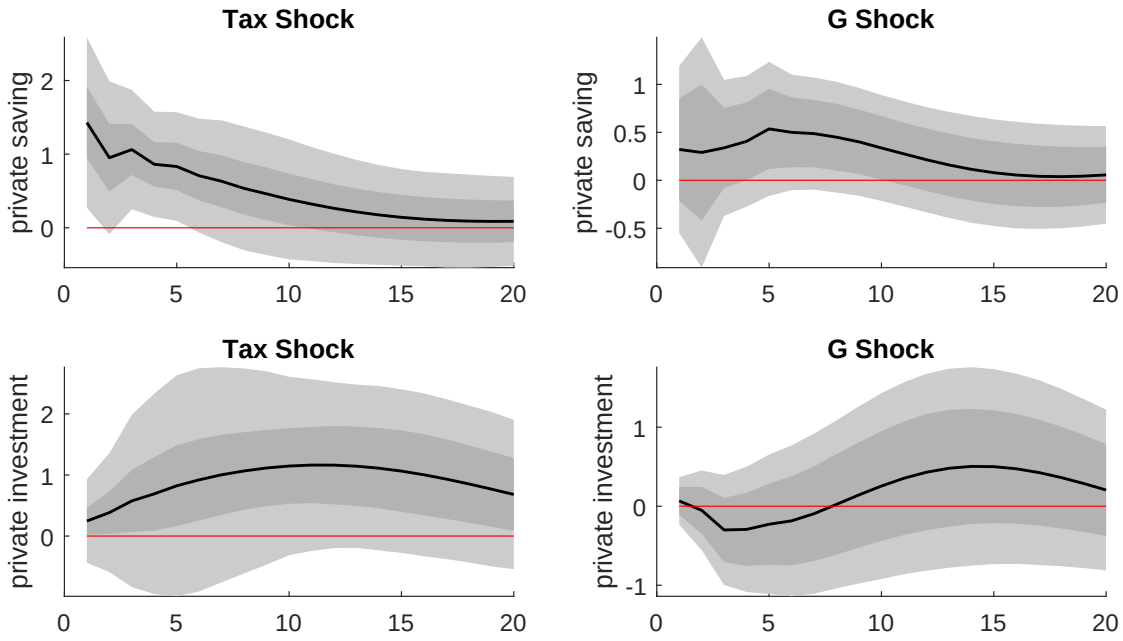


Figure 3: Private savings and investment.

Notes: Solid lines show point estimates. Shaded areas indicate 68% and 90% bootstrapped confidence intervals.

which is large and statistically significant at the 68% level throughout and even marginally attains significance at the 90% level around its peak. The import response to a government spending shock is initially insignificant, and only about half as large at the peak as the one with respect to tax reduction shocks. Hence, we conclude that the negative current account or net export response is mostly driven by the rise in imports.

In Figure 3, we show the results of an alternative specification intended to capture the income and savings perspective on the current account. We estimate the proxy-VAR in g_t, τ_t, r_t and p_t, as defined above, and additionally in the logarithms of real gross private savings per capita and real gross private fixed domestic investment per capita. As shown in Figure 3, tax shocks trigger an immediate, strong and highly significant increase in private savings, that slowly and almost monotonically declines over time. This is as expected, as a tax reduction directly increases private disposable income, part of which would be predicted to be saved by standard macroeconomic theories. On the other hand, private investment appears to increase more slowly following a tax reduction, and the response is less precisely estimated. However, the peak of the point estimate reaches almost a one percent private investment increase two years into the adjustment process. Hence, the private part of the saving-investment balance initially increases and later decreases after a negative tax shock, which explains the hump-shaped nature of the current account response reported above. The overall negative response of the current account shown in Figure 1 is thus explained through the public saving-investment balance: tax reductions lead to increases in the fiscal deficit, hence to more strongly negative public savings, which are apparently not outweighed by any public investment changes. Hence, the negative current account

