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DISCUSSION PAPER SERIES

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ABSTRACT

Macroeconomic Effects of the Anticipation and Implementation of Tax Changes in Germany: Evidence from a Narrative Account

This paper quantifies the dynamic macroeconomic effects of tax changes in Germany, allowing for anticipation effects of preannounced tax reforms. Identification is achieved using a narrative approach, which provides information about the timing of tax reforms. An anticipated cut in taxes has a positive effect on output with a peak multiplier of 1.7, observed not until nine quarters after implementation. This positive effect is accompanied by significant negative anticipation effects on output, consumption, investment, hours worked, and wages. Our results suggest that policy makers should take anticipa- tion effects into account when implementing fiscal policy measures.

JEL Classification: H20, H30, E32, E62
Keywords: fiscal policy, tax policy, anticipation effects

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Introduction

The nature of the legislative process of fiscal policy creates lags between the time when economic agents receive news about future policy changes and the date at which these policy changes come into effect. Forward-looking agents react to announcements by adjusting their behaviour before the policy measures are implemented (Hall, 1971; Auerbach, 1989; House and Shapiro, 2006; Leeper et al., 2013), a phenomenon referred to as fiscal foresight. Thus, analysing the macroeconomic effects of tax changes requires taking into account announcement effects (Yang, 2005).

The sluggishness of the policy-making process is a reason why monetary policy might be considered preferable to fiscal policy for stabilization purposes. However, in times of very low interest rates, the zero bound becomes binding and arguably makes monetary policy less effective (see, e.g., Woodford, 2012). This has led to an increased interest in the effectiveness of unconventional tax policies in recent times. Such policy uses distortionary taxes to replicate the effects of negative nominal interest rates (Feldstein, 2002; Hall, 2011; Correia et al., 2013). These policy measures rely on forward-looking agents and impact the prices that matter for intertemporal decisions. Therefore, fiscal policy can, in principle, use anticipation effects to its advantage. On the other hand, if anticipation effects are not taken into account by policy makers, negative anticipation effects of fiscal policies originally intended to be expansionary might even prolong an economic downturn (House and Shapiro, 2006; Mertens and Ravn, 2012).

Despite the theoretical relevance of fiscal foresight, there is limited empirical evidence on the macroeconomic anticipation effects of tax policy changes. In this paper, we allow for anticipation effects and estimate the dynamic macroeconomic effects of tax shocks in Germany. We use a sample covering the years 1970 to 2017 and take into account the dates of announcements and realizations of changes to tax laws in a VAR model as in Mertens and Ravn (2012). Fiscal policy is generally endogenous to the business cycle. The reason is that policy measures are often implemented with the aim to stabilize the economy. In the spirit of Romer and Romer (2010), we employ a narrative approach to identify exogenous tax shocks. This approach uses explicit information on the motivation of tax law changes and thus assumes that exogenous tax shocks are directly observable, see Section 1. We use a historical account of legislated tax changes that contains draft, announcement, and implementation dates as well as the motivation and magnitude of all relevant tax changes in Germany in the sample period. It was constructed by Hayo and Uhl (2014) and extended by Christofzik and Elstner (2021) for the period 2010 to 2017 and allows us to construct quarterly time series.

In the empirical fiscal policy literature, so far, the focus has been mainly on implications of anticipated government spending shocks (e.g., Ramey, 2011; Forni and Gambetti, 2016; Ben Zeev and Pappa, 2017). There are some studies on consumer responses to preannounced changes in social security or income tax (Parker, 1999; Souleles, 1999, 2002; Heim, 2007). These papers do not find strong anticipation effects. In contrast, papers that study anticipation effects to changes in consumption tax rates on households' consumption behavior (D'Acunto et al., 2017, 2018; Crossley et al., 2014) find that the announcement of consumption tax increases leads to sizable increases in goods purchases.

House and Shapiro (2006) construct a dynamic general equilibrium model to assess the impact of time lags in the implementation of income tax reductions. They show that the time lag depresses output and demonstrate how the slow phase-in of tax changes contributed to the sluggish recovery in the United States (US) after 2001. Mertens and Ravn (2012) use the Romer and Romer (2010) data set of narratively identified tax changes in the US and construct a VAR that allows for accounting for anticipation effects of tax changes. They find that anticipated decreases in tax liabilities have a negative impact on output in the years between announcement and implementation and a positive effect afterwards, demonstrating the importance of accounting for anticipation effects. Alesina et al. (2015) use the narrative approach to study the aggregate effects of fiscal consolidation plans for 17 countries including Germany in a set-up that allows for anticipation effects. In contrast to our paper, they pool fiscal adjustment plans from different countries in order to obtain sufficient observations. They find that the effects of tax shifts can partially be offset by anticipation of tax shifts in the opposite direction.

The main contribution of this paper is to demonstrate the relevance of fiscal foresight for the case of Germany, verifying that the main results by Mertens and Ravn (2012) obtained for the US also hold for this country. To our knowledge, this is the first paper to do so. Thereby, we add to the small literature that provides direct evidence on the macroeconomic anticipation effects of tax changes. Germany is an interesting case as it is the largest European economy, it is part of a currency area—and thus does not have its own monetary policy—and has close trade ties with many other countries which can create spillovers. Compared to the US, the strong manufacturing sector might cause different transmission effects. Additionally, we show that implementation lags of tax changes differ between the two countries.

We allow for anticipation effects by distinguishing between anticipated and unanticipated tax changes and including both lags and leads of anticipated tax changes in our VAR model. Anticipation effects are based on the official announcement date of tax reforms as in Mertens and Ravn (2012) and—in a robustness test—on the date of the draft.

Taking into account anticipation effects can affect the estimate of the tax multiplier. Consequently, we also contribute to the literature on the magnitude of the tax multiplier in Germany.[1] There is no consensus on its size in the literature. Using the narrative approach, but without accounting for anticipation effects, Hayo and Uhl (2014) find a tax multiplier of 2.4, which is in line with estimates using the narrative approach for the US. Other studies apply an SVAR approach in the spirit of Blanchard and Perotti (2002) to Germany and generally find rather small tax multipliers, in some cases even unexpected signs (Perotti, 2005; Tenhofen et al., 2010; Hollmayr and Kuckuck, 2018). Gechert et al. (2017) show that estimates between these two approaches are not necessarily comparable, while Gechert et al. (2020) provide additional evidence for the impact of social security shocks.

We find that a cut in taxes has a positive effect on output. For an anticipated tax shock, we estimate a peak tax multiplier of 1.7 nine quarters after implementation. However, this positive effect is accompanied by significant negative anticipation effects on output, consumption, investment, hours worked, and wages. A substantial positive impact is observed not until several quarters after implementation. In line with Mertens and Ravn (2012), the largest negative anticipation effects are on investment.

The paper is structured as follows. Section 1 describes the data set and our measure for legislated tax changes in Germany. We categorize these changes as unanticipated and anticipated based on their timing. Then we present the empirical specification. Section 2 reports our main results. We provide a number of robustness checks in Section 3. Section 4 concludes.

1 Empirical Strategy

Measuring Tax Policy Changes

To study the effects of tax reforms on output prior to their implementation, we first need to identify discretionary tax changes that are unrelated to other factors influencing output in the near term. This serves to disentangle the effects of tax changes from underlying factors. Second, we need detailed information on the timing of tax reforms. For both steps, we resort to the narrative approach, which was introduced by Romer and Romer (2010).

Romer and Romer (2009) identify the motivation for all major post-war tax law changes in the US. Using these data, Romer and Romer (2010) estimate the impact of exogenous tax changes on real output in the US and find that tax increases have a substantial negative impact on GDP with a considerable delay after implementation; the strongest effect is observed after two and a half years. Cloyne (2013) applies the narrative approach to the UK and Guajardo et al. (2014) construct a multi-country data set of deficit driven fiscal policy changes and estimate their impact on output.

We use information from the legislative process to identify exogenous tax changes and important dates in this process. We rely on the historical account of legislated tax changes by Uhl (2013) and Hayo and Uhl (2014), which was extended by Christofzik and Elstner (2021) for the period 2010 to 2017. The series of tax changes is based on official government documents, in particular annual budget reports of the German Federal Ministry of Finance and draft bills.[2] The data set includes estimations by the government of the impact of these tax changes on tax revenues. These estimations may vary between the draft, announcement, and implementation date. In our baseline specification, we use the estimations at implementation date.

Based on the underlying motive of the tax legislation, the tax changes are classified as either endogenous or exogenous.[3] In our analysis, we solely use tax changes identified as exogenous. These are either tax changes that are implemented in order to consolidate the budget or measures that aim at increasing long-run growth by improving structural conditions via promoting investment or consumption. The condition that the tax changes are exogenous allows us to use them in a straightforward way as exogenous regressors in our empirical application. Our data set contains 1,353 exogenous tax measures.

The data set based on the narrative approach also provides detailed information about the timing of the legislative process. Three key dates in the legislative process can be discerned: the date at which the draft bill is introduced to be debated in the federal parliament, the announcement date, and the implementation date of the law.

The different dates are each associated with an expected revenue impact of the reform estimated by the government. This allows us to construct quarterly time series of tax changes at each of the three stages, see also Christofzik and Elstner (2021). In case a tax change is temporary, the measure is offset in the data set by constructing an equal size change with the opposite sign at the expiration date. We construct a quarterly time series of exogenous tax changes for Germany between 1970 and 2017 by adding up the expected revenue effects of all tax policy measures $\tau_{i,t}$ assigned to a specific quarter so that a tax change at time t is defined as

$$\tau_t = \sum_{i=1}^{N_t} \tau_{i,t}, \tag{1}$$

where i denotes a single policy measure, and N_t is the number of tax measures in period t. In our baseline estimations, we use the annual revenue impact of the tax measures after they are fully implemented divided by nominal GDP as estimated by the government in the last step of the legislative process.[4] By aggregating the 1,353

Table 1: Descriptive statistics of exogenous tax changes

	All	Categorization based on draft date		Categorization based on announcement date	
		unanticipated	anticipated	unanticipated	anticipated
Tax policy measures					
Observations	1353	58	1295	740	613
Mean (% of GDP)	-0.004	-0.009	-0.003	-0.002	-0.006
Maximum (% of GDP)	0.835	0.102	0.835	0.835	0.822
Minimum (% of GDP)	-1.054	-0.182	-1.054	-1.054	-0.751
Standard Deviation	0.076	0.070	0.082	0.070	0.082
Non-zero quarters					
Observations	84	10	78	44	60
Mean (% of GDP)	-0.051	-0.050	-0.048	-0.026	-0.052
Maximum (% of GDP)	0.887	0.163	0.887	0.690	0.887
Minimum (% of GDP)	-1.269	-0.252	-1.269	-0.692	-1.269
Standard Deviation	0.207	0.034	0.205	0.103	0.179

Notes: Anticipated tax changes are those exogenous tax changes for which the time between draft, respectively announcement, and implementation exceeds 90 days. Unanticipated tax changes are characterized by an implementation lag shorter than or equal to 90 days. The descriptive statistics refer to the estimated annual revenue impact of legislated tax measures after they are fully implemented as estimated by the government in the last step of the legislative process, expressed in percent of nominal GDP. Tax policy measures comprise distinct legislative tax changes implemented between 1970 and 2017 in Germany. Non-zero quarters denote those quarters of the quarterly series of tax changes in which at least one tax policy measure has been implemented. Own calculations.

exogenous tax measures of our data set, we end up with 84 out of 192 quarters (44 percent) in which exogenous tax changes were implemented in Germany between 1970 and 2017, see Table 1.

The regulations of the legislative process in Germany allow for a precise identification of draft, announcement, and implementation dates. Therefore, we follow a timing-based approach to distinguish between anticipated and unanticipated tax changes. For the case of the US, Mertens and Ravn (2012) and Poterba (1988) define the anticipation horizon of a legislated tax change as the time between the announcement date, at which the US president signs the law, and the implementation date. In our baseline estimation, we adopt this procedure.[5]

On average, this process takes more than eight months (259 days), while the median is 73 days. Given this long implementation lag, it is reasonable to say that economic agents are able to anticipate tax changes and adjust their behavior accordingly.

The upper panel of Table 1 presents summary statistics of the tax measures. Following Mertens and Ravn (2012), we classify a tax change as anticipated if the time period between announcement (or draft) and implementation exceeds 90 days. Based on the anticipation horizon between announcement and implementation, more than half of the tax changes are categorized as unanticipated. When considering the anticipation horizon between draft and implementation, we identify only 58 unanticipated tax measures in Germany between 1970 and 2017, while 1,295 are anticipated. Note that the impact of policy changes in all cases refers to the estimated impact at implementation. For instance, the difference in the mean impact of unanticipated tax changes based on the draft date (-0.009) and unanticipated tax changes based on the announcement date (-0.002) is entirely due to the different samples. In some cases, a tax change is announced later than the implementation date. We categorize these retroactive measures as unanticipated.[6]

The lower panel of Table 1 shows summary statistics for quarters in which at least one tax measure (of the specific column type) was implemented. Note that in contrast to the upper panel, the number of total observations does not equal the sum of observations of quarters with at least one unanticipated or at least one anticipated tax measure. The reason is that in some quarters, both anticipated and unanticipated tax measures were implemented. In many cases, several tax measures are implemented within the same quarter. As a result, the standard deviation of the total change in tax revenue relative to GDP in non-zero quarters (0.21) is more than twice as large as the standard deviation of tax revenue changes per tax policy measure (0.08).

