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State-Dependent Effects of Tax Changes in Germany and the United Kingdom

Abstract

We study state-dependent effects of narratively identified tax shocks in Germany and the UK over the period 1974Q1–2018Q4 using local projections. In addition, we distinguish between aggregated and disaggregated tax types (direct and indirect taxes) as well as look for possible asymmetries between tax hikes and tax cuts. We find a number of differences across the business cycle, and between sample countries, tax types, and direction of tax changes. For instance, aggregated tax cuts initially have a larger effect during times of non-recession in Germany, whereas we find no state-dependent effects for the UK. When disaggregating tax types, German indirect tax cuts only appear expansionary during downturns, whereas the effect is positive throughout the business cycle in the UK. Furthermore, we find different reactions when considering tax cuts and hikes individually: tax hikes can be expansionary in Germany (UK) when implemented during non-recessionary (recessionary) periods whereas they are contractionary during recessions (non-recessions). When considering tax cuts, German GDP rises only when cuts are enacted in times of non-recession, whereas in the UK, the reactions is positive in either case and mostly symmetric. All these findings are robust to various changes in the econometric setup.

Keywords: Fiscal policy, tax policy, legislated tax changes, state dependence, direct taxes, indirect taxes, asymmetric effects, Germany, United Kingdom, local projections, narrative approach

JEL code: E62, E63, H20, H30, K34

1 Introduction

Since the Great Recession, there has been renewed interest in fiscal policy by both policymakers and academics, which has led to a reassessment of its effectiveness. For example, the IMF revised upwards its fiscal policy multiplier estimates from near 0.5 in advanced economies during the three decades leading up to 2009 to a range from 0.9 to 1.7 (IMF, 2012). However, most evidence on the effect of tax shocks is derived from linear models, which do not consider state-dependent responses (see, e.g., Blanchard & Perotti, 2002; Romer & Romer, 2010; Cloyne, 2013; Hayo & Uhl, 2014).

The focus of the present study is on state-dependent tax multipliers at different levels of aggregation in Germany and the UK using narratively identified shocks. We make three novel contributions to the literature. For Germany, we provide (i) the first results for symmetric narratively disaggregated tax shocks. For Germany and the UK, we estimate state-dependent effects of (ii) disaggregated tax shocks (direct and indirect taxes) and (iii) asymmetric tax shocks.

There are few studies analysing whether and, if so, how fiscal multipliers are affected by different states of the business cycle. Auerbach and Gorodnichenko (2012) extend Blanchard and Perotti's (2002) identification strategy to the nonlinear case in a regime-switching structural vector autoregression (SVAR). In this setup, strong state-dependent effects of tax policy emerge, as a tax hike has a positive (negative) effect in recessions (expansions). However, the authors argue that an SVAR framework is not ideal for identifying the macroeconomic effects of tax changes.

Employing a DSGE model, Sims and Wolff (2018) show that tax cuts have a rather low expansionary effect when output is low. However, their 'welfare multiplier' suggests that tax cuts are normatively most desirable during recessionary periods, as they ease distortions and affect consumption when marginal utility is highest.

Focusing on state-dependent tax multipliers and using the narratively identified exogenous US tax shocks by Romer and Romer (2009), as well as estimating local projections (LP, Jordà, 2005), Eskandri (2015) finds tax hikes to have large negative effects on aggregate income during periods of low unemployment and positive but small effects in times of high unemployment. Ziegenbein (2019) further disaggregates the US tax shocks and uses the narratively identified tax shocks as proxies in an instrument variable local projections (IV-LP) framework (Mertens & Ravn, 2013). For both personal income and business tax, he estimates tax cuts to have a large income effect during periods of low unemployment and no significant effect in phases of economic slack.

Demirel (2020) also employs narratively exogenous US tax shocks in an LP and IV-LP framework. Using a transition function of the unemployment gap rate and an unemployment rate threshold of 6.5% taken from Owyang et al. (2013) and Ramey and Zubairy (2018), he reports a large positive effect of tax cuts during times of no economic slack, whereas the effect is smaller, but still positive, when unemployment is high. He argues that the adjustment works through the labour market. Recession-induced credit constraints prevent workers from responding to the tax cuts by strongly changing their labour supply. In addition, tax cuts do not much affect labour demand, as the high rate of unemployment decreases firms' search costs.

Baum and Koester (2011) estimate state-dependent expenditure multipliers for Germany for the period 1976Q1–2009Q4. Using an output gap to indicate the state of the business cycle, they extend Blanchard and Perotti's (2002) identification strategy to the nonlinear case in a threshold SVAR. They find the government spending multiplier to be larger (smaller) when the output gap is negative (positive). This is interpreted as supporting the view that crowding out is an issue only near maximum capacity utilisation. Revenue shocks, on the other hand, have a more limited effect, but one that is relatively larger when the output gap is positive. The authors conclude that stimulation works better through revenue cuts (expenditure increases) when output gap is positive (negative).

Baum et al. (2012) apply a threshold VAR based on the sign of the output gap to six of the G7 countries (excluding Italy) and find German tax multipliers to be slightly larger in periods when the output gap is positive, arguing that firms and consumers act less like Ricardians when market sentiment is positive. In contrast, UK tax multipliers are reported to be insignificant.

Colombo (2020) employs the exogenous tax shocks identified by Cloyne (2012), the smooth transition parameter approach proposed in Auerbach and Gorodnichenko (2012, 2013a, 2013b, 2017), and LP estimation. In contrast to the US studies, she finds tax cuts to be more effective during times of contractions, with the key driver being private consumption. Overall, during recessions, consumption, investment, exports, and imports increase after a tax cut, whereas they barely react in expansionary phases. She explains this finding by a larger share of liquidity constrained consumers during downswings who use the additional disposable income for consumption. During expansions, a negative reaction of government spending appears to counteract the positive effect of a tax cut.

Bonam and Konietschke (2020) employ a panel of nine countries and narratively identified tax shocks, including Germany and the UK. They estimate state-dependent multipliers via LP, as we do, but rely on a smooth transition parameter to define the state of the business cycle. The authors report a significant influence of tax changes on GDP only during expansions, whereas the effect of taxes is insignificant during recessions. Moreover, they find tax hikes to be the driving force behind the results, as tax cuts turn out to be insignificant over the whole business cycle. An important assumption in such a panel data analysis is that the reactions are homogenous across countries, which the authors do not test.

Our research using time-series data on individual countries raises severe doubts about the appropriateness of the panel homogeneity assumption. We find German tax cuts to initially have a larger effect during times of non-recession, whereas for the UK, we discover no state-dependent effects over the business cycle. When disaggregating tax types, we observe that the impulse response functions (IRF) for direct tax cuts look similar to those of aggregated tax shocks. Indirect tax cuts only appear expansionary during downturns in Germany, whereas, in the UK, their effect is positive over the full business cycle. Furthermore, we find different reactions when considering tax cuts and hikes individually: tax hikes can be expansionary in Germany (UK) when implemented during expansionary (recessionary) periods, whereas they are contractionary during recessions (expansions). When considering tax cuts, German GDP rises only when cuts are enacted in times of non-recession, whereas in the UK, the reactions is positive in either case and mostly symmetric. Thus, the effect of tax changes appear to be heterogeneous across countries.