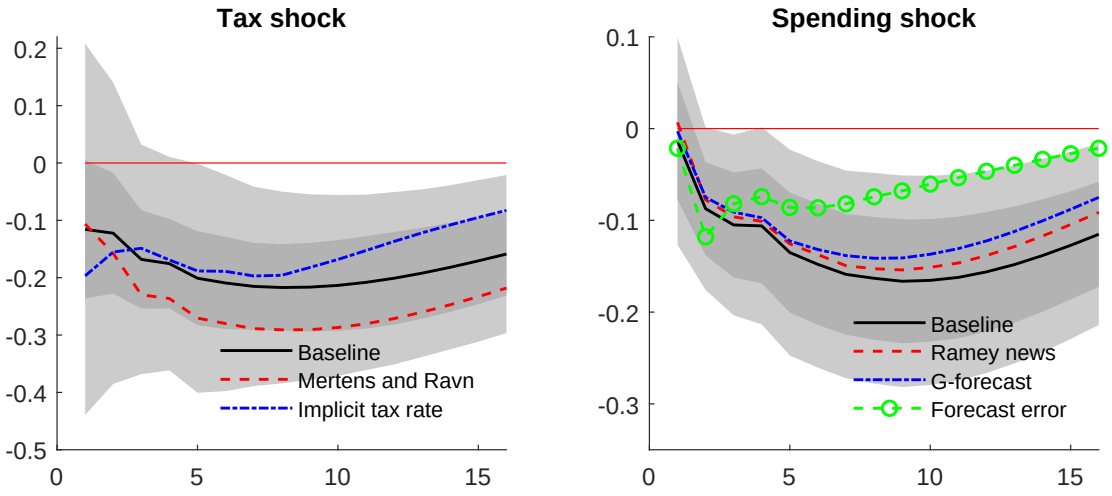
response to a tax reduction initially largely reflects the fact that the increase in the fiscal deficit is larger than the increase in private savings, whereas later into the response the rather quick return of private savings to normal coupled with a slow build-up of additional private investment contributes to the strongly negative hump in the current account. With respect to the government spending shock, all results are much less precisely estimated, and in particular there is hardly any discernible response of private investment. Private savings react somewhat positively to a government spending increase, but only attain 68% significance at their peak, and even there the response is only roughly 0.5 percent. Hence, with hardly any private investment response and a comparatively weak private savings increase, the negative current account response to government spending increases mostly reflects the associated public savings decrease.

To sum up the main results, we find that fiscal and external deficits appear to be twins in our data, in the sense that identified fiscal shocks that increase the fiscal deficit are also typically followed by protracted and relatively precisely estimated current account deficits over time. With respect to the counterparts of the current account in the national accounting framework, the results are clearest for tax reduction shocks, which tend to be followed by a surge in import demand, an initial but rather short-lived increase in private savings, and a more gradual increase in private investment.