Table 2 summarizes characteristics of anticipation horizons of the two series of anticipated tax shocks, in one case defined based on the lag between draft and imple-

Table 2: Anticipation horizons of anticipated exogenous tax changes in Germany in quarters

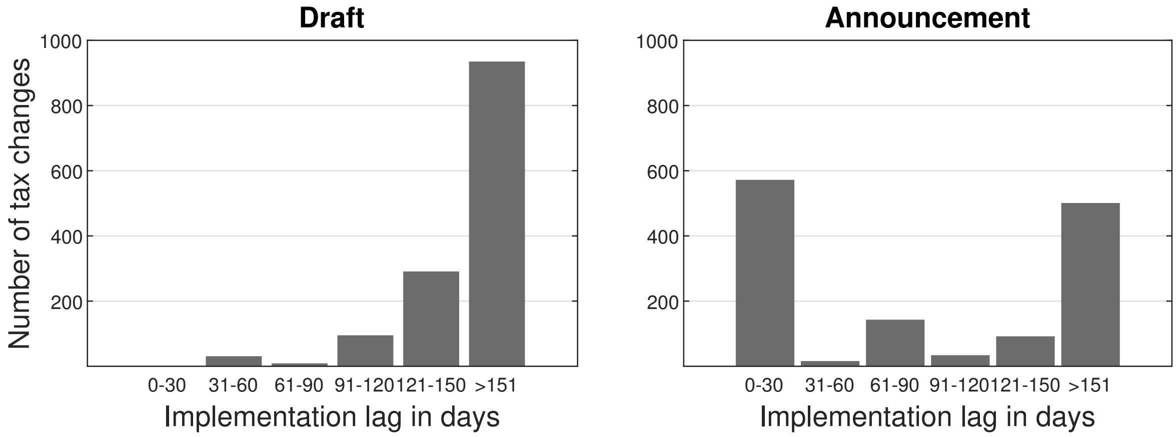
	Draft	**Announcement**
Median	3	2
Mean	4.6	4.9
Minimum	1	1
Maximum	31	30
Standard Deviation	4.96	5.70

Notes: The table shows anticipation horizons for those exogenous tax changes which we classify as anticipated, i.e., tax changes with an implementation lag between draft, respectively announcement, and implementation of more than 90 days. The anticipation horizon is expressed as the number of quarters between draft and implementation and between announcement and implementation, respectively. Own calculations.

mentation and in the other case defined based on the lag between announcement and implementation. Note that the two samples are not identical. The number of anticipated tax changes according to the draft date (1,295 observations) is substantially larger than the number of anticipated tax changes based on the announcement date (613 observations), see Table 1. The median of the implementation lag equals three quarters based on the draft date and two quarters based on the announcement date. Thus, the anticipation horizon is considerably smaller than in the US—Mertens and Ravn (2012) report a median anticipation lag of six quarters based on an anticipation horizon between announcement and implementation. The largest implementation lags observed in Germany amount to 30 quarters based on the announcement date and 31 based on the draft date, i.e., more than seven years. Allowing for anticipation horizons of such length would lead to a high number of parameters to be estimated in the analysis. Therefore, we limit the maximum anticipation horizon in the estimation equation in Section 1.

Figure 1 illustrates the distribution of the implementation lags of the identified exogenous tax changes in days. The panel on the left-hand side shows the distribution of implementation lags measured by the lag between draft date and implementation

Figure 1: Distribution of implementation lags



Notes: The figure shows the distribution of implementation lags for all exogenous tax changes in Germany, expressed in days. In the left panel, the implementation lag is the time between draft and implementation. In the right panel, the implementation lag is the time between announcement and implementation. Own calculations.

date. The majority of tax changes takes more than five months to come into effect. In the right-hand panel, the implementation lag is the period between announcement and implementation. The twin-peaked distribution of the implementation lags of German tax changes is similar to that of US tax changes reported in Mertens and Ravn (2012). Most tax changes are executed either within one month or after at least five months. However, in contrast to Mertens and Ravn (2012), we find that the majority of exogenous tax changes are implemented within 30 days after the announcement date. In the US, the largest share of tax changes is associated with an implementation lag exceeding 151 days.

Comprising those tax changes that are known at date t to be implemented at $t+i$, the quarterly series of anticipated tax changes is computed as

$$\tau^{a}_{t,i} = \sum_{j=0}^{M-i} s^{a,i+j}_{t-j}, \qquad (2)$$

where $s_{t-j}^{a,i+j}$ denotes anticipated tax measures s announced at date $t-j$ with an anticipation horizon of $i+j$, and M is the largest implementation lag in the data.[7] Thus, $\tau_{t,i}^{a}$ denotes the total tax liability change expected at date t to occur in i quarters. Figure 2 displays the time series of unanticipated and anticipated tax changes as well as the average implementation lag between announcement and implementation in quarters. Some notable spikes can be discerned. The largest unanticipated tax cut is observed in the first quarter of 2001, in which numerous measures originating from the *Tax Reduction Act* came into force. Large anticipated tax cuts occurred for instance in the first quarters of 1975 (*Income Tax Reform Act*) and 1990 (*Tax Reform Act 1990*). Larger tax increases resulted from the *Law on the Implementation of the Federal Consolidation Programme*, driven in particular by the levy of a solidarity surcharge on personal income and corporate income tax in 1995, and from the *Budget Accompanying Act 2006*, which comprised an increase of the standard value-added tax rate by three percentage points.

Empirical Specification

We incorporate the information on the timing of tax reforms to study anticipation effects empirically, following the approach taken by Mertens and Ravn (2012).

We base our analysis on the regression equation

$$X_t = Av_t + Bt + C(L)X_{t-1} + D(L)\tau_t^u + F(L)\tau_{t,0}^a + \sum_{i=1}^{K} G_i\tau_{t,i}^a + e_t, \qquad (3)$$

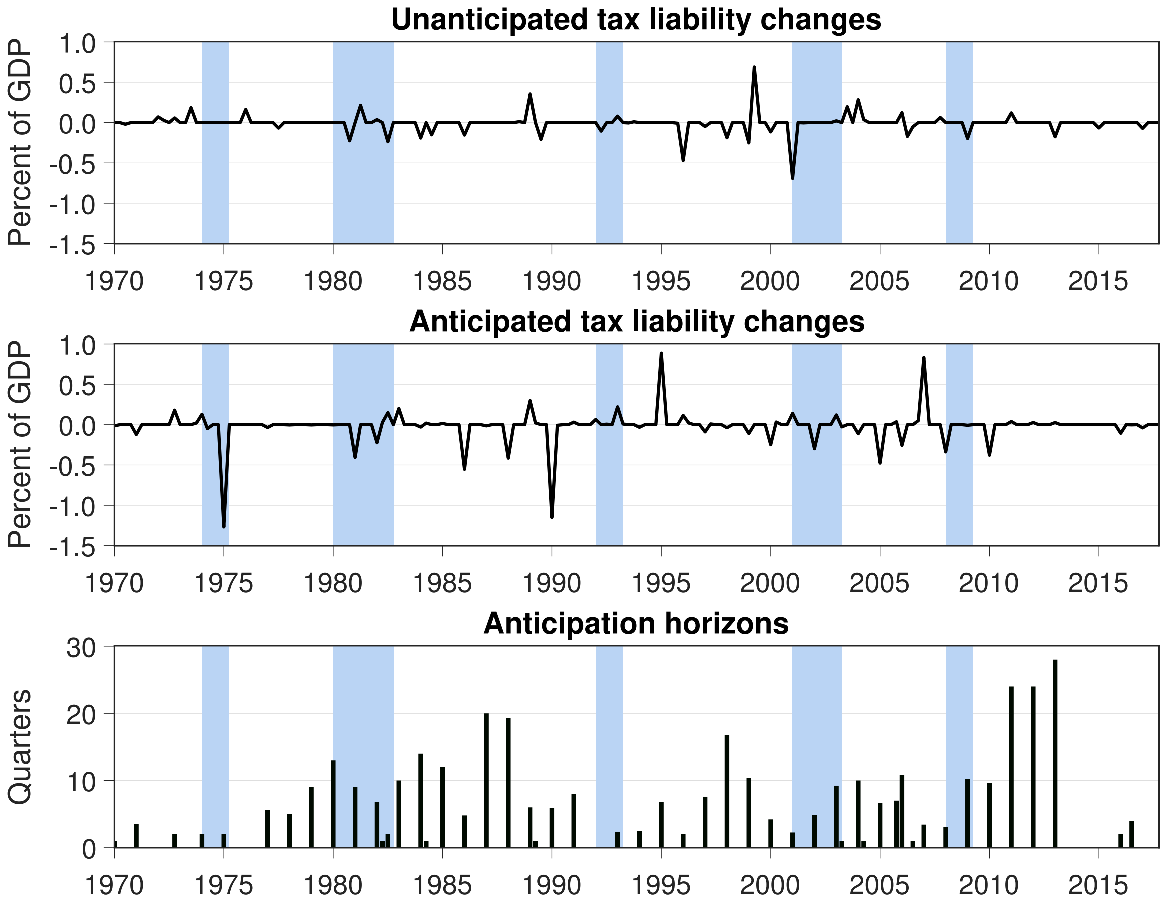
where X_t is a vector that contains the logarithms of real per capita GDP, real per capita investment, real per capita private consumption, the logarithm of hours worked per capita, and the logarithm of real wages per employee.[8] t is a linear trend, $C(L)$, $D(L)$ and $F(L)$ are lag polynomials and e_t is an i.i.d. error term.[9] To account for the financial crisis we further add a dummy variable, setting the last quarter of 2008 and the first quarter of 2009 to one. v_t contains this dummy in addition to a constant.[10]

Unanticipated tax changes are denoted by τ_t^u. We distinguish between contemporaneous tax changes that have been anticipated ($\tau_{t,0}^a$) and anticipated tax changes that will be implemented in $t+i$ ($\tau_{t,i}^a$). The construction of these tax series is explained in more detail above in Section 1. For illustrative purposes, we report and describe the narrative data for the period Q1 2006 to Q1 2007 in Online Appendix C.1. Allowing for differential coefficients for the lags of anticipated and unanticipated tax changes in the VAR model makes our results directly comparable to Mertens and Ravn (2012).

For our main specification, we set the order of the lag polynomials $D(L)$ and $F(L)$ to 12 and the number of lags of the endogenous variables, $C(L)$, to 1. As shown in Online Appendix C.8, Schwarz's Bayesian information criterion suggests that one lag is the most parsimonious model. We choose a maximum anticipation horizon of $K=6$. In Section 3, we show that the results are robust to varying these parameters.[11]

In practice, $\tau_{t,i}$ cannot be interpreted as actual changes in taxes because the forecasted revenue effects of tax law changes reported in the drafts and bills contain forecast errors. Assuming classical measurement error, this leads to a bias of the associated coefficients towards zero. In principle, an alternative approach would be to use our measures of tax shocks as instruments for the total change in the actual tax revenue, see Mertens and Ravn (2013), who formulate this approach as a proxy VAR. However, accounting for fiscal foresight is more straightforward in our set-up. Furthermore, the proxy VAR approach might be susceptible to weak instruments (see Hebous and Zimmermann, 2018). Moreover, the coefficient associated with the forecasted impact of tax changes on tax revenue instead of the impact of actual tax changes might be the more relevant policy parameter as policy makers can only use the former. It should also be relevant for individuals when anticipating tax changes.

Figure 2: Unanticipated and anticipated tax changes based on the announcement date



Notes: The first two panels show unanticipated and anticipated legislative tax changes in Germany between 1970 and 2017. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Unanticipated tax changes are characterized by an implementation lag shorter than or equal to 90 days. The bars in the bottom panel denote the average anticipation horizon in quarters for the anticipated tax changes. Shaded regions denote recessions as dated by the German Council of Economic Experts (2017): 1974Q1-1975Q2, 1980Q1-1982Q4, 1992Q1-1993Q2, 2001Q1-2003Q2, and 2008Q1-2009Q2.

2 Empirical Results

Baseline Results

Figure 3 reports our benchmark results. It shows the responses to a one percent decrease in tax revenue relative to GDP, based on the model specified in Equation (3). The left-hand side panels show responses for surprise tax cuts and the right-hand side panels show responses for anticipated tax cuts. The anticipation horizon is defined with respect to the announcement date of reforms. Throughout the paper, error bands are constructed by a residual-based bootstrap procedure as applied, e.g., by Mertens and Ravn (2012) with 10,000 replications. The left-hand side panel in Figure 3 reports that surprise tax cuts induce a gradual increase in output. Peak effects occur six quarters after the tax cut and imply a peak multiplier of 2.2.[12] Consumption increases immediately at the implementation, while there are no clear reactions of investments and hours. Wages increase slightly starting five quarters after the implementation.

The right-hand side panel of Figure 3 shows that anticipated tax cuts are associated with a significant decline in output before the implementation. These negative anticipation effects of tax cuts are not revealed when considering effects only after their implementation. Output continues to stay below its trend for some quarters after the implementation. At first glance, it might seem surprising that the impulse response function is still negative after tax cuts are realized. However, the increase in output occurs gradually. Mertens and Ravn (2011) use a DSGE model to study the channels through which anticipated tax cuts affect output. The sluggish adjustments can be explained with adjustment costs and habit formation. Our results show that output rises significantly above its trend not until two years after the implementation. This also resembles findings by Mertens and Ravn (2012) for the US. The implied peak tax multiplier of an anticipated tax cut for Germany based on the point estimate is 1.7, observed nine quarters after implementation

The other endogenous variables display the same pattern as output; they decrease prior to the implementation of the tax cut and increase afterwards. However, hours worked and real wages do not rise significantly above their trend after the implementation. We observe the largest negative anticipation effects for investment, which decreases by about five percent for several quarters. This result is remarkably similar to that obtained by Mertens and Ravn (2012) for the US. The strong response of investment is in line with the notion that capital is mobile and taxes have an impact on the rate of return to capital.

To gain more intuition about the results, consider an anticipated cut in labor income and corporate income tax rates. In our sample of 1,353 exogenous tax changes 1,195 relate to corporate or personal income taxes. An expected increase in after-tax wages in the future leads to a drop in labor supply pre-implementation due to both a wealth effect and an intertemporal substitution effect. This drop in hours reduces returns on capital, which is one reason for the drop in investments. The expectation of lower taxes in the future also motivates firms to delay the purchase of capital goods. The theoretically expected pre-implementation response of real wages is ambiguous. On its own, the shift of the labor supply curve to the left exerts upward pressure on wages. On the other hand, decreased investments pre-implementation lower the marginal product of labor, leading to a shift of the labor demand curve to the left, which exerts downward pressure on wages. Our estimated negative anticipation effect on wages suggests that the latter channel dominates in Germany. Output decreases in line with the drops in wages, investments, and hours prior to the implementation. In contrast to our finding for Germany, for the US, Mertens and Ravn (2012) observe, if anything, an *increase* in wages pre-implementation.