In Section 2 of the paper, we discuss our database and in Section 3 our econometric approach. Section 4 contains the estimated unconditional tax multipliers and Section 5 conditions them on the states of the business cycle. In Section 6, we check the robustness of our results. Section 7 concludes.

2 Data

Macroeconomic Data

For both countries, our analysis is based on quarterly data from 1974Q1–2018Q4. German macroeconomic data are from the German Federal Statistical Office (Destatis). We use West German growth rates until 1991, that is, for the pre-unification period. Tax revenues are from the Bundesbank and Datastream. UK data were obtained from the Office for National Statistics (ONS). We downloaded the 10-year government bond interest rate from the Federal Reserve Economic Database (FRED) provided by the St. Louis Fed. All data are seasonally adjusted. When appropriate, variables are divided by working-age population 16 years and older and deflated by the respective GDP deflator with base year 2015. We commence our analysis in 1974Q1 to make our results comparable to those of Hayo and Uhl (2014) and Nguyen et al. (2017) and because Perotti (2004) finds a structural break in the German series around this time.

Tax Data

Our narrative tax data are taken from Hayo and Mierzwa (2021), who extend the dataset collected by Cloyne (2012) for the UK and from Hayo and Uhl (2014) for Germany. However, here we also consider temporary tax changes. In line with Romer and Romer's (2010) narrative approach, we concentrate on tax changes that are not motivated by the business cycle. For the UK, we follow Nguyen et al. (2017) and exclude the anticipated measures in 1979Q3 and 1988Q2. The authors argue that keeping these observations violates the assumption of exogeneity as those shocks can be predicted by lagged values of macroeconomic variables.

We provide the outcome of the corresponding Granger-causality tests in Table A2 of the Appendix. Column I contains the results for the original series, whereas Column II excludes German tax changes that were implemented more than 90 days after they were signed into law and UK tax changes that were implemented more than 90 days after they were announced as well as the two anticipated UK tax measures mentioned above. We find no anticipation problem in the case of German tax changes, as the exogenous tax shocks cannot be predicted by lags of the control variables. Using only changes implemented within one quarter does not improve the exogeneity assumption but leaves us with about 50% fewer observations. Hence, we keep the original series of German tax shocks. For the UK, we find results similar to those of Nguyen et al. (2017): removing the changes implemented more than 90 days after announcement in addition to the two critical outliers ensures that the tax shocks cannot be predicted by past values of the control variables.

Table A1 in the Appendix provides summary statistics of the tax shock series. It becomes apparent that the series are fairly similar across the two economies. For all aggregates, we have a comparable number of observations, but German tax shocks have higher means and standard deviations in almost all cases. Over time, in both economies, we record mainly indirect tax increases and direct tax decreases, reflecting a shift of the tax burden from income to consumption. We observe more indirect tax hikes in the UK during the 1980s and 1990s, whereas they are more equally spread across time in Germany. In the US, direct taxes are mostly adjusted via changes to the main rates and depreciation (see Hussain and Liu, 2018), whereas in Germany and the UK, many different measures were implemented. The similarities in the tax changes in combination with different legislative procedures make the comparison of these two G5 countries particularly interesting.

3 Method

We estimate tax multipliers using LPs (Jordà, 2005), as they are simpler and more robust to model misspecification than VAR. As argued by Ramey and Zubairy (2018), the results derived from structural VARs (SVAR) are sensitive to the fixed ex-post conversion factor, that is, the sample average of Y/T, which is usually used to translate the responses into multipliers. Moreover, the authors argue that translating SVARs to the nonlinear case is far from straightforward. As laid out by Ramey and Zubairy (2018), the LPs are similar to a direct forecast of GDP at time $t+h$ if the shock = 1 at time t is compared to the scenario shock = 0. Transitions between states not induced by the shock are captured by the state-dependent controls and intercept.

In the unconditional symmetric case, our model takes the form:

$$z_{t+h} = \alpha + \beta_h(L)\Delta\tau_{t-j} + \psi_h(L)X_{t-i} + \phi D + \epsilon_{t+h} \tag{1}$$

z_{t+h}, is defined as the cumulated h-step ahead growth rate of the dependent variable, i.e., $z_{t+h} = \frac{Y_{t+h}-Y_{t-1}}{Y_{t-1}}$ in the case of GDP, which is approximately equal to $\ln(Y_{t+h}) - \ln(Y_{t-1})$. To keep the model parsimonious, the vector X contains lags of the dependent variable, government spending, and tax revenues, all in logs of real per capita local currency values, as in Blanchard and Perotti (2002) and

Colombo (2020). D contains a linear trend and, in the case of Germany, a step dummy for unification, taking the value 1 from 1991Q1 onward. ψ and β are lag polynomials of order 4.

The LP method directly estimates a set of single regressions at each time horizon $t = 0, 1, 2, \dots, H$, projecting the value of the dependent variable *h-steps* ahead, based on the information set at time *t*. Hence, the coefficient β_h gives the response of the dependent variable at time t+h to a tax shock at time *t*. In contrast, a standard VAR estimates the parameters for horizon 0 and iterates them forward to construct the IRF (see Ramey & Zubairy, 2018). A drawback of the LP approach is that, by construction, the error terms are serially correlated and potentially correlated with X_{t-1} and $\Delta\tau$. To partially account for this, we employ heteroscedasticity and autocorrelation consistent standard errors as proposed by Newey and West (1987), where the number of lags is selected automatically (Newey & West, 1994). IRFs are presented with 90% confidence bands.

The state-dependent model takes the form:

$$z_{t+h} = I_{t-1}\left[\alpha_{R,h} + \psi_{R,h}(L)X_{R,t-i} + \beta_{R,h}\Delta\tau_{\mathrm{R,t-j}}\right] \\ +(1 - I_{t-1})\left[\alpha_{NR} + \psi_{NR,h}(L)X_{NR,t-i} + \beta_{NR,h}\Delta\tau_{NR,t-j}\right] + \phi D + \varepsilon_{t+h} \quad (2)$$

with subscripts R and NR indicating recessions and non-recessions.

The state indicator is defined as $I_t = \begin{cases} 1, in\ recession \\ 0, in\ non-\text{recessions} \end{cases}$

As is standard in the literature, *I* is lagged by one quarter to account for delayed adjustments in employment and government revenues.[1] As before, the dependent variable is expressed as a cumulative log growth rate and vector *X* contains the controls. ϕD indicates a linear trend. ψ_s and β_s are lag polynomials of order 4, with subscript $s = \{NR, R\}$.