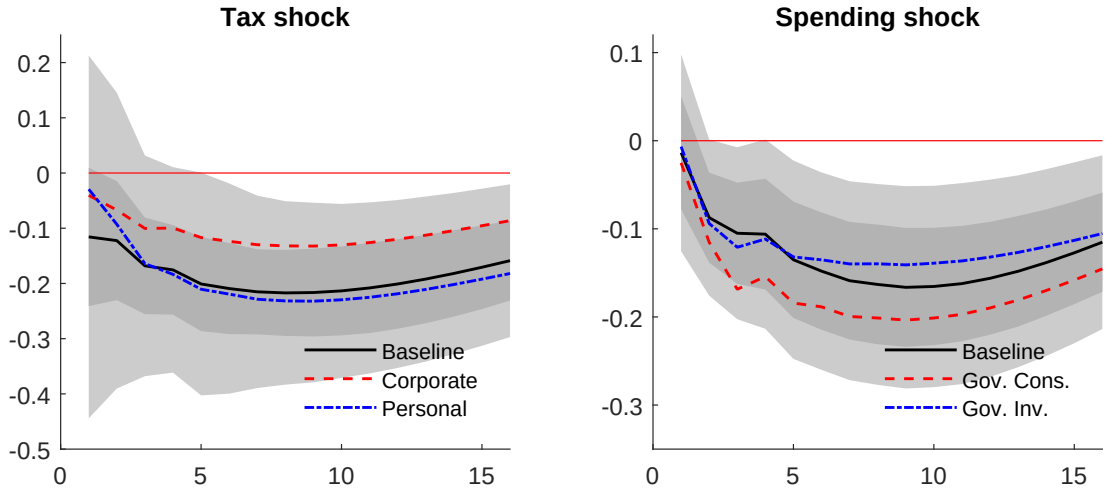
3.3 Robustness

In this section, we demonstrate in how far our main result, namely the decline of the current account in response to an exogenous tax cut or government spending increase, is robust to several modifications of the baseline model. In particular, we analyze the robustness of the central result with respect to controlling for fiscal foresight, differentiating between personal and corporate income tax shocks and changes in government consumption and investment, and allowing for changes in the sample. For easier visual comparison, in the following we just focus on the current account response.

(a) Fiscal foresight.



(b) Type of fiscal intervention.



(c) Sample changes.

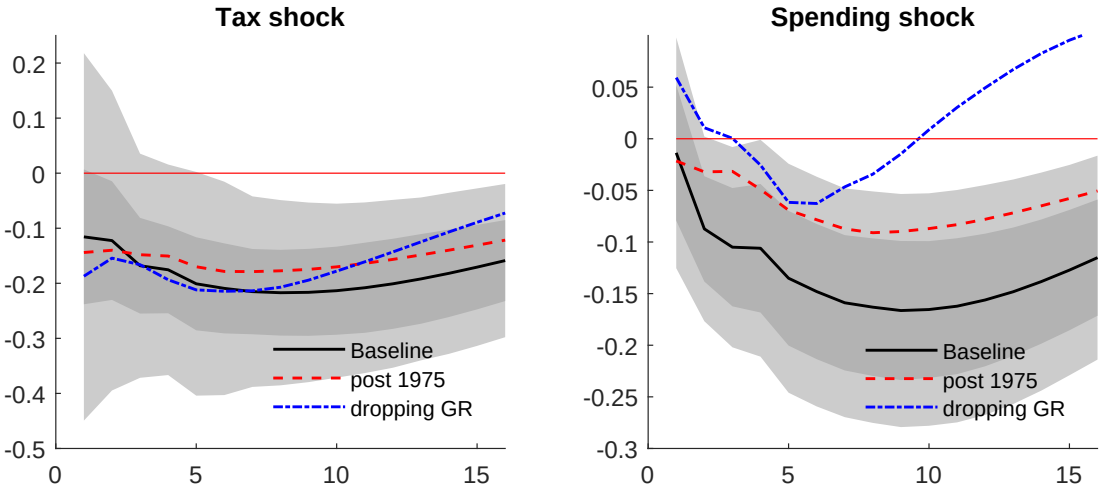


Figure 4: Robustness (current account response).

Notes: Solid lines, dashed lines and dashed-dotted lines show point estimates. Shaded areas indicate 68% and 90% bootstrapped confidence intervals of our baseline model.

Fiscal foresight. A potential obstacle for estimating the effects of fiscal shocks is the so-called fiscal foresight problem. It arises when private agents not only react to actual fiscal policy changes, but to breaking news about impending future policy plans. In this case, the econometrician cannot recover the true unexpected fiscal shock because due to an implementation lag the agents' and the econometricians' information sets are misaligned (Leeper et al. 2013). We conduct several modifications of our baseline model to properly address this issue. With respect to tax shocks, we add the implicit tax rate as constructed by Leeper et al. (2012) to the set of endogenous variables in the VAR. The implicit tax rate is a measure of average expected future tax rates thus capturing private agents' anticipation about future tax policies. As an alternative, we follow Mertens and Ravn (2011) and use only those tax shocks to instrument exogenous policy changes for which potential anticipation effects are arguably unlikely. More precisely, we omit all tax liability changes that were implemented more than 90 days (one quarter) after becoming law. With respect to government spending shocks, we include as additional endogenous variable either Ramey and Zubairy's (2018) defense spending news variable or real-time professional forecasts for government spending. The defense spending variable is a measure of anticipated government spending equal to the present discounted value of expected future spending as recovered from newspaper sources. Real-time professional forecasts for government spending is a spliced series of government spending forecasts provided by the Greenbook and the Survey of Professional Forecasters. We extend the series provided by Auerbach and Gorodnichenko (2012) which covers the period 1966-2008 to include the Great Recession and the following years. As an additional check, we use the government spending forecast error to instrument exogenous changes in government spending. This approach was also applied by Ramey (2011) and Auerbach and Gorodnichenko (2012). The underlying idea is that the forecast error captures only those changes in government spending that are not related to aggregate news and thus unanticipated by private agents.[7]