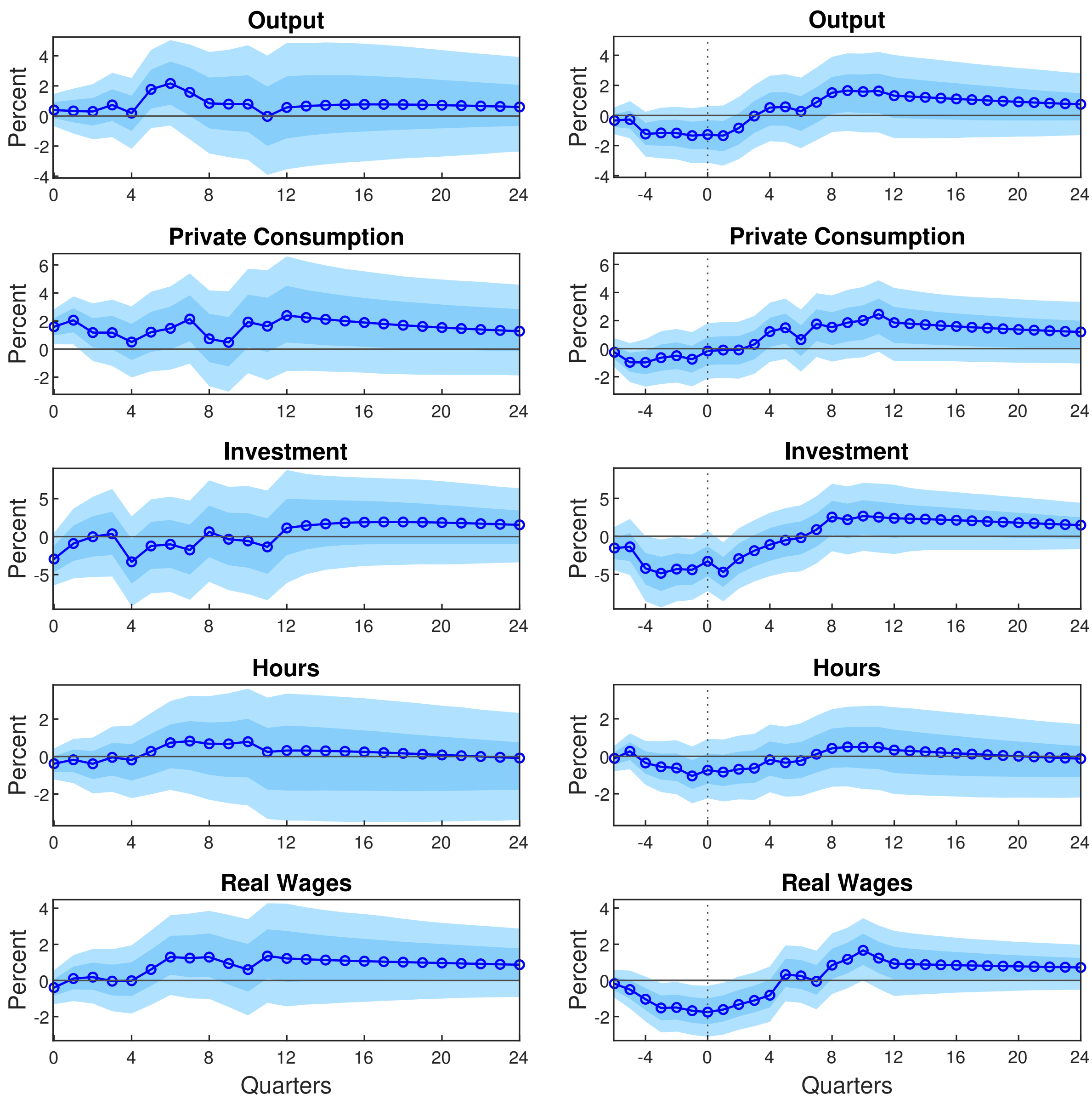
We find significant negative anticipation effects on private consumption. The theoretical expectation of the pre-implementation response of consumption to income tax cuts is ambiguous as well. On the one hand, the expected increase in permanent income should lead to an increase in consumption before implementation. On the other hand, liquidity constrained consumers reduce consumption if incomes drop due to lower returns to capital and lower wages. Moreover, if in-period utility is non-separable in consumption and leisure and the two are substitutes, a temporary drop in hours of work is accompanied by a drop in consumption. This assumption matches average life-cycle paths of consumption and leisure in micro data (Low, 2005).

We observe negative anticipation effects for hours worked, again similar to Mertens and Ravn (2012). In contrast to that paper, we find no significant positive impact on hours worked post-implementation. This result can be explained with a Marshallian labor supply elasticity close to zero, which is in line with micro evidence (see e.g. Keane, 2011). While a permanent income tax reduction has little impact on hours worked in the long run, an anticipated tax reduction provides an incentive to shift hours of work intertemporally, away from the current periods with higher taxes than in the future.

If instead of income taxes, consumption taxes (118 out of 1,353 exogenous tax changes in our sample) are cut, the theoretical expectation is that substitution effects lead to a decrease in private consumption prior to the implementation. The direct effect on labor supply, both pre- and post-implementation, is ambiguous. Due to the expected decrease in net consumer prices, one hour of work can buy more goods. This leads to a positive intratemporal substitution effect and a negative wealth effect on labor supply. Additionally, the decrease in pre-implementation demand for consumer goods is expected to lead to fewer hours worked pre-implementation.

Figure 3: The impact of a 1 percent tax cut

(a) Surprise tax cut **(b)** Anticipated tax cut



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP. The panels on the left-hand side show effects stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panels on the right-hand side depict effects stemming from an anticipated tax cut announced six quarters before implementation. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications.

Results for the Effective Tax Rate

Based on the results for the macroeconomic variables, we study how the average tax rate is affected by tax cuts. To this end, we re-estimate Equation (3) with the same parameters, including as variables the logarithms of real per capita GDP, real per capita investment, real per capita private consumption, and, in addition, the effective tax rate, defined as total tax revenue in relation to nominal GDP. The response of the effective tax rate is plotted in Figure 4.

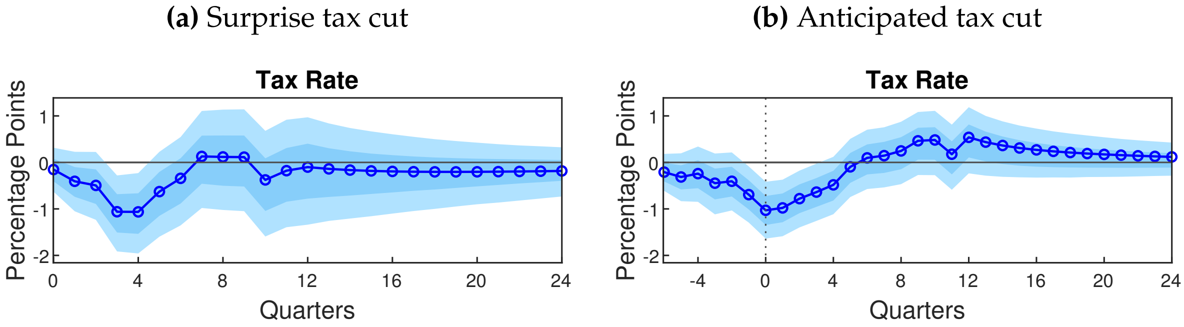
Figure 4a shows a decrease in tax revenues in percent of GDP after the implementation of a surprise tax cut. After seven quarters, the tax rate returns to its trend. Figure 4b shows that prior to an anticipated tax cut, the tax rate decreases. This might reflect that activities that are directly affected by the tax cut are postponed until implementation. For instance, households delay consumption of certain goods and increase savings when expecting a consumption tax cut. In such a case, the tax base decreases stronger than output. This would be in line with the prompt increase after implementation. Moreover, as the income tax is progressive, a decrease in real wages leads to a more than proportional decrease in tax revenues. The tax rate remains below its trend for only one year.

3 Robustness

Robustness to the Inclusion of Fiscal Policy Variables

Figure 5 reports the responses based on a VAR that includes real per capita government spending and tax revenues as additional endogenous variables. For comparison, the dashed lines show the responses based on the baseline set of variables. For output, private consumption, and investment, the post-implementation responses are

Figure 4: The impact of a 1 percent tax cut on tax revenue



Notes: The figure shows the responses of the effective tax rate (tax revenue in relation to nominal GDP) in percentage points to an exogenous tax cut corresponding to one percent of GDP. The panel on the left-hand side shows the effect stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panel on the right-hand side depicts the effect stemming from an anticipated tax cut announced six quarters before implementation. Anticipated tax changes are those exogenous tax changes for which the time between draft and implementation exceeds 90 days. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications.

slightly stronger but within the confidence bands of the baseline results. The peak multiplier of surprise tax changes is 2.4 and that of anticipated tax changes is 1.8.[13]

Anticipation Based on the Draft Date

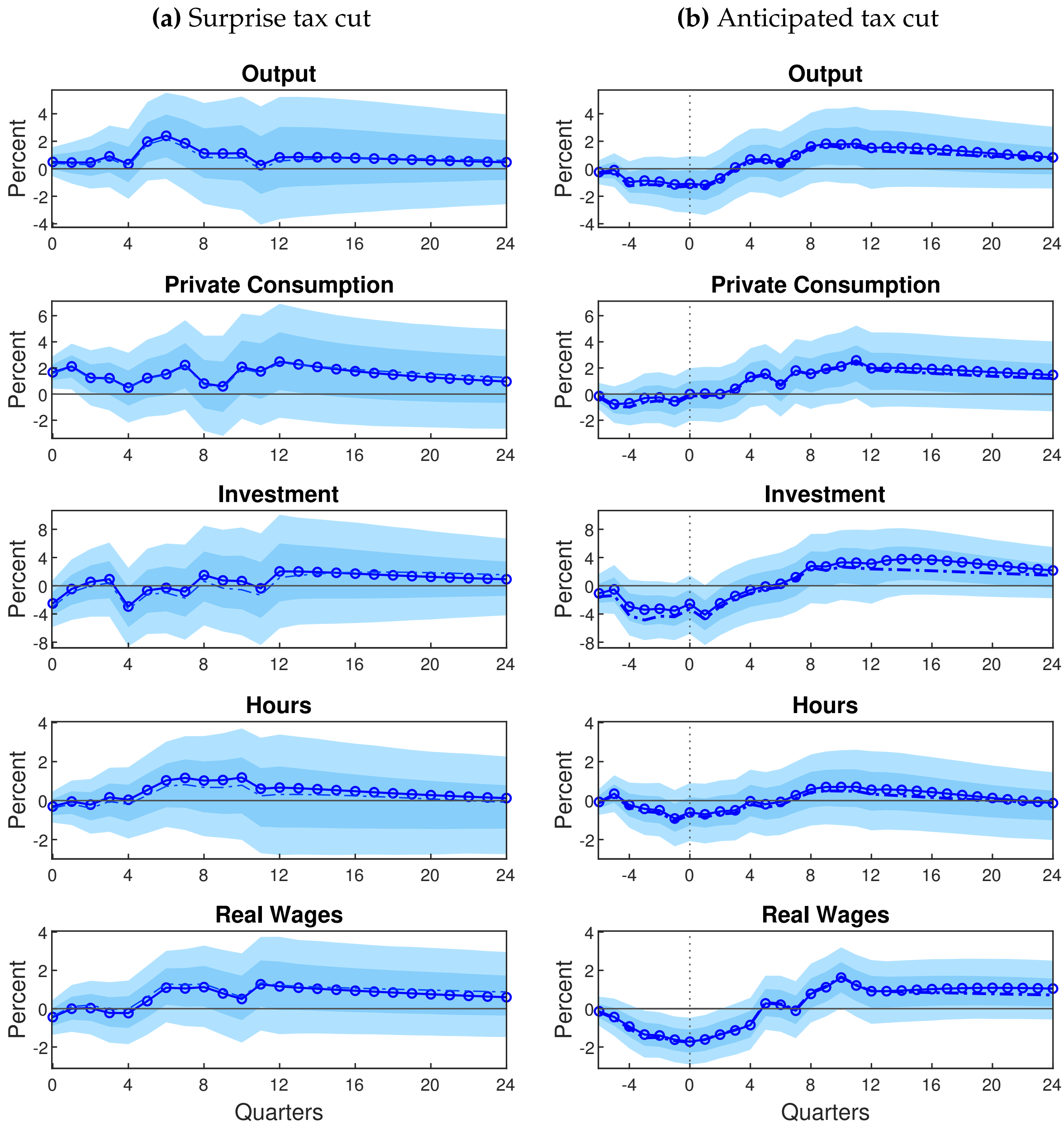
While our main results rest on anticipation horizons based on the official announcement date of tax changes, in Figure 6 the anticipation horizon is defined as the time between the date of the draft and the date of the implementation. Compared to the baseline specification presented in Figure 3b, the pre- and post-implementation responses to an anticipated tax cut are generally similar. The observed expansion in output, consumption, and investment is less pronounced. However, similar to Figure 3b, the run-up to tax cuts is characterized by a slight downturn, which seems to be driven largely by a reduction in investment. Moreover, hours worked decline significantly before implementation and return to their previous level afterwards. Wages decrease significantly pre-implementation and increase beyond their previous level afterwards.

Further Robustness Tests

Impulse response functions based on additional alternative specifications and sample restrictions are reported in the online appendix. In Online Appendix C.2 we do not allow for differential contemporaneous effects of anticipated and unanticipated tax changes, while still accounting for tax leads of the anticipated tax changes. The responses differ only marginally from those based on the main specification. In Online Appendix C.3, we evaluate the unanticipated shocks with the revenue estimates conducted at the implementation date, but use estimates published at the announcement stage in case of anticipated tax changes.[14] The impulse response functions lie within the confidence intervals of the baseline estimation. Demirel (2021), Fotiou et al. (2020), and Sims and Wolff (2018) find that the effects of tax changes depend on the state of the economy. Therefore, in Online Appendix C.4, we restrict the sample to the periods 1970-2011, when the zero lower bound was not binding. Results are virtually unchanged. Moreover, the result of negative anticipation effects is robust to controlling for periods with high inflation rates (Online Appendix C.5). Online Appendix C.6 reports the responses based on different anticipation horizons from $K = 2$ to $K = 10$. As in Mertens and Ravn (2012), longer anticipation horizons lead to more pronounced negative anticipation effects. The impact of the anticipation horizon on estimated post-implementation effects is relatively small. Online Appendix C.7 shows responses based on different lag lengths of the endogenous variables. The responses to anticipated tax cuts all lie within the 68-percent confidence interval of the baseline specification with one lag. We also show statistics for different lag selection criteria (Online Appendix C.8).