Choosing an appropriate business cycle indicator is not straightforward. Owyang et al. (2013), Ramey and Zubairy (2018), and Demirel (2020) use US unemployment as an indicator of economic slack and define periods of unemployment rates above 6.5% as the ‘bad’ state. In our sample, setting a fixed threshold would leave us with very few observations of the bad state. Colombo (2020) follows Auerbach and Gorodnichenko (2012, 2013a, 2013b, 2017) and uses a smooth transition parameter based on a two-year moving average of (log-) real GDP.

Alternatively, we can use the evaluation of the business cycle made by the German Counsel of Economic Experts (*Sachverständigenrat)*,[2] which follows the methodology of the National Bureau of Economic Research (NBER;[3] see Sachverständigenrat, 2017, p. 134). However, there is no such committee for the UK and, hence, we cannot compare our two economies based on a consistent classification. Another alternative is to define a technical recession as two succeeding quarters of contracting real GDP. However, this usually results in very short periods of contraction, putting the analysis at risk to the influence of outliers.

Instead, we use the Composite Leading Indicator (CLI) provided by the OECD.[4] First, this ensures a comparable classification across the two countries. Second, the CLI is constructed to predict turning points six to nine months before they occur, thus avoiding the use of ex-post information. The indicator is available at a monthly frequency and we code a quarter as recessionary when at least two months of the quarter are classified as *recessions*. Figure 1 shows the distributions of exogenous tax shocks, coded

[1] Our results are generally insensitive to lagging the state indicator, although there is one exception: for state-dependent effects of German tax hikes (left panel of Figure 5) the IRF is positive in either state of the business cycle. It can be shown that this outcome is driven by the budget consolidation efforts in 1995Q1, which were implemented on the brink of a recession.

[2] Für eine zukunftsorientierte Wirtschaftspolitik. Jahresgutachten 2017/18, https://ideas.repec.org/b/zbw/svrwjg/201718.html

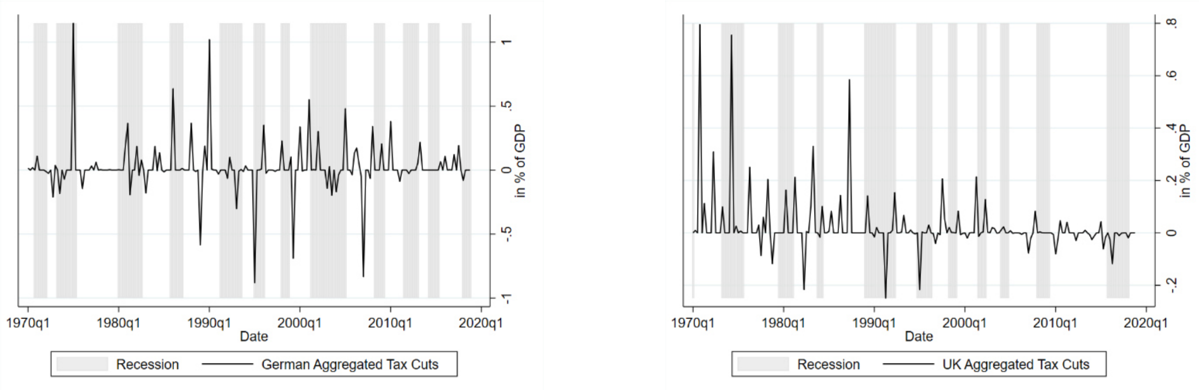
[3] https://www.nber.org/research/business-cycle-dating

[4] http://www.oecd.org/sdd/leading-indicators/oecdcompositeleadingindicatorsreferenceturningpointsandcomponentseries.htm

as decreases in overall liabilities, i.e. *tax cuts*, over the business cycle phases. Table A1 in the Appendix yields summary statistics of the aggregated and disaggregated tax shocks over the full sample and the two business cycle phases.

Figure 1: Aggregated Exogenous Tax Shocks

Germany **UK**



4 Results

Unconditional Effects

Before analysing state-dependent effects, we check our model by reproducing the baseline results of Hayo and Uhl (2014), Cloyne (2013), and Nguyen et al. (2021). Figure A1 in the Appendix shows the response of GDP after a cut to aggregated tax liabilities equal to 1% of GDP in Germany and the UK. Two years after the shock, there is a peak impact on GDP of about 2.3%, which is almost identical to Hayo and Uhl's (2014) estimate using a narrative VAR approach and a shorter sample length. The right panel of Figure A1 shows the baseline estimates of exogenous tax cuts on GDP for the UK. They resemble the ones in Cloyne (2013) and Colombo (2020), but with an even higher peak effect of more than 3%.

Figure A2 shows the response of German GDP after a cut to direct (left panel) and indirect (right panel) taxes. We discover that cuts in direct taxes raise GDP after about three quarters, with a peak effect of about 2% after five quarters. In contrast, the GDP reaction following cuts in indirect taxes becomes significantly positive only after about 2.5 years, but with an even higher peak effect of more than 6%. The overall effect displayed in the left panel of Figure A2 reflects the average of the two tax categories, with the effect of income tax changes dominating over the first two years and the effect of indirect tax cuts dominating thereafter.

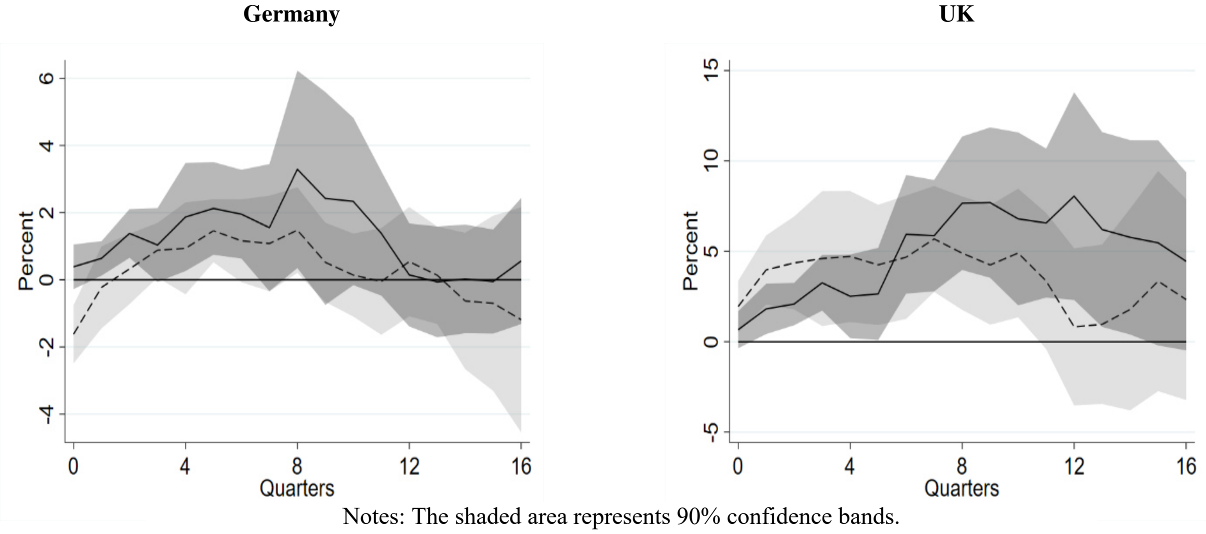
Figure A3 yields the results for the UK. Starting with direct taxes (left panel), we find a positive impact effect on GDP of about 2%. This is similar to what Nguyen et al. (2017) report, but, here, the effect dies out more quickly. As the right-hand side of Figure 4 demonstrates, the influence of consumption tax cuts is positive too, even raising GDP by about 3.5% after two years. The latter finding is different from that discovered by Nguyen's et al. (2017) SVAR approach, which found consumption taxes to have small and insignificant effects.