The upper part of Figure 4 shows the result of the respective estimations, where the left graph shows the current account response following a negative tax shock and the right graph presents the respective response after an exogenous increase in government spending. Solid lines and shaded areas show the point estimates of the responses and their confidence bands from our baseline specification presented in Figure 1. The remaining lines correspond to point estimates of the responses from the respective modified models. When taking the Mertens and Ravn (2011) narrative series as an instrument to identify exogenous tax shocks, we find that the current account response is somewhat larger in absolute value compared to the baseline estimates which relied on the Romer and Romer (2010) instrument. The on-impact response of the current account becomes slightly larger in absolute terms when controlling for the implicit tax rate, whereas at longer horizons the current account reduc-

[7]Because the implicit tax rate and the defense spending news series are just available for shorter time periods (until 2005Q4 for the implicit tax rate, until 2015Q4 for defense spending news), the results reported are based on VAR estimations on these shorter samples.

tion is estimated to be smaller relative to the baseline.[8] Turning to the current account response following a government spending shock, we see that changes in the results relatively to the baseline model are quantitatively small when controlling for anticipation by either including defense spending news or government spending forecasts. When we use the forecast error as an alternative instrument for exogenous changes in government spending, the current account response in the first three or four quarters is again quantitatively similar to the baseline, but afterwards the alternative model predicts a faster and non-hump shaped normalization of the current account. Thus, while some ways of accounting for potential foresight problems lead to quantitative differences in the results, the key result of a negative current account response appears qualitatively robust.

Specific type of fiscal intervention. Does the current account response depend on the specific type of tax change or government spending increase? In particular, do personal and corporate income tax shocks have similar effects on the current account, and does higher government consumption induce different current account dynamics compared to an increase in public investment? To study whether the specific component of the tax and spending shock affects our result, we proceed as follows: we differentiate between exogenous personal and corporate income tax changes by relying on the classification proposed by Mertens and Ravn (2013). The authors produce a narrative account of legislated federal personal and corporate income tax liability changes in the United States based on the narrative series by Romer and Romer (2010). We analyze the dynamic effects of personal and corporate income tax changes by replacing the aggregate tax variable τ_t of the baseline specification with either log real personal income taxes per capita, or log real corporate income taxes per capita, respectively. To study the impact of higher government consumption (investment), we include the log of real government consumption (investment) per head of population instead of aggregate government spending in the VAR. Exogenous variations in these government spending components are still instrumented by the growth rate of military spending per head of population.

As the middle panel of Figure 4 shows, the current account response to a tax and government spending shock to some extent does depend quantitatively on the specific component of the fiscal intervention. While a personal income tax cut is associated with a larger current account decline compared to our baseline estimate, lower corporate income taxes lead to a notably smaller current account reduction. The maximum response is roughly twice as large (in absolute terms) when the tax shock is due to a change in personal income taxes. This finding highlights the role of changes in household demand for imports for understanding the current account reduction following an exogenous tax change as shown above in Figure 2. The differences with respect to government consumption and investment shocks are slightly less pronounced. From about a year after a shock, higher government consumption

[8] Note that the sample period between the baseline estimation and the model which includes the implicit tax rate differs.

leads to a stronger fall in the current account than estimated by our baseline specification, whereas positive shocks to government investment have a slightly smaller effect.