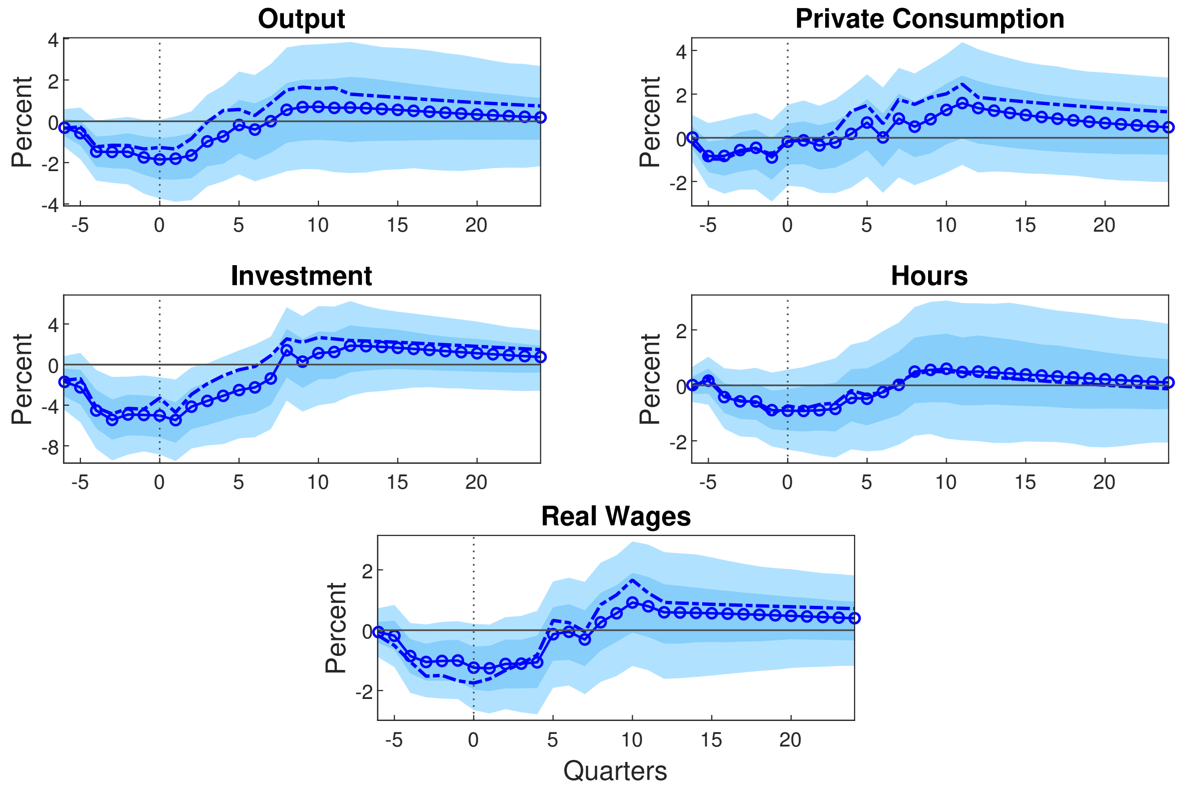
Online Appendix C.9 reports responses based on a specification that allows for different effects of tax cuts and tax increases. Anticipated tax cuts seem to drive our main results. For tax increases, we find a small, but insignificant pre-implementation expansion in output and no statistically significant post-implementation contraction. In Online Appendix C.10, we assess the relevance of the length of the implementation lag by estimating the baseline specification with modified anticipated tax change series. Here we only include anticipated tax measures that have an implementation lag between 90 and 1,838 days (95% quantile) or between 90 and 1,403 days (90% quantile). The motivation for this robustness test is that tax changes announced far in the past might only have a small impact on agents' decision making. The impulse responses to an anticipated tax cut using these series are similar to our baseline result. Finally, in Online Appendix C.11, following Mertens and Ravn (2012), Cloyne (2013), and Hayo and Uhl (2014), we test whether the exogenous tax shocks at announcement date can be predicted by past values of the endogenous variables. We cannot reject the null hypothesis that the tax changes cannot be predicted, which lends additional credibility to the claim of exogeneity.

Figure 5: The impact of a 1 percent tax cut – Specification with fiscal policy variables



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP, based on the baseline specification where the vector of endogenous variables additionally contains the log real per capita values of government spending and tax revenues. The panels on the left-hand side show effects stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panels on the right-hand side depict effects stemming from an anticipated tax cut announced six quarters before implementation. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications. Dashed lines are the point estimates of the baseline results in Figure 3.

Figure 6: The impact of an anticipated 1 percent tax cut – Anticipation based on the draft date



Notes: The figure shows the responses of macroeconomic variables
to an anticipated exogenous tax cut announced six quarters before implementation corresponding to one percent of GDP. Anticipated tax changes are those exogenous tax changes for which the time between draft and implementation exceeds 90 days. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications. Dashed lines are the point estimates of the baseline results of the left-hand side in Figure 3b.

4 Conclusions

We have estimated the macroeconomic effects of tax changes in Germany. In our baseline estimation, the implied tax multiplier of an unanticipated tax shock, i.e., the peak response of output to a tax cut corresponding to one percent of GDP relative to its trend, is 2.2. For an anticipated tax shock, the peak multiplier is 1.7. Table 3 compares our results for the peak tax multiplier with other studies for Germany. The maximum effect on GDP is in the same range as the estimates by Hayo and Uhl (2014) and larger than in the studies that follow the approach by Blanchard and Perotti (2002).

Table 3: Overview and comparison with other tax multiplier studies for Germany

	Peak Multiplier	Approach	Sample	Notes
Our results				
Baseline	2.2	narrative	1970-2017	unanticipated
	1.7	narrative	1970-2017	anticipated
	1.5	narrative	1970-2017	all[a]
Fiscal policy variables[b]	2.4	narrative	1970-2017	unanticipated
	1.8	narrative	1970-2017	anticipated
	1.8	narrative	1970-2017	all[a]
Other estimations for Germany				
Hollmayr and Kuckuck (2018)	0.6	restrictions	1993-2017	
Gechert et al. (2017)	0.5	narrative	1974-2013	
	≈ 0.6	restrictions	1974-2013	
Hayo and Uhl (2014)	2.4	narrative	1974-2010	VAR in growth rates
	1.6	narrative	1974-2010	VAR in levels
Tenhofen et al. (2010)[c]	0.4	restrictions	1974-2008	
Perotti (2005)[c]	≈ 0	restrictions	1960-1989[d]	

Notes: The table summarizes peak tax multipliers for Germany from studies that either use a narrative identification approach (*narrative*) or an approach in the spirit of Blanchard and Perotti (2002) (*restrictions*). Note that estimates between these two approaches are not necessarily comparable, see Gechert et al. (2017). [a]Specification which does not take into account anticipation effects (see Appendix B). [b]See Section 3. [c]Estimates refer to the effect of changes in net revenues. [d]Two subsamples: 1960-1974 and 1975-1989, multiplier is negative in some specifications.

However, the post-implementation effect does not tell the whole story. We estimate negative anticipation effects, observing significant contractions in output, private consumption, hours of work, and real wages prior to implementation. The increase after implementation occurs gradually. For output, it takes two years to rise significantly above its trend after a tax cut is realized.

Our findings are broadly in line with those for the US by Mertens and Ravn (2012), who find important negative anticipation effects of tax cuts on output, investment and hours of work. In contrast to that paper, we observe a pre-implementation decrease in real wages. Our results provide additional evidence for the importance of anticipation effects and can be used for model evaluations. While anticipations effects are in line with forward-looking consumers, future research, building, e.g., on Mertens and Ravn (2011), should explicitly model expectation formation and the particular goods and labor markets implied by our estimated responses. The precise policy implications depend on the results of such modelling exercises. Nonetheless, a note of caution regarding fiscal policy with substantial implementation lags is warranted. When using conventional expansionary tax policy measures such as income tax cuts, policy makers need to take into account negative anticipation effects. In case of a long implementation lag, fiscal policies originally intended to be expansionary may actually worsen an economic slump. Analogously, announcing a tax cut during an economic upturn is not necessarily pro-cyclical.

This paper presents stylized facts in the sense that tax policy measures are characterized through their effect on the average tax rate. In practice, the effect of tax law changes depends on income and substitution effects, where the latter are determined by the change in the *marginal* tax rate. Future research could analyze differential effects of different kinds of taxes. It could also aim at characterizing tax law changes more completely. Of course, the draw-back is that long time series with detailed tax law changes needed for such an endeavor are not readily available.

Acknowledgements

We thank Steffen Elstner for many valuable suggestions and discussions, and two anonymous referees, Jens Boysen-Hogrefe, Marcell Göttert, and seminar participants at RWI and the Annual Congress of the Verein für Socialpolitik in Cologne for helpful comments.

Notes

[1]Recent estimates of the tax multiplier for the US include Demirel (2021) and Fotiou et al. (2020). Ramey (2019) provides an overview of the recent literature on the fiscal multiplier.

[2]A similar data set that includes Germany in the sample was constructed by Devries et al. (2011) and extended by Alesina et al. (2020). That data set, however, presents data at an annual frequency and focuses on the implementation date only. We construct a quarterly time series based on the data set by Hayo and Uhl (2014) and Christofzik and Elstner (2021) and consider the announcement of tax changes.

[3]Explanations and motives for tax changes are primarily drawn from the budget report or government statements (Hayo and Uhl, 2014).

[4]The tax revenue estimated at the draft or announcement stage may differ from the expected revenue impact at implementation. For a robustness check, we assign the revenue estimate at the implementation date to the surprise tax changes and the revenue estimate at the announcement date to the anticipated tax changes, see Online Appendix C.3. This specification does not change our conclusions from the main section.

[5]In a robustness check, we estimate the effects based on anticipation between draft and implementation, see Section 3.

[6]For instance, on 16 July 2015, the income tax was reduced for the entire year 2015. Overall, there are 21 such retroactive tax changes in the data set. In an alternative specification (not reported), we

use the announcement date of these tax changes instead of the implementation date. The differences in the results compared to the baseline specification are negligible.

[7]It is not feasible to account for differential effects of tax changes with different anticipation horizons as this would imply a considerable loss of degree of freedom. Since the largest anticipation horizon in the data is 30 quarters, this would lead to a high number of parameters to be estimated. Therefore, we take into account tax liability changes based on their remaining anticipation horizon as in Mertens and Ravn (2012).

[8]Mertens and Ravn (2011) show that this equation can be derived as an approximation of the observables in a DSGE model that incorporates stochastic shocks to tax rates.

[9]Using a quadratic trend changes the results only marginally.

[10]We use seasonally adjusted data. Additionally including quarterly dummies has a negligible impact on the impulse response functions, which are available from the authors upon request.

[11]We estimate Equation (3) by OLS and construct impulse response functions from these estimates. Error bands are constructed using a residual-based bootstrap procedure with 10,000 replications.

[12]Table C4 in Online Appendix C.12 reports point estimates and standard errors for the multipliers in all quarters displayed in Figure 3. In that table, we also show the multipliers based on a VAR that ignores anticipation effects of tax changes and does not distinguish between anticipated and surprise tax changes as is done in most of the literature on fiscal multipliers. In Figure B1 in Appendix B, we show responses to a tax cut based on that specification. It yields a peak multiplier of 1.5, which is close to the 1.6 peak multiplier estimated in the specification in levels in Hayo and Uhl (2014), see Table 3. Online Appendix C.13 reports the difference between post-reform responses to anticipated and surprise tax cuts based on our main specification.

[13]Table C4 in the online appendix additionally reports the point estimates and standard errors for the multipliers shown in the figure as well as multipliers based on a specification including these variables, but not accounting for anticipation effects or distinguishing between anticipated and unanticipated tax shocks. The peak multiplier based on that specification is 1.8, which, again, is close to the 1.6 peak multiplier estimated in the specification in levels in Hayo and Uhl (2014).

[14]In that specification as in the baseline specification, we only use one set of estimates for the revenue impact of tax changes. Using the same data set, future research could use the different estimated impacts at the draft, announcement, and implementation stage. For instance, the difference between estimated impacts at announcement and implementation stages can be used to construct an additional set of surprise tax shocks.