State-Dependent Effects of Aggregated Tax Shocks

We conduct three analyses of state-dependent effects of tax shocks on macroeconomic variables: first, aggregated tax cuts, second, disaggregated tax cuts, and, third, asymmetric effects of tax cuts and hikes.

According to Sims and Wolff's (2018) theoretical predictions and the empirical results of Eskandri (2015), Bonam and Konietschke (2020) and Demirel (2021), aggregated tax cuts should have a stronger effect during non-recessions and no effect during recessions. However, Colombo (2020) finds the opposite outcome for the UK. The left panel of Figure 2 shows the results for aggregated German taxes conditional on the state of the business cycle. Employing the OCED classification, the dashed line and lighter-shaded confidence bands represent the response during *recessions* and the solid line and darker-shaded confidence bands represent the reaction during *non-recessions.* The particularly dark areas reflect overlapping confidence bands, indicating insignificant differences between the two series. In periods of non-recession, the positive effect of tax cuts is larger than in the baseline model, causing an increase in GDP of more than 3% after two years. Overall, the response during non-recessionary periods is in line with the theoretical and empirical findings mentioned above.

Figure 2: State-Dependent Effects of Aggregated Exogenous Tax Shocks



Notes: The shaded area represents 90% confidence bands.
The lighter (darker) shaded area indicates recession (non-recession) periods.

In recessions, GDP initially drops by about 1.5%, but quickly recovers, and steadily rises until, after six quarters, it reaches its peak of about 1.5% above the baseline. On impact and in the first period, there is a significantly larger effect of tax cuts during non-recessions compared to during recessions, whereas there are no significant differences in the rest of the observation window. The initial drop in German GDP could be explained by firms engaging in a 'wait-and-see' strategy, as government intervention in times of high uncertainty might fuel pessimistic views (Alloza, 2017). However, Berg (2019) does not find such a relationship for Germany and, in our estimation, the effect is only short lived.

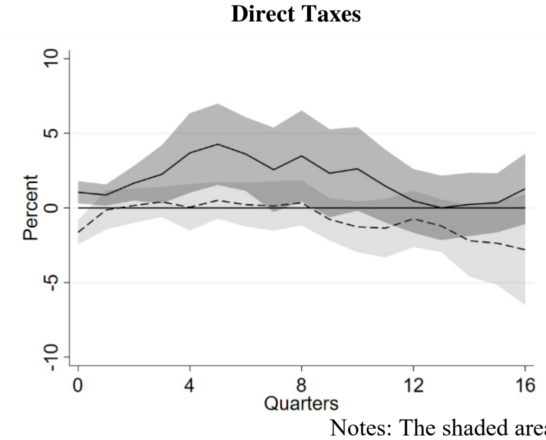
The state-dependent aggregated tax multipliers for UK GDP are presented in the right panel of Figure 2. As the confidence bands completely overlap throughout the forecast period, we cannot rule out that there is a symmetric response across the two states, which differs from Colombo's (2020) conclusion. In either case, the effect is positive and large. When implemented during non-recessionary times, GDP rises up to 8% after three years and stays significantly positive over the full forecast horizon. The peak effect during recessions occurs earlier but only reaches about 6% two years after the shock, becoming insignificant after three years.

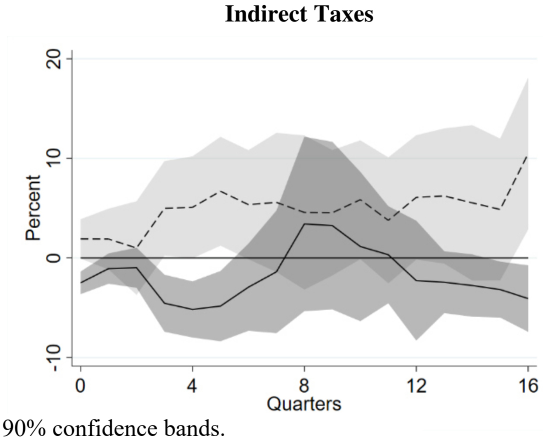
Why do the GDP reactions differ across the two economies? To better understand the dynamics, we replace z_{t+h} and GDP in the vector of controls in (2) with private consumption, investment, and employment. As in Owyang et al. (2013) and Colombo (2020), we scale the components of GDP by lagged real GDP, i.e. $z_{t+h} = [\ln(Z_{t+h}) - \ln(Z_{t-1})] * \frac{Z_{t-1}}{Y_{t-1}}$, such that shocks and responses are expressed in per cent of GDP. Employment enters in growth rates. Results are given in Figure A4 in the Appendix. German consumption (investment) follows the path of GDP during non-recessions (recessions), whereas German employment (lower panel) does not react to changes in legislated taxes. Overall, UK consumption and investment are boosted during non-recessionary times, whereas they tend to drop slightly during recessions, as already found for government spending in the US by Berger and Vavra (2014). The effect on employment is similarly positive in either state, but longer lasting during recessions. Hence, consumption, investment and employment appear to drive up GDP during non-recessions, whereas employment growth seems to be responsible for a positive GDP reaction during recessions.

State-Dependencies of Disaggregated Tax Shocks

To analyse state dependencies of disaggregated tax shocks in the two economies, we augment Model (2) by disaggregating the tax shocks into direct taxes on income (personal income, capital gains, corporate income, and other taxes borne by private entities) and indirect taxes (on consumption, duties, and other indirect taxes).[5] When analysing one specific tax category, we control for the contemporaneous and lagged influence of the other. This is important, as individual measures are usually implemented contemporaneously as part of a larger tax package. Figure 3 displays the state-dependent reactions of German GDP to cuts in direct (left) and indirect taxes (right). We find that cuts in direct taxes have a positive effect on GDP only when enacted during non-recessionary times. German GDP jumps by about 1% in the quarter of implementation, continues rising until it reaches a peak of more than 4% after six quarters, and then slowly returns to the baseline. In recessions, the impact effect is negative, though, which supports findings by Alloza (2017): when growth is low, a tax cut could be interpreted as a signal that times are even more dire than believed. Consequently, GDP drops by more than 1.5% in the quarter of implementation and then becomes insignificantly different from zero. Indirect tax cuts, on the other hand, cause asymmetric behaviour: during recessions, four years after the shock, GDP increases up to 10%, whereas it tends to fall during other times.[6] These outcomes suggest that German fiscal policymakers should take into account both the type of tax change and the state of the business cycle, as cuts in direct taxes are only expansionary in non-recessionary periods, whereas the opposite is true for indirect tax changes.