Sample changes. As a final robustness check, we test whether the current account response depends on the specific sample that underlies the estimation. First, we extend the sample and choose as starting date 1975Q1, such that the beginning of the sample corresponds to the start of the flexible exchange rate period, while omitting the first two turbulent years after the breakdown of the Bretton-Woods system. Second, we exclude the Great Recession and the subsequent years from the sample and thus just consider the period 1983Q1 to 2007Q4. This exercise should indicate whether the conditional comovement between fiscal and current account deficits significantly changed after the global financial crisis.

The lower panel of Figure 4 shows the estimation results related to the respective sample changes. The decline in the current account following an exogenous tax cut is rather similar across different samples. While both sample changes lead to a slightly larger current account reduction on impact compared to the baseline estimate, they both imply a slightly smaller current account decline in the medium run. Overall, however, different sample periods lead to relatively minor changes in the impulse response of the current account to tax cuts.

In contrast, the response to government spending shocks is more strongly affected by the underlying sample. Starting the sample earlier still leads to a negative current account reaction, but the absolute size of the trough of the response is clearly smaller. Moreover, stopping the sample at 2007 leads to an unclear current account response, with a positive impact effect, a negative effect after five to six quarters, and again a positive effect from ten quarters into the response and onwards. This apparent sensitivity of the current account response to government spending shocks with respect to the precise sample period may explain why previous studies have found varying results, as mentioned in the introduction. Qualitatively, our baseline result of negative external balance effects of spending shocks seems to depend on the inclusion of the Great Recession period with its relatively large swings in both budget and current account deficits. It is currently unclear whether this period is unusual, or if the strong variation observed in this sample part helps with a more precise identification of the effects of spending shocks, a topic that we expect to be taken up by future research.

To sum up, we find that the key result of negative current account effects of fiscal shocks holds up to most robustness checks, with some question marks in the case of government spending shocks which may be sensitive to the sample period. In particular, the evidence that tax reduction shocks lead to negative current account dynamics appears to be highly robust to various specification changes.