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Appendix

A Data Definitions and Sources

Table A1: Macroeconomic variables: description and sources

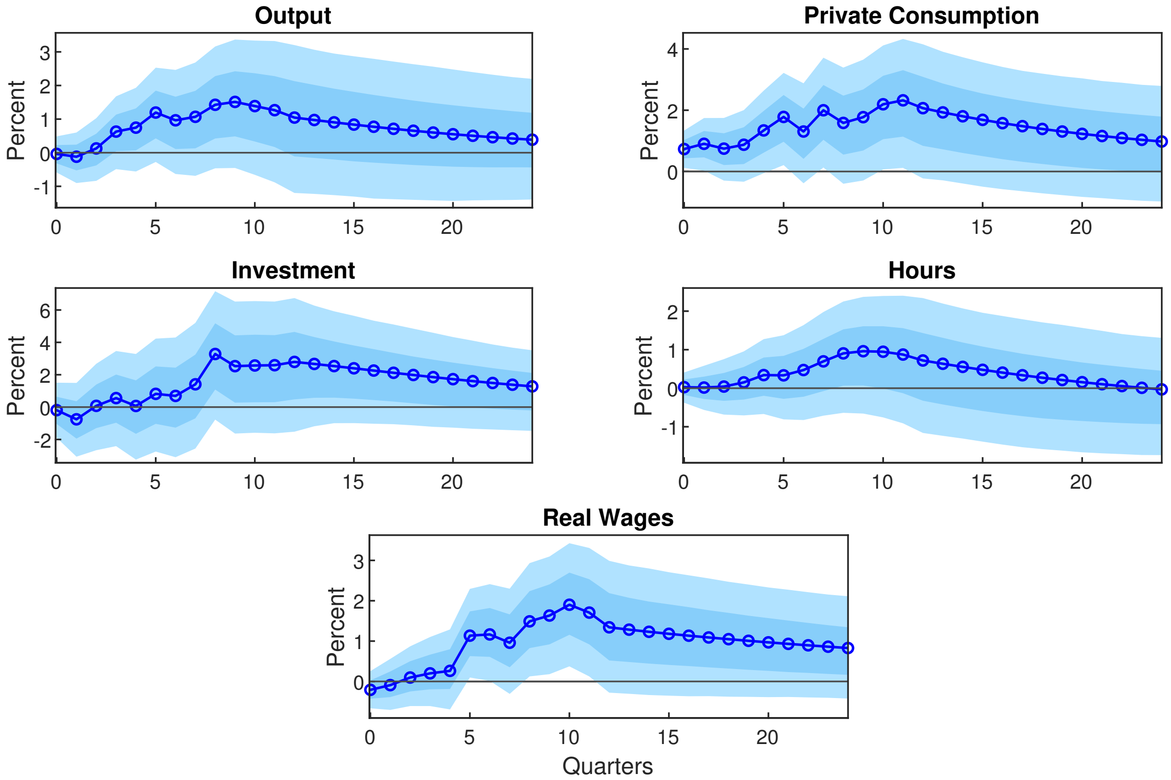
Variable	Description	Source
Gross domestic product per capita	Real gross domestic product (GDP) divided by total population; GPD data are chained volume (base year=2010); post-1991 data are extended backwards by using the growth rates of the pre-1991 data; quarterly; seasonally- and working day adjusted; period Q1 1970 to Q4 2017, Fachserie 18 Reihe 1.3 (Table 2.3.2) and Reihe S. 28 (Table 2.3.2)	DESTATIS (Federal Statistical Office)
Consumption per capita	Real private consumption divided by total population; consumption data are chained volume (base year=2010); post-1991 data are extended backwards by using the growth rates of the pre-1991 data; quarterly; seasonally- and working day adjusted; period Q1 1970 to Q4 2017, Fachserie 18 Reihe 1.3 (Table 2.3.2) and Reihe S. 28 (Table 2.3.2)	DESTATIS
Investment per capita	Gross fixed capital formation divided by total population; investment data are chained volume (base year=2010); post-1991 data are extended backwards by using the growth rates of the pre-1991 data; quarterly; seasonally- and working day adjusted; period Q1 1970 to Q4 2017, Fachserie 18 Reihe 1.3 (Table 2.3.2) and Reihe S. 28 (Table 2.3.2)	DESTATIS
Hours	Total hours worked divided by total population; post-1991 data are extended backwards by using the growth rates of the pre-1991 data; quarterly; seasonally- and working day adjusted; period Q1 1970 to Q4 1970, Fachserie 18 Reihe 1.3 (Table 2.1.8) and Reihe S. 28 (Table 2.1.7)	DESTATIS
Real wages	Total compensation divided by total employees; price adjusted by the implicit GDP deflator; post-1991 data are extended backwards by using the growth rates of the pre-1991 data; quarterly; seasonally- and working day adjusted; period Q1 1970 to Q4 1970, Fachserie 18 Reihe 1.3 (Tables 2.2.3 and 2.2.6) and Reihe S. 28 (Tables 2.2.3 and 2.2.6)	DESTATIS
Population	Population; thousand persons; quarterly; seasonally adjusted; post-1991 data (referring to reunited Germany) are extended backwards by using the growth rates of the pre-1991 data that refer to Western Germany only; Fachserie 18 Reihe 1.3 (Table 2.1.7) and Reihe S. 28 (Table 2.1.6)	DESTATIS

Notes: All series were downloaded from the cited sources in February 2019 at the most recent vintage available at that time.

B Neglecting Anticipation Effects

Figure B1 shows impulse responses to a cut of all exogenous taxes based on a specification that does not distinguish between anticipated and unanticipated tax changes and does not allow for anticipation effects prior to implementation, as is commonly done in the literature (see, e.g., Cloyne, 2013; Hayo and Uhl, 2014).

Figure B1: The impact of a 1 percent tax cut – Without anticipation effects



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP. The panels show effects for all exogenous tax shocks based on a specification that does not account for anticipation effects. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications.

Online Appendix to Macroeconomic Effects of the Anticipation and Implementation of Tax Changes in Germany: Evidence from a Narrative Account

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C Online Appendix

C.1 Example for Narrative Data

For presentation purposes, we show the values of the tax variables used in our analysis for the period Q1 2006-Q1 2007 in Table C1. The most important tax law change in this period was the increase in value-added tax rates in Q1 2007. The table reports the values for exogenous surprise tax changes and exogenous anticipated tax changes in a given quarter as well as the value of exogenous tax changes to be implemented in i quarters, with i ranging from 1 to 6. In the first quarter of 2006 (first row), some temporary tax reforms were—expectedly—phased out, by themselves reducing the tax-to-GDP ratio by 0.09 At the same time, preannounced tax reforms were implemented, which reduced the tax ratio by 0.17. Together, these account for the anticipated reduction ($\tau^a_{t,0}$) of the tax ratio by 0.26 percentage points. Surprise exogenous tax rate changes amounted to 0.12 (τ^u_t). At the same time, changes in the tax ratio expected in four quarters ($\tau^a_{t,4}$) amounted to 0.01.

Table C1: Example for narrative data

	τ^u_t	$\tau^a_{t,0}$	$\tau^a_{t,1}$	$\tau^a_{t,2}$	$\tau^a_{t,3}$	$\tau^a_{t,4}$	$\tau^a_{t,5}$	$\tau^a_{t,6}$
Q1 2006	0.12	-0.26	0.00	0.00	0.00	0.01	0.00	0.00
Q2 2006	-0.17	0.00	0.00	0.05	0.01	0.00	0.00	0.00
Q3 2006	-0.05	0.00	0.05	0.83	0.00	0.00	0.00	0.04
Q4 2006	0.00	0.05	0.83	0.00	0.00	0.00	0.04	0.00
Q1 2007	0.00	0.83	0.00	0.00	0.00	0.04	0.00	0.00

Notes: The table shows changes in tax revenues in percent of GDP. τ^u_t: exogenous unexpected tax changes; τ^a_t: exogenous expected tax changes; $\tau^a_{t,i}$ exogenous anticipated tax changes known at t to be implemented in i quarters.

In the third quarter of 2006 (third row), the plan to increase the rates of the value-added tax and the insurance premium tax (*Versicherungsteuer*) from 16 to 19 percent was announced. The *Budget Accompanying Act 2006 (Haushaltsbegleitgesetz 2006)* put these changes into law. It was motivated by the desire to consolidate the budget and is therefore classified as exogenous. In our data, ten separate measures relate to this law. The first two measures are the direct effects on revenues from the VAT and the insurance premium tax. Moreover, a blanket allowance for input tax deduction in some sectors was adjusted. Finally, the increase in tax rates had indirect effects on revenues from other taxes, decreasing revenues from the personal income tax and several corporate taxes. Overall, these measures were expected to increase Germany's tax ratio by 0.67 percentage points. In the same quarter, other reforms to be implemented in Q1 2007 were announced. Overall, the expected increase in the tax-to-GDP ratio due to exogenous preannounced tax changes was 0.83. In Q3 2006, this is the value of the variable $\tau^a_{t,2}$, in Q4 2006 of $\tau^a_{t,1}$ and in Q1 2007 of $\tau^a_{t,0}$.

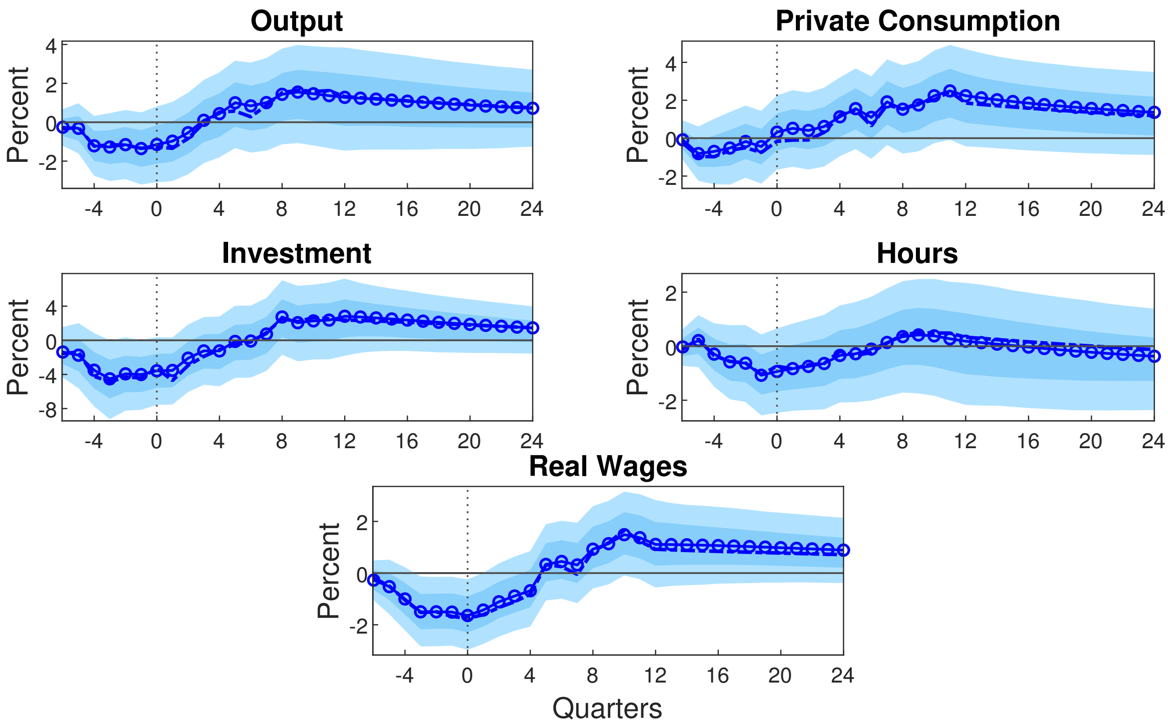
C.2 Alternative Regression Specification

In our main specifications, we adopt the methodology of Mertens and Ravn (2012). We further set up an alternative regression specification in which we summarize unanticipated and anticipated tax changes under τ_t, i.e., we do not allow for differential contemporaneous effects of the two types of tax changes, while still accounting for tax leads of anticipated tax changes τ^a_t:

$$X_t = Av_t + Bt + C(L)X_{t-1} + D(L)\tau_t + \sum_{i=1}^{K} E_i \tau^a_{t,i} + e_t. \tag{C1}$$

Figure C1 shows the responses of the macroeconomic variables based on this specification. It leads to effects that differ only marginally from the baseline results of an anticipated shock.

Figure C1: The impact of an anticipated 1 percent tax cut – Alternative specification

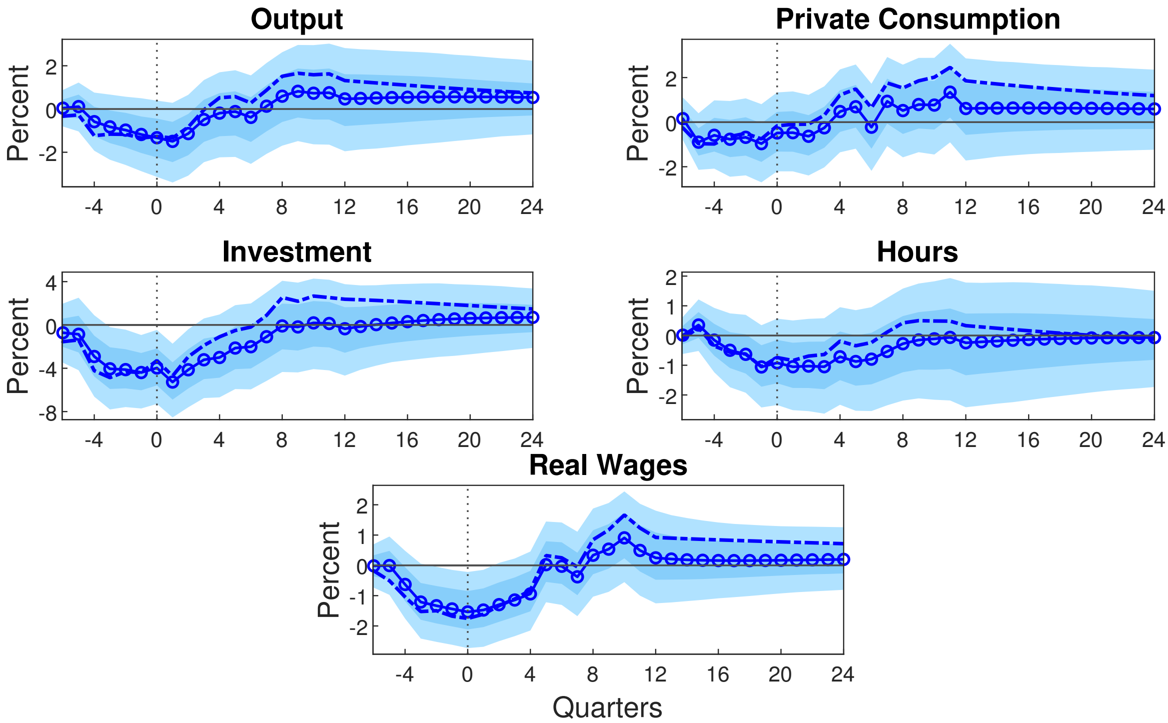


Notes: The figure shows the responses of macroeconomic variables to an exogenous anticipated tax cut announced 6 quarters before implementation corresponding to one percent of GDP, based on Equation (C1). Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications. Dashed lines are the point estimates of the baseline results in Figure 3b.

C.3 Alternative Sizes of Tax Shocks

In our baseline estimations, we use the revenue estimates made at the implementation stage of the tax change. These revenue estimates may differ from those conducted at the draft or announcement stage. Therefore, we check whether changing this assumption affects our results. In an alternative specification, we evaluate the unanticipated shocks with the revenue estimates conducted at the implementation date, but use estimates published at the announcement stage in case of anticipated tax changes. Figure C2 shows the impulse responses and compares them to our baseline results.