Figure 3: Germany: State-Dependent Effects of Disaggregated Exogenous Tax Shocks





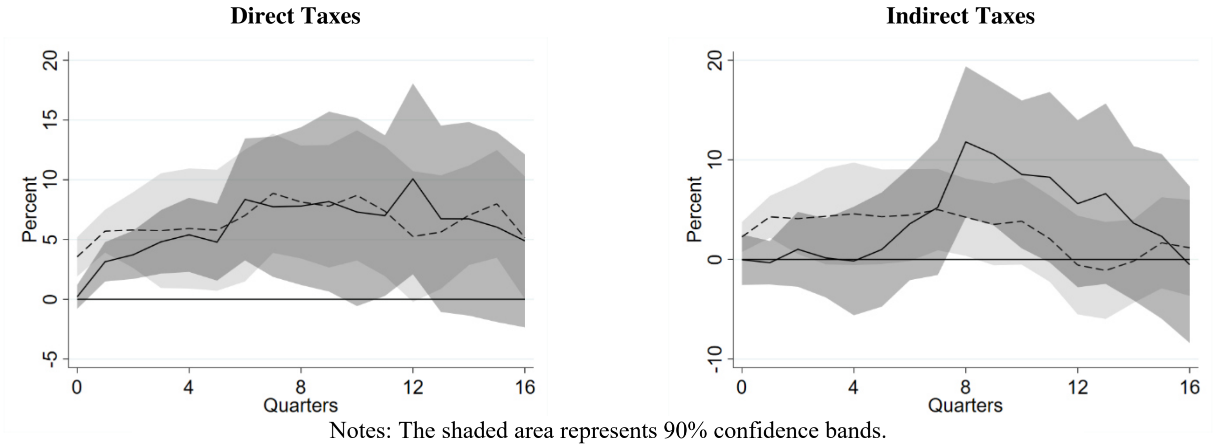
Notes: The shaded area represents 90% confidence bands.
The lighter (darker) shaded area indicates recession (non-recession) periods.

[5] We adopt the broad definition of direct taxation proposed by Hayo and Mierzwa (2021). However, narrowing the definition of the disaggregated tax shocks to wage tax (Lohnsteuer), assessed income tax (Einkommenssteuer), corporate income tax (Körperschaftssteuer), and local business tax (Gewerbesteuer) does not noticeably change our results.

[6] Note that this result is not directly applicable to the COVID-19-related temporary VAT cut in Germany that was in effect from July to December 2020, as we have both temporary and permanent measures in our sample and, due to degrees of freedom issues, an analysis of only temporary measures is not advisable

Figure 4 displays the results for the UK. We find positive effects of cuts in direct taxes (left panel) in either state of the business cycle, which is in contrast to the German case. The effect on impact is larger during recessions, though, with GDP jumping up by 3.5%, compared to just 0.2% during non-recessionary times. After the impact effect, confidence bands quickly begin to overlap and we no longer find statistical evidence of a state-dependent tax multiplier. In either case, the peak effects on UK GDP are greater than 8%. Indirect tax cuts have an immediate expansionary effect when enacted during recessions. This is similar to what occurs in Germany except that, at 5%, the peak effect is smaller. When enacted during non-recessions, the effect of indirect tax cuts reaches 10% after two and a half years. Except for the first period, the confidence bands for the IRFs associated with the two business cycle states overlap.

Figure 4: UK: State-Dependent Effects of Disaggregated Exogenous Tax Shocks



Notes: The shaded area represents 90% confidence bands.
The lighter (darker) shaded area indicates recession (non-recession) periods.

Again, we analyse the responses of consumption, investment and employment to better understand the underlying mechanisms (Figure A5). For both economies, we discover that the responses to aggregated tax changes are driven by changes in direct taxes. A cut to direct taxes boosts German consumption during non-recessionary times, whereas there is no effect in the other state. Initially, investment drops during recessions, but the effect quickly becomes insignificant. Employment remains unaffected. Indirect tax cuts have a positive (negative) effect on consumption during recessions (non-recessions). For employment, during recessions, there is an upward tendency after an indirect tax cut, but the effect is only significant for two quarters after the shock. In the UK, consumption and investment react strongly positive to cuts in direct taxes outside of recessions, whereas the effect on employment resembles the one of aggregated tax shocks discussed above. UK indirect tax changes leave the two components of GDP unaffected when implemented outside of recessions, but, during recessions, cause them to decrease after two to three years. Quite the reverse is found for employment, which rises during recessions and falls (at least initially) during non-recessions.

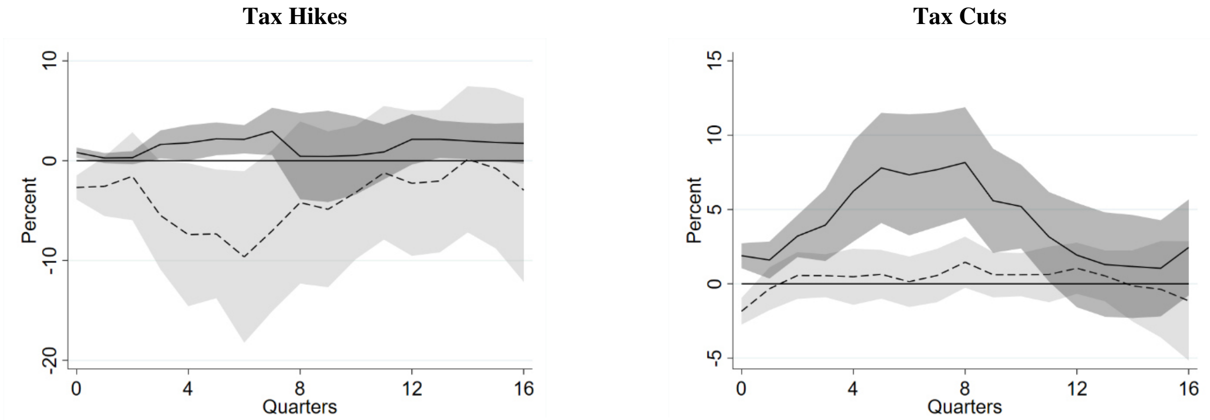
State Dependencies of Asymmetric Tax Shocks

Next, we separate the aggregated tax shocks into increases and decreases (see Eskandri 2015; Jones et al. 2015; Hussain & Malik, 2016). The left-hand side of Figures 5 and 6 contains the results for tax *hikes*, the right-hand side for tax *cuts* and, as before, dark-shaded (light-shaded) areas indicate non-recessions (recessions).