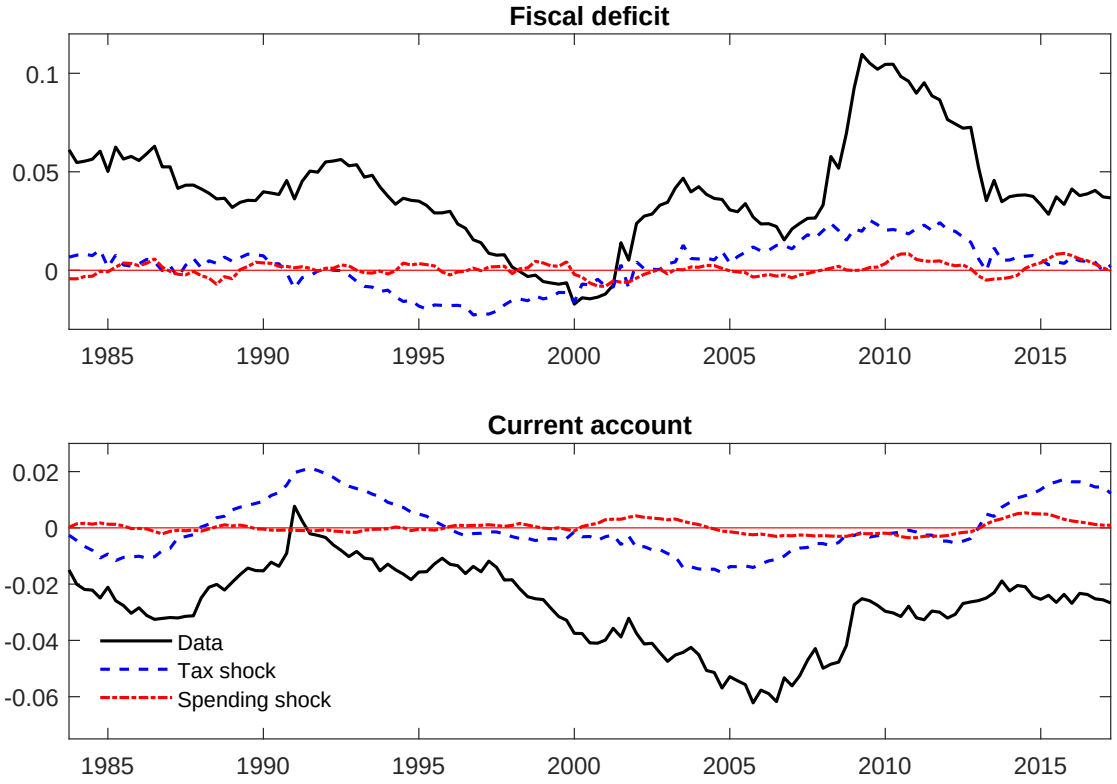


Figure 5: Historical decomposition.

Notes: Solid lines show observed data. Dashed and dashed-dotted lines show the contribution of tax and government spending shocks, respectively.

3.4 Historical decomposition

In the following, we investigate the historical role played by the estimated fiscal shocks in driving the fiscal and external deficit during the sample period.[9] Figure 5 reports the historical decomposition for the tax and government spending shocks. The solid lines in Figure 5 show the observed data of the fiscal deficit (upper panel) and the current account (lower panel). The dashed and dashed-dotted lines in each panel report the contribution of the tax and government spending shock, respectively, to the deviation of the observed series from their sample means.[10]

It is obvious from Figure 5 that government spending shocks have contributed very little to the observed fluctuations both in the fiscal deficit and the current account. Of course, this does not contradict our above finding that the impulse responses to these shocks can be sizeable and significant. The interpretation is that while government spending shocks do generate twin deficits if they occur, the limited size and frequency of the shocks that actually took place in the sample period have been too small to attribute more than a negligible fraction of the observed fiscal and current account deficits to public spending.

Figure 5 also shows that the situation is different with respect to tax shocks, which appear to drive a comparatively large part of the fiscal deficit and the current account.

[9] We are grateful to an anonymous referee for suggesting the historical decomposition exercise.

[10] The method for the computation of the historical decomposition is taken from the exposition in Montiel Olea et al. (2018).

This can most clearly be seen when looking at specific episodes with well-known changes in tax policy that is reflected in the tax shock measure. For example, we find that at the time of the tax increases by the Clinton administration in the 1990s, also known as the Omnibus Budget Reconciliation Act, the estimated tax shocks contributed to the reduction of the fiscal deficit and the increase in the external balance. On the other hand, the tax reductions by the Bush administration in the 2000s show up as negative tax shocks in the historical decomposition that increased both the fiscal and the external deficit. At the end of the same decade, as a part of its policy response to the Great Recession the Obama administration enacted a stimulus package which consisted of tax cuts and spending increases. According to our results, these countercyclical fiscal measures induced an increase in the government budget deficit and also contributed to the negative external deficit during that episode. However, the contribution of both fiscal shocks to the current account during the Great Recession is relatively small implying that most of the current account deficit during the crisis years is driven by the remaining shocks in the VAR, which is in line with the conventional wisdom that the dynamics of this period was driven largely by non-fiscal (e.g. financial) shocks.

4 Conclusion

Does a higher fiscal deficit induce a larger current account deficit? The twin deficits hypothesis has received considerable attention both in academic research and among economic policy commentators. Although there is often a positive unconditional correlation between fiscal deficits and current account deficits, the existing empirical literature on the correlation between both variables conditional of fiscal (tax or spending) shocks is ambiguous. While some studies find indeed evidence in support of the twin deficits hypothesis, others report opposing results stressing twin divergence. In this paper, we present new evidence by estimating the open economy effects of US fiscal policy shocks using the recently developed method of proxy - vector autoregressions (Stock and Watson 2012, Mertens and Ravn 2013) for identification. In particular, we identify exogenous tax and government spending shocks by relying on a widely used narrative measure of tax policy and military spending as instrumental variables.