Figure C2: The impact of an anticipated 1 percent tax cut – Alternative tax change size

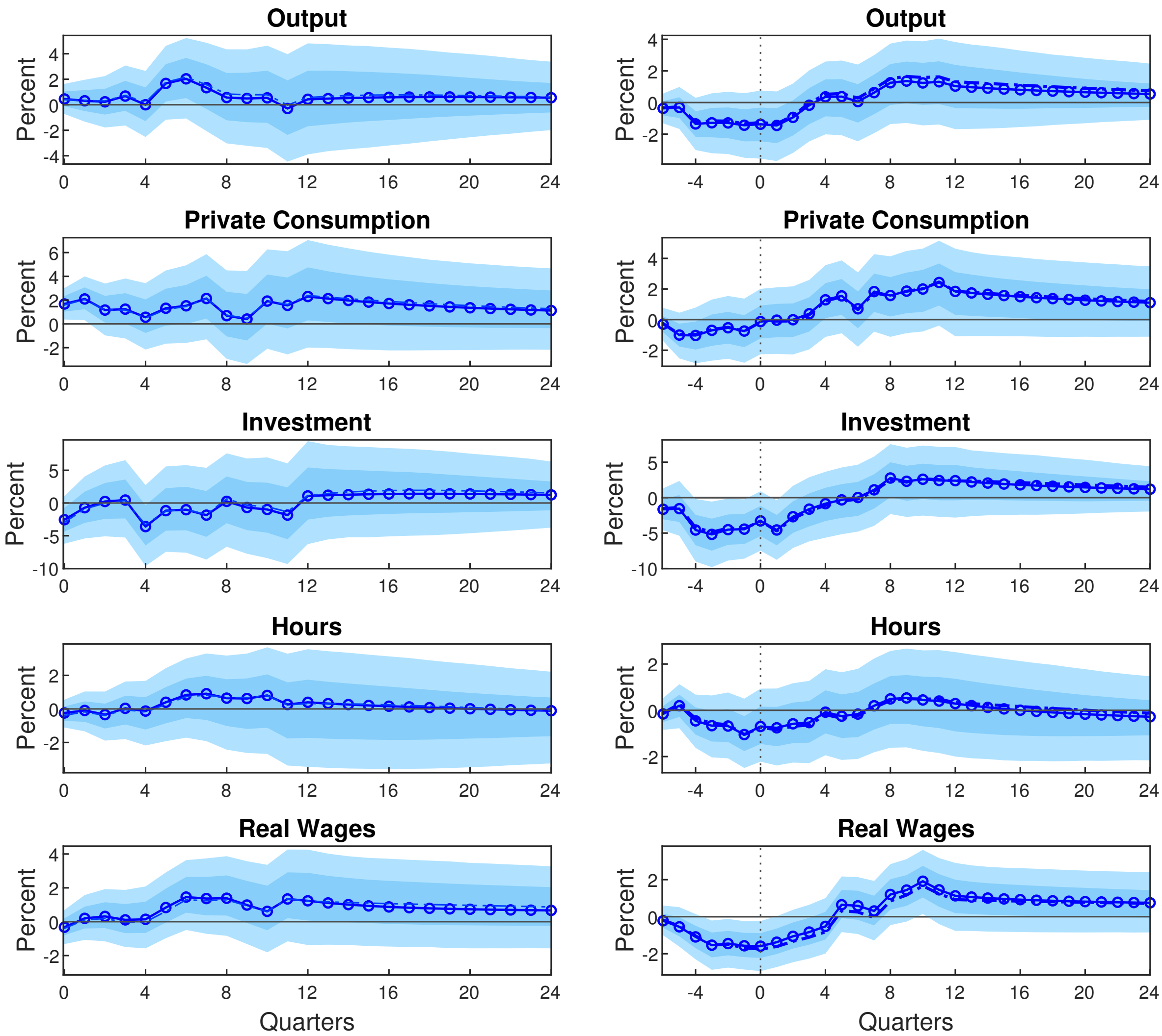


Notes: The figure shows the responses of macroeconomic variables to an exogenous anticipated tax cut announced 6 quarters before implementation corresponding to one percent of GDP. Anticipated tax changes are constructed using the estimated revenue impact at announcement. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Solid lines with circles denote point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications. Dashed lines are the point estimates of the baseline results in Figure 3b, where anticipated tax changes are constructed using estimates at implementation.

C.4 Excluding Periods with Binding Zero Lower Bound

Figure C3: The impact of a 1 percent tax cut – 1970Q1-2011Q4 Subsample

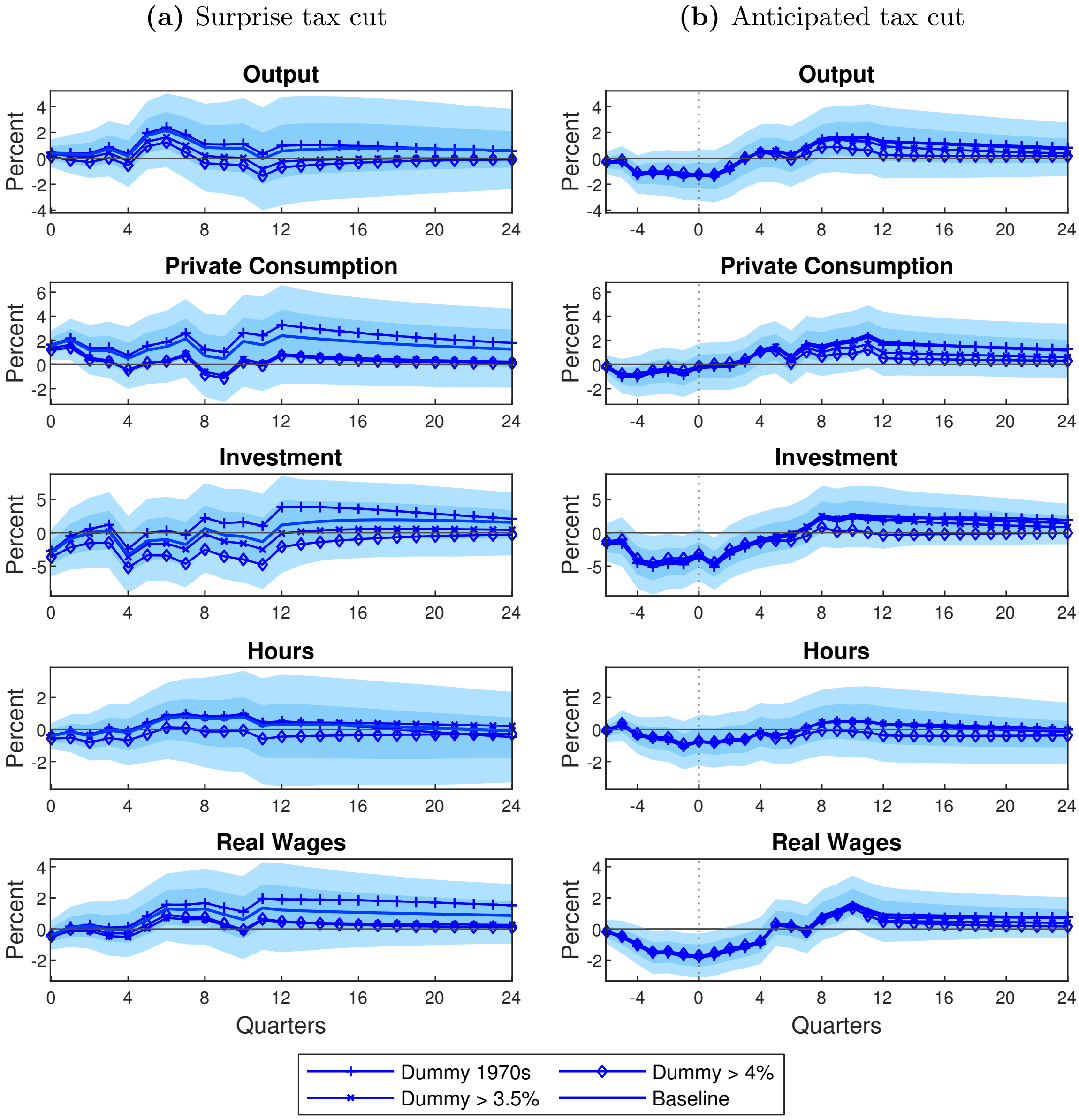
(a) Surprise tax cut **(b)** Anticipated tax cut



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP, based on the sample 1970Q1 to 2011Q4. The panels on the left-hand side show effects stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panels on the right-hand side depict effects stemming from an anticipated tax cut announced six quarters before implementation. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications. Dashed lines are the point estimates of the baseline results in Figure 3.

C.5 Controlling for High Inflation Periods

Figure C4: The impact of a 1 percent tax cut – High inflation period dummies



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP with different dummies for high inflation periods. The panels on the left-hand side show effects stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panels on the right-hand side depict effects stemming from an anticipated tax cut. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with markers represent the point estimates based on different choices for the high inflation period dummy. Lines without markes are the point estimates of the baseline results in Figure 3. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals of the baseline specification.

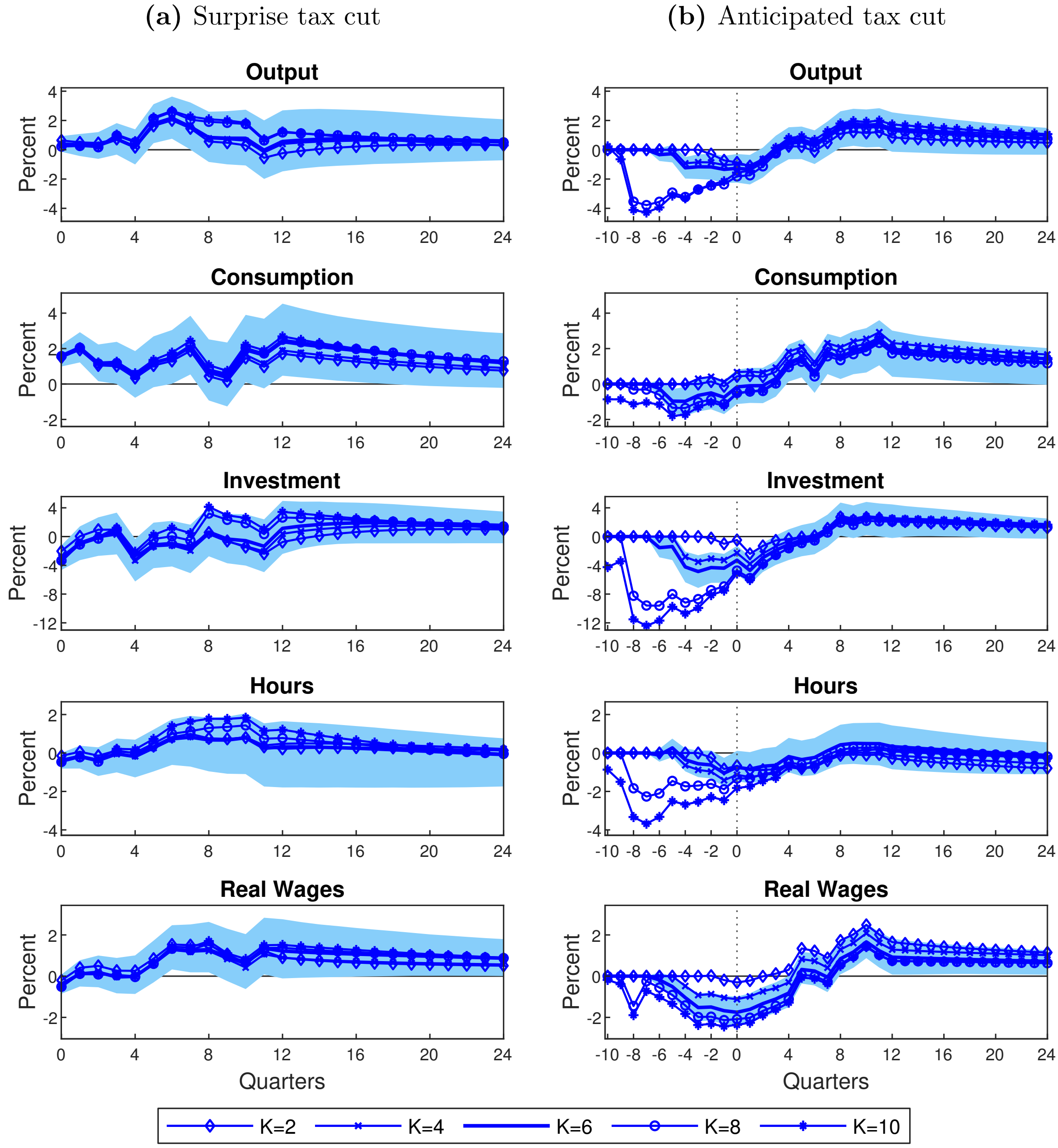
C.6 Robustness to the Length of the Anticipation Horizon

Figure C5 shows the responses to tax cuts allowing for different anticipation horizons. As expected, allowing for longer anticipation horizons leads to earlier anticipation effects. Moreover, as is the case for the US (Mertens and Ravn, 2012), the negative anticipation effect on output is more pronounced when using a horizon of eight or even ten quarters. In practice, few tax law changes have such a long implementation lag. While the assumed anticipation horizon has an impact on the timing and magnitude of anticipation effects, the post-implementation effects are almost unchanged relative to the baseline specification and do not differ statistically significantly.