The empirical literature is ambiguous with respect to the signs of the multipliers. For the US, Jones et al. (2015) report the standard result of increasing GDP after tax cuts, but no negative GDP effects of tax hikes, whereas for the UK, it seems that tax hikes exert a larger effect, in absolute terms, than do tax cuts. However, the authors do not take state dependency into consideration. For the US, Eskandri (2015) finds tax cuts to have a larger positive impact in times of low unemployment, whereas the effect of tax hikes does not differ across states and is mostly insignificant anyway. Ardagna (2004) argues that fiscal contractions could have expansionary effects through expectations, as agents might interpret a current increase in taxes as reducing the need for future tax hikes and vice versa. Hence, although counterintuitive, tax cuts could be contractionary, whereas tax hikes could be expansionary.[7]

Analysing the reactions of German GDP over the business cycle, we find a fairly consistent pattern (see Figure 5): tax cuts (hikes) are expansionary (contractionary) in non-recessions (recessions) and mostly ineffective in recessions (non-recessions). On the one hand, a tax cut enacted outside of a recession raises German GDP on impact and by a maximum of about 8% after two years. On the other hand, during recessions, a cut could be contractionary on impact. German tax hikes cause a larger negative effect when the economy is in a recession. Given the frequency of consolidation-motivated tax hikes in our sample, this could correspond to what Jordà and Taylor (2016) find for fiscal consolidation in a panel of OECD countries. Indeed, when we only consider tax hikes motivated by deficit consolidation, the negative effect during recessions is even higher, whereas the effect on GDP is mostly insignificant outside of recessions. Hence, our results suggest conducting austerity policy only outside of recessions.

Figure 5: Germany: State-Dependent Effects of Exogenous Tax Cuts & Hikes



Notes: The shaded area 90% confidence bands.
The lighter (darker) shaded area indicates recession (non-recession) periods.

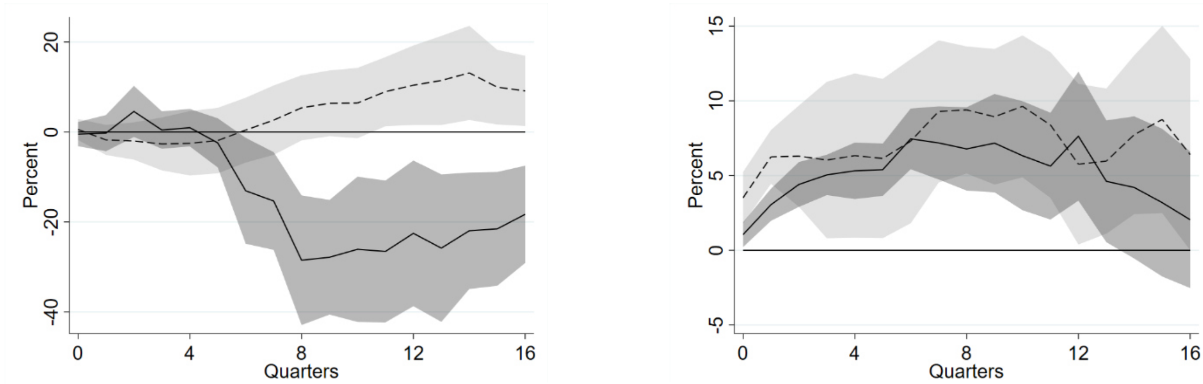
Figure 6 shows the results for the UK. After tax hikes in non-recession times, we see a substantial drop in GDP. Note that Jones et al. (2015) and Hussain and Liu (2018) report large negative effects after tax hikes for the UK as well. These authors only estimate an average effect over the business cycle; however, the negative effect becomes even more pronounced when discriminating between business cycle phases. The stronger negative effect during non-recessions is consistent with Bonam and Konietschke's (2020) finding, but the positive effect of tax cuts is not. However, we count only six tax hikes during recessions in our sample (see Table A1 in the Appendix). During recessions, UK tax hikes have a positive impact on GDP after about two and a half years. A UK tax cut during a recession also causes a positive GDP reaction, but it manifests in a relatively larger estimated effect on impact (3.5% compared to 1%). The confidence bands overlap quickly, though, and we cannot say with great certainty which effect is larger. What we can say is that the effect is positive in either case, raising GDP by more than 5%. Note that this effect is even more pronounced when considering only tax changes classified as 'deficit consolidations'. The difference in our results from those derived by Jordà and Taylor (2016) is due to the use of alternative business cycle indicators. The OECD CLI classifies the post-2010 period as a non-recessionary

[7] Usually, discussion about fiscal contraction centres around episodes of fiscal consolidation. Two prominent views are that a fiscal consolidation is either expansionary (Alesina et al., 2015) or contractionary (Guajardo et al., 2014), possibly affected by the state of the business cycle (Jordà & Taylor, 2016). However, our dataset allows encompassing these studies, as we have about as many long-run and ideologically motivated tax increases for the UK as we have increases motivated by deficit consolidation. For Germany, tax increases due to consolidation efforts are about twice as frequent as those due to other reasons.

phase, as the economy was catching up, whereas the output gap used by Jordà and Taylor (2016) was still negative, that is, indicating a recession. When using an impulse dummy based on the sign of the output gap, the effect of tax hikes becomes negative in either state of the cycle and is quantitatively larger during recessions, which is in line with Jordà and Taylor's (2016) findings for the UK.

Figure 6: UK: State-Dependent Effects of Exogenous Tax Cuts & Hikes

Tax Hikes **Tax Cuts**



Notes: The shaded area represents 90% confidence bands.
The lighter (darker) shaded area indicates recession (non-recession) periods.

During non-recessions, we find German tax cuts to cause relatively larger movements in consumption, investment, and employment (Figure A6 in the Appendix). The responses of these variables after tax hikes follow the paths of GDP in either state, though insignificantly in the case of employment. In the UK, after a tax hike in either state, consumption and investment follow GDP , whereas employment remains unaffected. In contrast, tax cuts boost consumption and investment only during non-recessions but not during recessions. Employment, however, increases in either state of the business cycle, but, as in case of aggregated tax shocks, the effect lasts longer during recessions. Allowing for the effects of tax changes to vary across the business cycle, leads to results that are similar, but even more pronounced, than those reported by Jones et al. (2015) for unanticipated tax hikes and cuts in the UK.

5 Cumulative Multiplier

The LP method allows easy inclusion of instruments and, as shown by Ramey and Zubairy (2018), the IV-LP estimation yields more robust estimates in the presence of measurement error in both the shock and the revenue series. Moreover, we can directly test for statistical differences between estimators across regimes. This allows us to directly translate the effect into a multiplier, that is, the resulting euro (pound sterling) change in GDP after a one euro (pound) change in tax revenues (Mountford & Uhlig, 2009). Following Ramey and Zubairy (2018) and Demirel (2020), we estimate:

$$\begin{aligned} z^k = {} & I_{t-1}\left[\alpha_{R,h} + \psi_{R,h}(L)X_{R,t-i} + \beta_{R,h}\Delta\tau^{\mathrm{k}}_{\mathrm{R,t-j}}\right] \\ & +(1-I_{t-1})\left[\alpha_{NR,h} + \psi_{NR_h}(L)X_{NR,t-i} + \beta_{NR,h}\Delta\tau^{k}_{NR,t-j}\right] + \phi D + \varepsilon_{t+h} \end{aligned} \tag{3}$$

where: $z^k = \frac{\sum_{i=0}^{k} Real\ GDP_{t+i}}{Real\ GDP_{t-1}}$ and $\Delta\tau^{\mathrm{k}}_{\mathrm{t}} = \frac{\sum_{i=0}^{k} Real\ Revenues_{t+i}}{Real\ GDP_{t-1}}$.