We provide empirical evidence showing that exogenous fiscal shocks that increase the government budget deficit lead to a sizeable and persistent reduction in the current account. Tax reductions work mainly through higher import demand, coupled with a transitory increase in private savings and a delayed increase in private investment, a pattern that is qualitatively similar but weaker and less significant for spending shocks. Based on impulse response analysis, thus, we find that twin deficits can occur as a result of fiscal shocks either in the form of lower taxes or higher government spending. However, only the former seem to have made a substantial contribution to the public and external deficits historically.

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Appendix

A1 Estimation of impulse responses and bootstrap error bands

We first estimate by least squares the reduced form VAR in the $k \times 1$ - variable vector x_t

$$x_t = \sum_{l=1}^{n} A_l x_{t-l} + u_t$$

and compute the estimated residuals $\widehat{u}_t$ (a constant is present in estimation but is suppressed for notational convenience). From the estimated parameter matrices $\widehat{A}_l$, we compute the reduced form impulse responses $\widehat{R}_h$ by inverting the autoregressive lag polynomial, such that $\widehat{R}_h$ are the estimates of R_h in

$$x_t = \sum_{h=0}^{\infty} R_h u_{t-h}$$

with $R_0 = I$, the identity matrix.

Suppose for ease of exposition that the effects of a tax shock are to be estimated, and that the first variable in x_t is taxes τ_t, and the associated first element of the reduced form VAR residual vector is $\widehat{u}_{\tau t}$. Suppose the proxy-instrument for tax shocks is $z_{\tau t}$. We then estimate instrumental variables regressions

$$\widehat{u}_{it} = b_i \widehat{u}_{\tau t} + \eta_{it},\ i = 2, ..., k$$

where $\widehat{u}_{it}$ is the i-th VAR residual and η_{it} is an error term, using $z_{\tau t}$ as an instrumental variable for $\widehat{u}_{\tau t}$. Note that the sample size used in this IV regression step is limited by the availability of the instrument $z_{\tau t}$. The estimated parameters $\widehat{b}_i$ of these instrumental variable regressions are used to form the impact vector $\widehat{B}_1 = (1, \widehat{b}_2, ..., \widehat{b}_k)'$, which is an estimate of the first column of the matrix B that links reduced form and structural shocks through $Be_t = u_t$. The impulse responses to the structural tax shock $e_{\tau t}$ (being the first element of e_t) are then computed as $\left\{\widehat{R}_h \widehat{B}_1\right\}_{h=0}^{H}$ where H is the horizon of the responses. (To estimate the response to government spending shocks, an analogous procedure is used to estimate a second column of B).

To assess the uncertainty around these response estimates, we compute error bands in the following way.

1. Following Jentsch and Lunsford (2018), we set a block length of $\mathfrak{L} = [\kappa T^{1/4}]$, where $\kappa = 5.03$ and T is the effective sample size, and draw with replacement blocks of length $\mathfrak{L}$ of adjacent residuals from $\widehat{u}_t$ to form an artificial residual sequence $\widetilde{u}_t$ of length T.

2. We use $\widetilde{u}_t$ to simulate an artificial data sample $\widetilde{x}_t$ using the point estimates $\widehat{A}_l$ and

the artificial residuals $\widetilde{u}_t$.

3. We reestimate the reduced form VAR from the artificial sample $\widetilde{x}_t$ to get estimates of the associated reduced form responses $\widetilde{R}_h$ and residuals $\widetilde{\widetilde{u}}_t$.

4. We rearrange the blocks of observations of length $\mathfrak{L}$ on the instrumental variable $\widetilde{z}_{\tau t}$ in the same way as $\widetilde{u}_t$. For this purpose, periods in which no sample values for $z_{\tau j}$ are available are replaced by zeros.

5. We estimate the IV regression of $\widetilde{\widetilde{u}}_{it}$ on $\widetilde{\widetilde{u}}_{\tau t}$, $i = 2, ..., k$, using $\widetilde{z}_{\tau t}$ as instrument, to form a bootstrap impact vector $\widetilde{B}_1$. This is used to compute the structural impulse response in the artificial sample $\left\{\widetilde{R}_h \widetilde{B}_1\right\}_{h=0}^{H}$.