C.7 Robustness to Alternative Lag Lengths

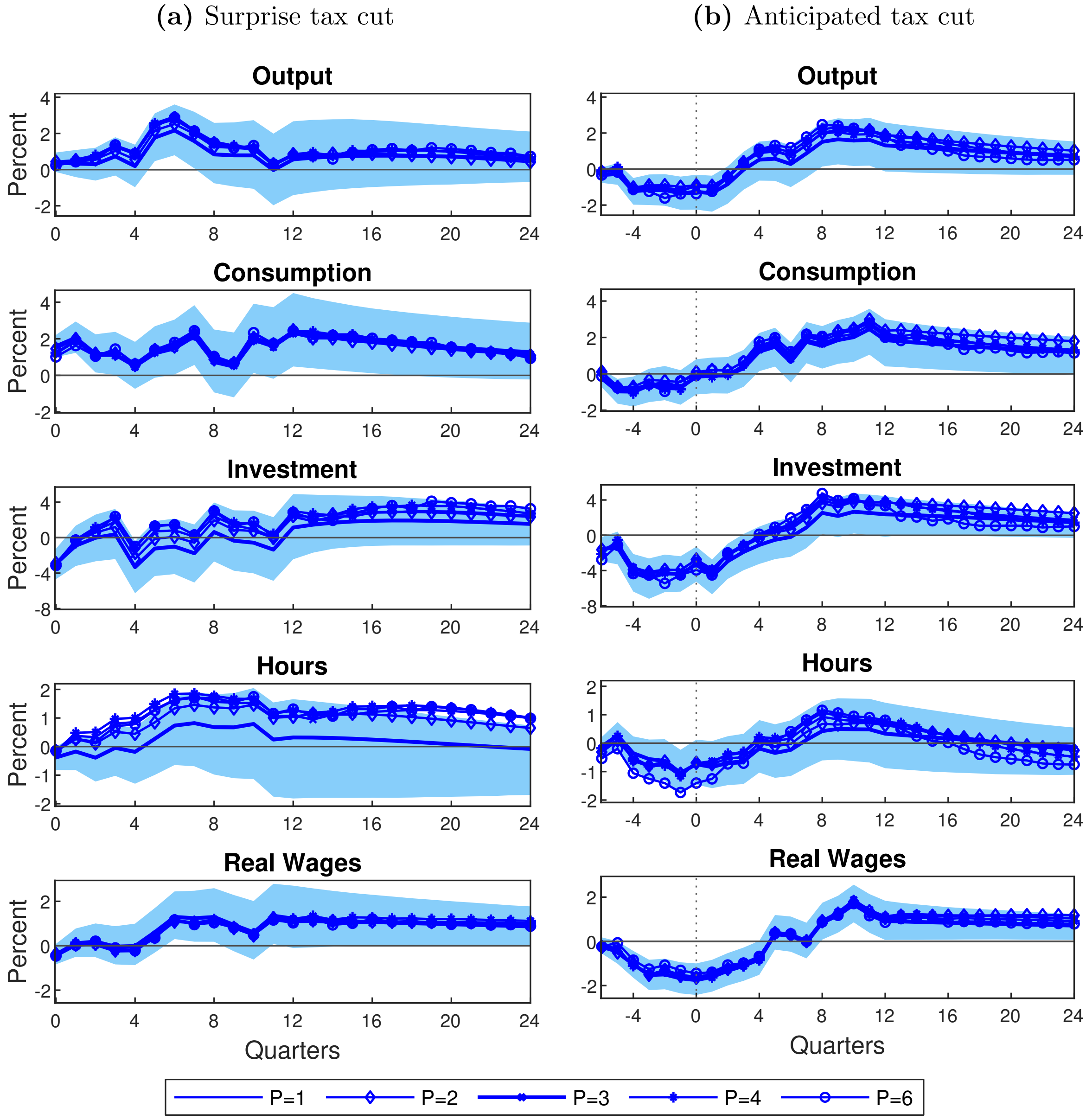
Figure C6 shows the same impulse responses as Figure 3 but with varying lag lengths of the endogenous variables. In our baseline specification, we set the lag length to 1. The responses are strikingly similar when extending the lag length and lie within the 68-percent confidence bands of the baseline specification.

Figure C5: The impact of a 1 percent tax cut – Alternative anticipation horizons



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP with different anticipation horizons. The panels on the left-hand side show effects stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panels on the right-hand side depict effects stemming from an anticipated tax cut. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with markers represent the point estimates based on different choices for anticipation horizon K. Shaded areas denote 68 percent bootstrapped confidence intervals of the baseline specification ($K = 6$).

Figure C6: The impact of a 1 percent tax cut – Alternative lags of endogenous variables



Notes: The figure shows the responses of macroeconomic variables to an exogenous tax cut corresponding to one percent of GDP based on specifications with different numbers of lags (P) of endogenous variables. The panels on the left-hand side show effects stemming from a non-anticipated tax cut. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. The panels on the right-hand side depict effects stemming from an anticipated tax cut announced 6 quarters before implementation. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with markers represent the point estimates based on different choices for the lags of endogenous variables P. Shaded areas denote 68 percent bootstrapped confidence intervals of the baseline specification ($P = 1$).

C.8 VAR Lag Selection

Table C2 reports test statistics of various lag selection tests. Schwarz's Bayesian information criterion (SBIC) suggests that the model with one lag is the most parsimonious model. In contrast, Akaike's information criterion (AIC) suggests a model with six lags.

Table C2: Lag selection criteria

lags	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	2192.33				1.3×10^{-16}	-22.4148	-21.1562	-19.3105
1	3223.27	2061.9	25	0.000	1.8×10^{-21}	-33.5919	-32.1534	-30.0441*
2	3273.41	100.28	25	0.000	1.4×10^{-21}	-33.8712	-32.253*	-29.88
3	3308.75	70.685	25	0.000	1.3×10^{-21}	-33.9861	-32.1881	-29.5515
4	3337.84	58.185	25	0.000	1.3×10^{-21}	-34.0316	-32.0537	-29.1535
5	3368.5	61.32	25	0.000	1.2×10^{-21}*	-34.0945	-31.9368	-28.7729
6	3395.01	53.011*	25	0.001	1.3×10^{-21}	-34.1112*	-31.7737	-28.3462

Notes: The table shows log likelihood (LL), likelihood ratio (LR), p-value of a likelihood ratio test (p), the final prediction error (FPE), Akaike's information criterion (AIC), Hannan and Quinn information criterion (HQIC), and Schwarz's Bayesian information criterion (SBIC) for VARs of order 1 through 6.

C.9 Asymmetric Responses

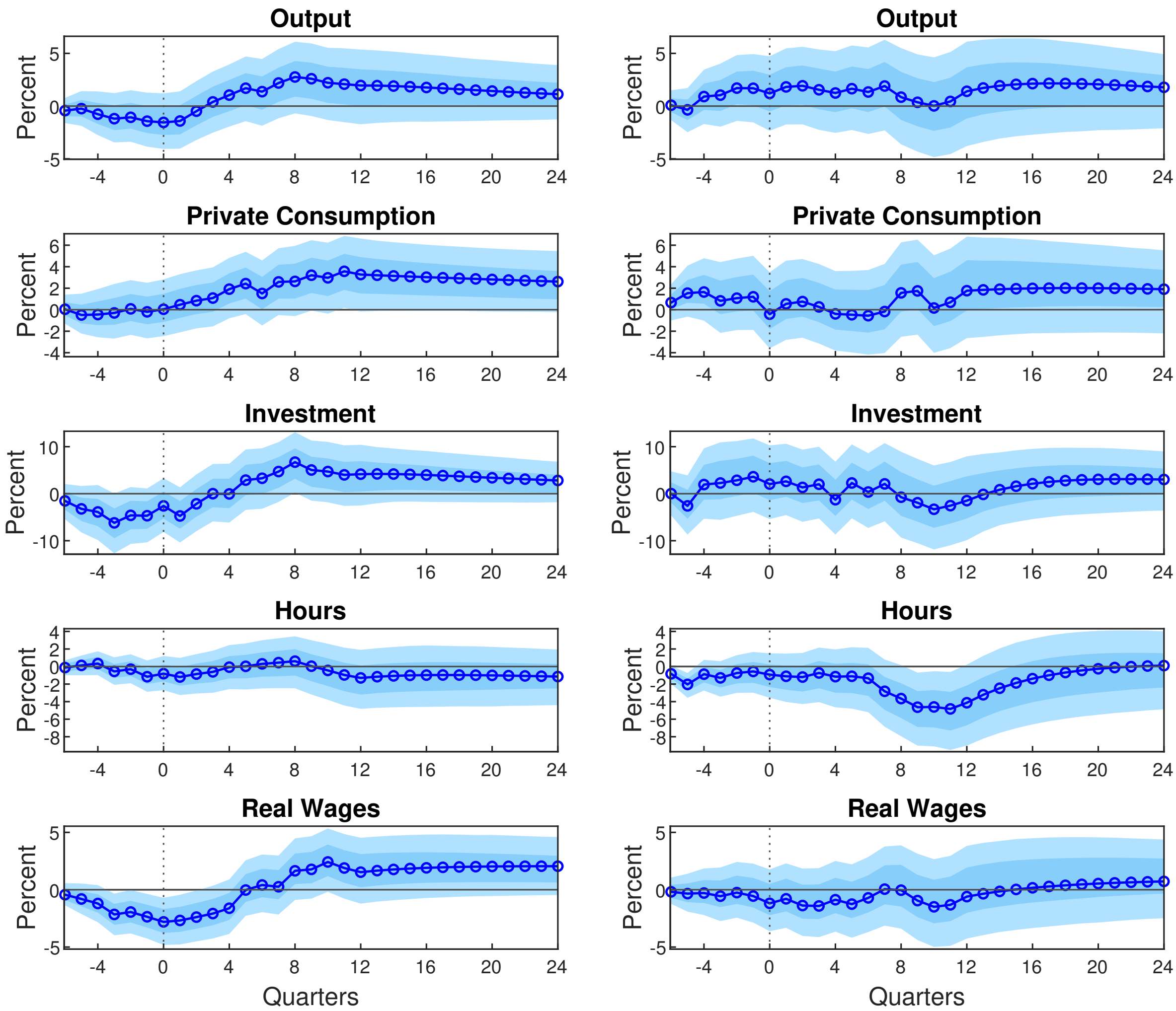
Figures C7 and C8 report responses based on a specification that allows for different effects of tax cuts and tax increases. It is based on the estimation of the specification

$$\begin{aligned} X_t = Av_t + Bt + C(L)X_{t-1} + D(L)\tau_t^{u+} + F(L)\tau_{t,0}^{a+} + \sum_{i=1}^{K} G_i \tau_{t,i}^{a+} \\ + H(L)\tau_t^{u-} + I(L)\tau_{t,0}^{a-} + \sum_{i=1}^{K} J_i \tau_{t,i}^{a-} + e_t, \end{aligned} \tag{C2}$$

where the superscripts + and − denote positive and negative tax changes, respectively.

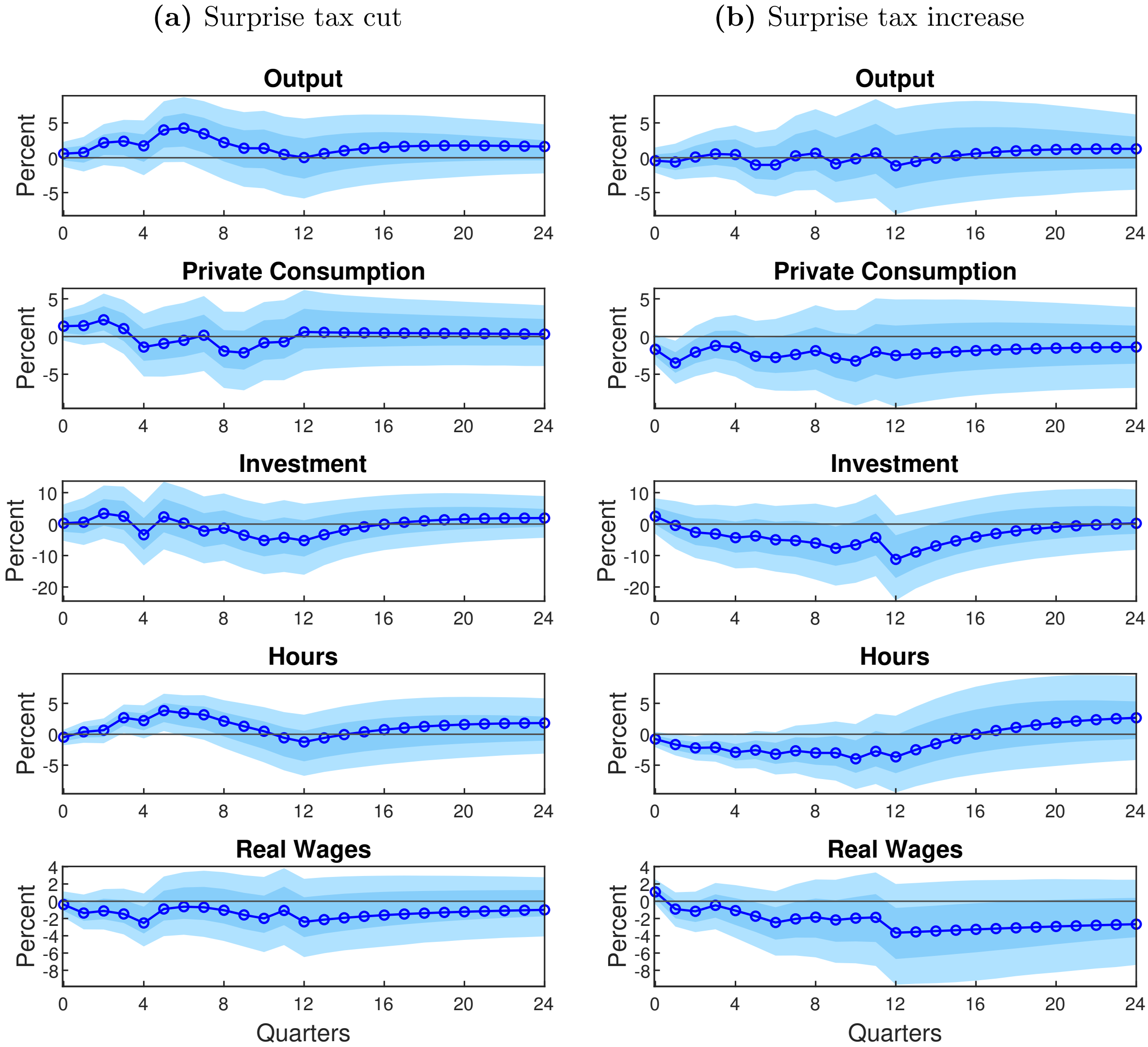
Figure C7: The impact of an anticipated 1 percent tax change – Asymmetric Response

(a) Anticipated tax cut **(b)** Anticipated tax increase



Notes: The figure shows the responses of macroeconomic variables to an anticipated exogenous tax cut and an anticipated exogenous tax increase, respectively, corresponding to one percent of GDP, announced six quarters before implementation. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications.