We use the narratively identified tax shocks as instruments for $\Delta\tau^{\mathrm{k}}_{\mathrm{t}}$. As before, X is the vector of controls, containing lagged log per capita real GDP, tax revenues, and government spending, and, in the disaggregated analysis, the series of tax shocks not under consideration. $\psi_R(L)$ and $\psi_{NR}(L)$ are of order 4.

The corresponding results are presented in the Appendix, Tables A3–A7. In the case of Germany, the previous results hold in general, but instrument relevance can be shown only for the first 1.5 years.

For the UK, results follow the previous pattern as well, but the instrument does not appear to be relevant, thus urging caution in interpreting the results.

6 Robustness

To rule out that our results are driven by the choice of a specific business cycle indicator, we consider different classifications. First, to account for demographic effects, as in Owyang et al. (2013), as well as a multitude of other possible drivers of deterministic non-stationarity, we employ quadratic and cubic trends (see Figures A7–A9). Next, as in Auerbach and Gorodnichenko (2012, 2013a), we employ a smooth transition parameter based on a symmetric moving average of GDP. The results are given in Figures A10–A12. Third, we use a different binary indicator provided by the Economic Cycle Research Institute (ECRI), the results of which are displayed in Figures A13–A15.

Moreover, we experiment with varying lag lengths of the series of tax shock and explanatory variables. The results are presented in Figures A16–A18 for varying lags of the tax shock series and in Figures A19–A21 for varying lags of the controls.

In addition, we estimate a threshold VAR (TVAR), the results of which are given in Figures A22–A24. The confidence bounds are now wider and the adjustment dynamics less pronounced, thus supporting our choice of estimating LPs rather than VARs.

To control for the influence of monetary policy on the real economy, we re-estimate the model. As a monetary policy indicator, we include the 3-month German interbank rate and, due to data availability, the 3-month UK Treasury rate. For the period from 2009Q1 onward, we instead use the respective shadow rates (Wu & Xia, 2015, 2017, 2020).[8] As an additional control variable, we add log CPI. As before, the additional controls enter with four lags (Figures A25–A27).

Next, we exclude temporary tax shocks and re-estimate the model using only permanent tax shocks (see Cloyne, 2013). The results are shown in Figures A28–A30.

Throughout the analysis, last 16 observations are excluded from our sample size, a practice that stems from the use of leads in the LP approach (see Ramey & Zubairy, 2018). In Figures A31–A33, we allow the sample size to vary, which means we can utilise all observations.

Based on our robustness checks, we conclude that our results are generally robust to a wide variety of different specifications.

7 Conclusion

We study state-dependent effects of narratively identified tax shocks in Germany and the UK estimated via local projections (Jordà, 2005) over the period 1974Q1–2018Q4. Recessions are identified with an ex-ante dummy provided by the OECD. When only considering aggregated tax shocks and symmetric shocks, we find German tax cuts to have a larger effect on impact during times of non-recession, but the error bands quickly overlap. For the UK, we discover no state-dependent effects of tax cuts.

When disaggregating the tax shocks into direct and indirect taxes, we find the point estimates for German GDP after direct tax shocks to be higher in non-recessions. However, in both countries, the respective tax effects are not statistically different from each other. In Germany, indirect tax cuts seem to be expansionary only in non-recessions, whereas we observe positive effects in the UK regardless of the business cycle phase.

When separating tax hikes from tax cuts, GDP behaves differently in the two economies: in Germany, GDP rises up to 7% when cuts are enacted in non-recessions, but remains mostly unaffected during recessions. In the UK, we find peak effects of around the same size across both business cycle states. German GDP contracts after tax *hikes* only during a recession, whereas during non-recessions, we find an upward tendency of German GDP. In contrast, UK GDP drops sharply about two years after

[8] Shadow rates can be downloaded from https://sites.google.com/view/jingcynthiawu/shadow-rates.

a tax hike in non-recession times, whereas we find an expansionary effect after about three years when the hike is enacted during recessions.

Our results are generally robust to various definitions of recessions, instrumenting the tax changes, and varying lag lengths of the series of tax shock and explanatory variables, as well as to varying the length of the sample size.

To summarise, we provide evidence that asymmetries matter in a statistically significant and economically relevant way for our two countries across three dimension. First, there are differences in the effects of tax changes over the course of the business cycle. Second, we discover different responses depending on the type of tax, direct or indirect, and the sign of the tax change, hikes or cuts. Third, there are notable cross-country differences. Our results suggest that the impact of tax changes appears to be even more complex than previously thought.

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Appendix

Table A1: Summary Statistics of Tax Shocks

Tax Shock: Full Sample	**Mean**	**Std. Dev.**	**Max**	**Min**	**N**
Germany					
All	0.05	0.32	1.15	-0.88	70
Increases	0.16	0.25	0.88	0.00	31
Decreases	0.22	0.26	1.15	0.00	39
Direct	0.11	0.30	1.15	-0.81	60
Indirect	-0.07	0.14	0.14	-0.73	44
UK					
All	0.04	0.14	0.76	-0.25	79
Increases	0.04	0.07	0.25	0.00	30
Decreases	0.09	0.15	0.76	0.00	49
Direct	0.08	0.16	0.76	-0.12	67
Indirect	-0.04	0.15	0.16	-0.87	52

Tax Shock: State-Dependent	**Mean**		**Std. Dev.**		**Max**		**Min**		**N**	
	Rec.	**Non-Rec.**	**Rec.**	**Non-Rec.**	**Rec.**	**Non-Rec.**	**Rec.**	**Non-Rec.**	**Rec.**	**Non-Rec.**
Germany										
All	0.10	0.02	0.28	0.34	1.15	1.02	-0.30	-0.88	32	38
Increases	0.10	0.20	0.09	0.31	0.30	0.88	0.01	0.00	13	18
Decreases	0.24	0.21	0.28	0.25	1.15	1.02	0.00	0.00	19	20
Direct	0.16	0.07	0.28	0.32	1.15	1.03	-0.20	-0.81	27	33
Indirect	-0.06	-0.07	0.09	0.17	0.08	0.14	-0.35	-0.73	21	23
United Kingdom										
All	0.05	0.04	0.17	0.12	0.76	0.58	-0.25	-0.22	28	51
Increases	0.08	0.03	0.12	0.05	0.25	0.22	0.00	0.00	6	24
Decreases	0.09	0.10	0.16	0.13	0.76	0.58	0.00	0.00	22	27
Direct	0.12	0.06	0.22	0.13	0.76	0.54	-0.02	-0.12	21	46
Indirect	-0.06	-0.02	0.21	0.08	0.16	0.12	-0.87	-0.34	20	32

Notes: Shocks are expressed in percent of nominal GDP at the quarter of implementation. The table reports arithmetic means, standard deviations, maximum values, minimum values, and number of tax changes. ‘Rec.’ during recessions, ‘Non-Rec.’ during non-recessions.