This procedure is repeated 10,000 times, after which we estimate the width of 68% and 90% confidence intervals by discarding in a pointwise way the largest and the lowest 16% or 5% of the bootstrapped impulse responses $\left\{\widetilde{R}_h \widetilde{B}_1\right\}_{h=0}^{H}$. As an alternative, we experimented with resampling $\widetilde{u}_t$ not by rearranging moving blocks but using an *i.i.d.* bootstrap (i.e. using a block length $\mathfrak{L} = 1$); we found the results very similar in both cases.

A2 Data

Variable	Source/Construction	FRED ID
(1) Real government spending	FRED	GCEC1
(2) Population	FRED	CNP16OV
(3) Real government spending per head	(1)/(2)	
(4) Federal government total receipts	FRED	W018RC1Q027SBEA
(5) Contributions for government social insurance	FRED	W780RC1Q027SBEA
(6) Corporate income taxes from Rederal Reserve Banks	FRED	B677RC1Q027SBEA
(7) GDP implicit price deflator	FRED	GDPCTPI
(8) Real taxes per head	((4)+(5)-(6)) / (7) / (2)	
(9) Real GDP	FRED	GDPC1
(10) Real GDP per head	(9) / (2)	
(11) Federal government total expenditures	FRED	W019RCQ027SBEA
(12) Nominal GDP	FRED	GDP
(13) Fiscal deficit	((11)-(4))/(12)	
(14) Current account balance	FRED	NETFI
(15) Current account balance as fraction of GDP	(14)/(12)	
(16) Federal Funds Rate	FRED	FEDFUNDS
(17) Real military spending	FRED	B824RA3Q086SBEA
(18) Real military spending per head	(17)/ (2)	
(19) Narrative tax shocks	Romer and Romer (2010)	
(20) Net exports as fraction of GDP	FRED	A019RE1Q156NBEA
(21) Real exports	FRED	EXPGSC1
(22) Real exports per head	(21) / (2)	
(23) Real imports	FRED	IMPGSC1
(24) Real imports per head	(23)/(2)	
(25) Gross private savings	FRED	GPSAVE
(26) Real gross private savings per head	(25) / (7) / (2)	
(27) Fixed private investment	FRED	FPI
(28) Fixed investment implicit price deflator	FRED	A008RD3Q086SBEA
(29) Real private investment per head	(27) / (28) / (2)	
(30) Implicit tax rate	Leeper et al. (2012)	
(31) Unanticipated narrative tax shocks	Mertens and Ravn (2011)	
(32) Defense spending news	Ramey and Zubairy (2018)	
(33) Forecast government spending	1966-2008: Auerbach and Gorodnichenko (2012) 2009-2017: Survey of Professional Forecasters	
(34) Forecast error government spending	1966-2008: Auerbach and Gorodnichenko (2012) 2009-2017: Survey of Professional Forecasters	

Variable	Source/Construction	FRED ID
(35) Narrative corporate income tax shocks	Mertens and Ravn (2013)	
(36) Narrative personal income tax shocks	Mertens and Ravn (2013)	
(37) Personal current tax receipts	FRED	A074RC1Q027SBEA
(38) Contributions for government social insurance	FRED	W780RC1Q027SBEA
(39) Real personal income taxes per head	((37)+(38)) / (7) / (2)	
(40) Taxes on corporate income	FRED	B075RC1Q027SBEA
(41) Real corporate income taxes per head	((40)-(6)) / (7) / (2)	
(42) Government consumption expenditures	FRED	A955RC1Q027SBEA
(43) Government spending price deflator	FRED	A822RD3Q086SBEA
(44) Real government consumption expenditures per head	(42) / (43) / (2)	
(45) Government investment expenditures	FRED	A782RC1Q027SBEA
(46) Real government investment expenditures per head	(45) / (43) / (2)	

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