Figure C8: The impact of a surprise 1 percent tax change – Asymmetric Response

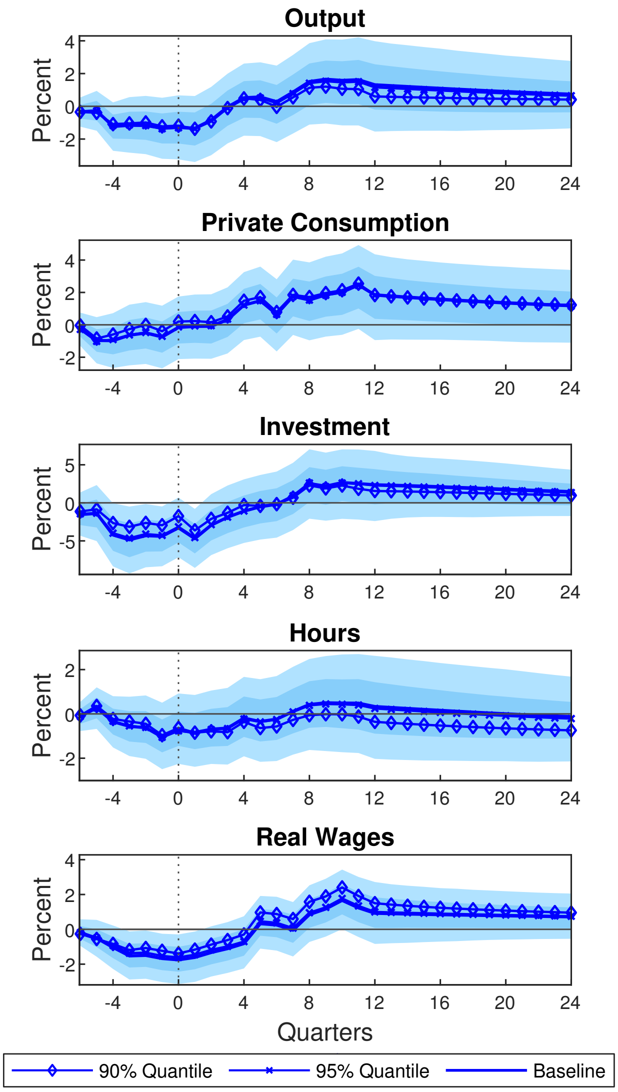


Notes: The figure shows the responses of macroeconomic variables to an unanticipated exogenous tax cut and an unanticipated exogenous tax increase, respectively, corresponding to one percent of GDP. Non-anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. Lines with circles indicate point estimates. Shaded areas denote 68 and 95 percent bootstrapped confidence intervals based on a nonparametric bootstrap with 10,000 replications.

C.10 No Anticipation to Tax Changes with Long Implementation Lag Lengths

Figure C9: The impact of a 1 percent tax cut – Excluding long implementation lags

(a) Anticipated tax cut



Notes: The figure shows the responses of macroeconomic variables to an anticipated exogenous tax cut corresponding to one percent of GDP. Anticipated tax changes are those exogenous tax changes for which the time period between announcement and implementation lies between 90 and 1403 days (90%-quantile) and between 90 and 1838 days (95%-quantile), respectively. Lines with markers represent the point estimates based on different choices for the cutoff period for the implementation lag. The line without markers denotes the point estimates of the baseline specification, shaded areas denote 68 and 95 percent bootstrapped confidence intervals of the baseline specification (no cutoff, longest implementation lag 2746 days).

C.11 Predictability of Exogenous Tax Shocks

Our identification strategy relies on the assumption that exogenous tax changes are uncorrelated with the contemporaneous error term in Equation (3). By nature, this assumption cannot be tested. Nonetheless, as in Mertens and Ravn (2012), Cloyne (2013), and Hayo and Uhl (2014), we test whether the exogenous tax shocks at announcement date can be predicted by past values of X_t. Failure to reject the null hypothesis that the tax changes cannot be predicted lends additional credibility to the claim of exogeneity. For this purpose, we consider all exogenous tax changes and then, separately, exogenous tax changes aimed at increasing long-run growth (structural tax changes) and tax changes aimed at reducing the budget deficit (consolidation tax changes). Within these categories we distinguish between anticipated, unanticipated, and all tax changes. First, we estimate a linear regression of the tax changes on four lags of log per capita values of GDP, investment, and consumption, hours worked, and log real wages per employee, as well as a linear trend. The left column of Table C3 shows the p-values of an F-test that the coefficients of the lags of X_t are zero. Second, we estimate an ordered probit, where the dependent variable is defined as follows:

$$y_t^{i,j} = \begin{cases} -1 & \text{if} \quad \tau_t^{i,j} < 0 \\ 0 & \text{if} \quad \tau_t^{i,j} = 0 \\ 1 & \text{if} \quad \tau_t^{i,j} > 0, \end{cases} \tag{C3}$$

where $\tau_t^{i,j}$ denotes a tax change of type i (anticipated, unanticipated, all) with motivation j (exogenous, structural, consolidation). The second column of Table C3 shows the p-values of a likelihood ratio test that the coefficients of the lags of X_t equal zero. Neither test provides evidence that the tax changes can be predicted by past values of X_t, thus supporting our claim that the tax changes are exogenous.

Table C3: Predictability of exogenous tax changes

	Linear	Ordered Probit
All exogenous tax changes		
All tax changes	0.875	0.918
Unanticipated tax changes	0.938	0.499
Anticipated tax changes	0.669	0.903
Structural tax changes		
All tax changes	0.911	0.966
Unanticipated tax changes	0.984	0.893
Anticipated tax changes	0.776	0.775
Consolidation tax changes		
All tax changes	0.771	0.689
Unanticipated tax changes	0.382	0.080
Anticipated tax changes	0.914	0.951

Notes: This table reports the outcomes of tests of the predictability of the exogenous tax measures dated by the announcement date. The tests are specified with the null hypothesis that four lags of log GDP per capita, log investment per capita, log consumption per capita, log hours worked per capita and log real wages are jointly equal to zero. For the linear model, the values denote the p-values of F-tests of H_0; for the ordered probit model, the values denote p-values of likelihood ratio tests of H_0.

C.12 Tax Multipliers

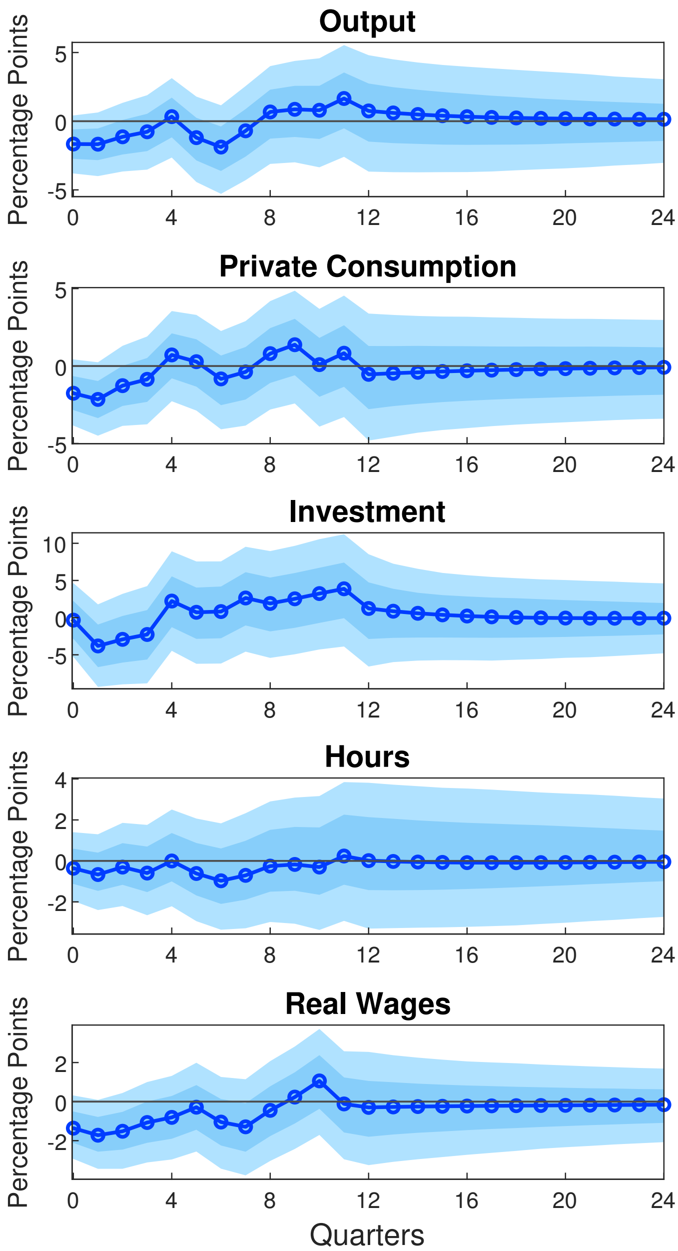
Table C4: Tax Multipliers

Quarter	Baseline			Fiscal Policy Variables		
	Surprise	Anticipated	All	Surprise	Anticipated	All
-6		-0.3345			-0.2408	
		(0.4527)			(0.4387)	
-5		-0.2703			-0.0956	
		(0.6231)			(0.6219)	
-4		-1.2332			-0.9724	
		(0.7622)			(0.7715)	
-3		-1.1620			-0.8610	
		(0.8660)			(0.9030)	
-2		-1.1713			-0.9410	
		(0.9041)			(0.9611)	
-1		-1.3408			-1.1411	
		(0.9432)			(1.0031)	
0	0.3942	-1.2678	-0.0361	0.4946	-1.0902	0.0348
	(0.5543)	(0.9902)	(0.2732)	(0.5463)	(1.0571)	(0.2705)
1	0.3326	-1.3415	-0.1197	0.4509	-1.1806	-0.0074
	(0.7720)	(1.0244)	(0.3859)	(0.7804)	(1.1017)	(0.3919)
2	0.2988	-0.8368	0.1278	0.4585	-0.7018	0.2807
	(0.9430)	(1.0504)	(0.4662)	(0.9683)	(1.1267)	(0.4805)
3	0.7325	-0.0381	0.6284	0.9057	0.0970	0.8298
	(1.0961)	(1.0756)	(0.5396)	(1.1346)	(1.1440)	(0.5717)
4	0.1897	0.5218	0.7458	0.3417	0.6711	0.9896
	(1.2174)	(1.1095)	(0.6234)	(1.2739)	(1.1715)	(0.6693)
5	1.7694	0.5725	1.1949	1.9700	0.7046	1.4569
	(1.3647)	(1.1381)	(0.7096)	(1.4241)	(1.2001)	(0.7654)
6	2.1625	0.2792	0.9641	2.3959	0.4264	1.2547
	(1.4770)	(1.1649)	(0.7798)	(1.5473)	(1.2350)	(0.8497)
7	1.5714	0.8717	1.0681	1.8545	0.9888	1.3496
	(1.6309)	(1.2001)	(0.8565)	(1.7059)	(1.2769)	(0.9341)
8	0.8396	1.5131	1.4257	1.1153	1.6156	1.6969
	(1.7325)	(1.2410)	(0.9241)	(1.8279)	(1.3239)	(1.0157)
9	0.7877	1.6528	1.5117	1.1085	1.8138	1.8242
	(1.8207)	(1.2765)	(0.9778)	(1.9327)	(1.3600)	(1.0775)
10	0.7861	1.5831	1.3874	1.1309	1.7643	1.7254
	(1.9352)	(1.3016)	(1.0188)	(2.0501)	(1.3912)	(1.1293)
11	-0.0279	1.6250	1.2659	0.2627	1.8245	1.6028
	(2.0196)	(1.3305)	(1.0643)	(2.1451)	(1.4223)	(1.1813)
12	0.5670	1.3147	1.0454	0.8302	1.5134	1.3687
	(2.1216)	(1.3624)	(1.1147)	(2.2337)	(1.4597)	(1.2377)
13	0.6580	1.2603	0.9732	0.8465	1.5648	1.3381
	(2.0709)	(1.3259)	(1.0882)	(2.2001)	(1.4327)	(1.2265)
14	0.7180	1.2060	0.9033	0.8378	1.5572	1.2676
	(2.0326)	(1.2964)	(1.0709)	(2.1646)	(1.4071)	(1.2169)
15	0.7534	1.1522	0.8361	0.8134	1.5130	1.1759
	(1.9938)	(1.2679)	(1.0562)	(2.1196)	(1.3790)	(1.2051)
16	0.7695	1.0994	0.7719	0.7797	1.4469	1.0747
	(1.9506)	(1.2386)	(1.0414)	(2.0670)	(1.3491)	(1.1911)
17	0.7708	1.0479	0.7111	0.7409	1.3689	0.9712
	(1.9028)	(1.2083)	(1.0254)	(2.0099)	(1.3184)	(1.1752)
18	0.7609	0.9980	0.6538	0.6997	1.2852	0.8701
	(1.8514)	(1.1774)	(1.0082)	(1.9506)	(1.2879)	(1.1580)
19	0.7429	0.9498	0.6001	0.6582	1.2003	0.7741
	(1.7977)	(1.1464)	(0.9897)	(1.8909)	(1.2579)	(1.1398)
20	0.7191	0.9037	0.5501	0.6174	1.1168	0.6848
	(1.7428)	(1.1159)	(0.9703)	(1.8318)	(1.2289)	(1.1209)
21	0.6914	0.8597	0.5039	0.5782	1.0365	0.6031
	(1.6881)	(1.0862)	(0.9503)	(1.7741)	(1.2009)	(1.1014)
22	0.6615	0.8179	0.4613	0.5410	0.9605	0.5293
	(1.6343)	(1.0576)	(0.9300)	(1.7183)	(1.1740)	(1.0813)
23	0.6305	0.7784	0.4224	0.5061	0.8896	0.4634
	(1.5823)	(1.0304)	(0.9096)	(1.6646)	(1.1482)	(1.0610)
24	0.5994	0.7411	0.3869	0.4736	0.8238	0.4053
	(1.5324)	(1.0047)	(0.8893)	(1.6134)	(1.1236)	(1.0405)

Notes: This table shows tax multipliers, defined as the impulse responses of output to a tax cut corresponding to one percent of GDP. Values in parentheses denote bootstrap standard errors based on a nonparametric bootstrap with 10,000 replications. In the baseline specification the logarithms of real per capita GDP, real per capita private consumption, real per capita investment, the logarithm of hours worked per capita, and the logarithm of real wages per employee are included as endogenous regressors. In the specification with fiscal policy variables, the logarithms of real per capita tax revenues and government spending are additionally included. Column 'Surprise' denotes the response of output to an unanticipated tax cut, column 'Anticipated' denotes the response of output to an anticipated tax cut, column 'All' denotes the response of output to a tax cut without distinguishing between anticipated and non-anticipated tax changes.

C.13 Difference Between Anticipated and Surprise Shocks

Figure C10: Difference Between Anticipated and Surprise Shocks



Notes: The figure shows the difference between post-reform responses of macroeconomic variables to an anticipated and a surprise exogenous tax cut, each corresponding to one percent of GDP, based on our baseline specification. Surprise tax changes are those exogenous tax changes for which the time between announcement and implementation is less than 90 days. Anticipated tax changes are those exogenous tax changes for which the time between announcement and implementation exceeds 90 days. Lines with circles represent the point estimates of the differences in the IRF, shaded areas denote 68 and 95 percent bootstrapped confidence intervals, respectively.

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