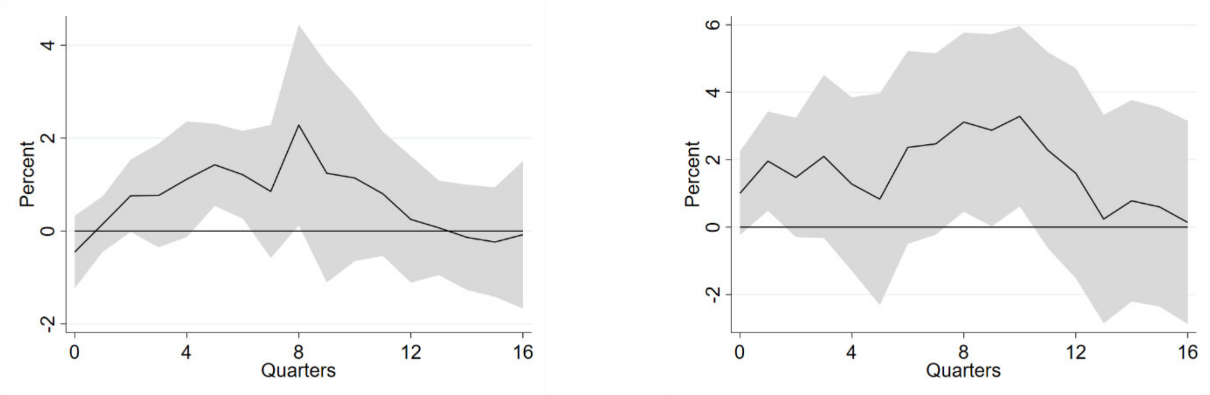
Table A2: Granger Causality Tests

Tax Type and Variables	All Tax Changes		< 90 Days to Implementation	
	Germany	UK	Germany	UK
Aggregated Tax Shocks				
GDP	0.99	0.87	0.28	0.51
Government Expenditure	0.46	0.01	0.87	0.38
Revenues	0.90	0.29	0.01	0.27
ALL	0.88	0.06	0.10	0.64
Direct Tax Shocks				
GDP	0.48	0.91	0.69	0.19
Government Expenditure	0.33	0.11	0.71	0.25
Revenues	0.79	0.72	0.09	0.28
ALL	0.74	0.44	0.21	0.45
Indirect Tax Shocks				
GDP	0.13	0.94	0.33	0.37
Government Expenditure	0.91	0.64	0.19	0.46
Revenues	0.40	0.67	0.31	0.93
ALL	0.41	0.95	0.16	0.51

Notes: Table yields p-values for Granger causality test conducted by regressing the various tax shocks on the four lags of the control variables. The UK regression includes a linear trend, the German regression a linear trend and the step-dummy for unification. A lag length of one was chosen based in the Schwarz criterion.

Figure A1: Aggregated Exogenous Tax Shocks

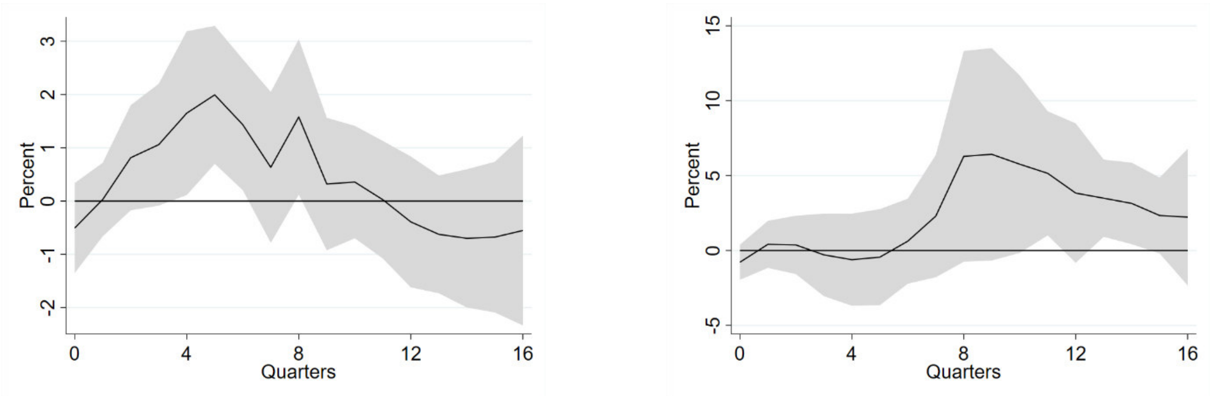
Germany **UK**



Notes: The shaded area represents 90% confidence bands.

Figure A2: Germany: Disaggregated Exogenous Tax Shocks

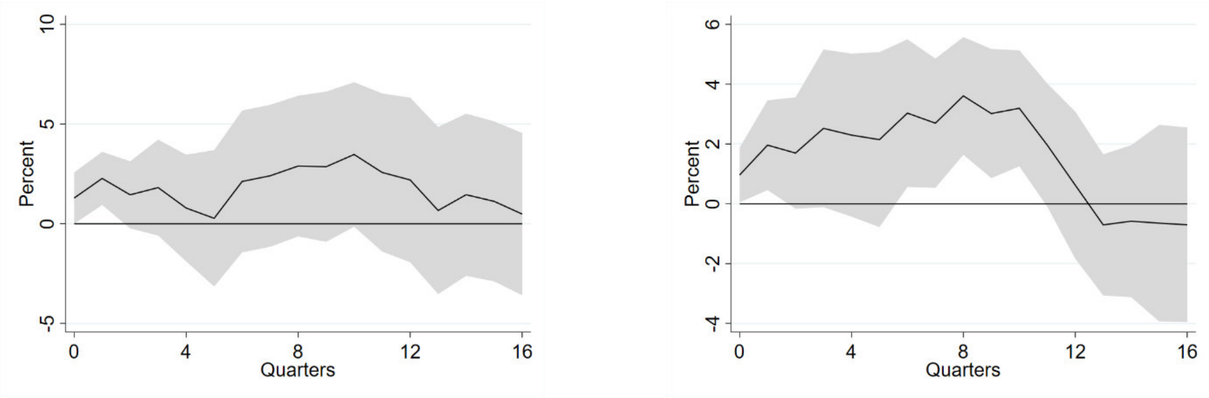
Direct Taxes **Indirect Taxes**



Notes: The shaded area represents 90% confidence bands.

Figure A3: UK: Disaggregated Exogenous Tax Shocks

Direct Taxes **Indirect Taxes**



Notes: The shaded area represents 90% confidence bands.

Figure A4: Transmission Channels, Aggregated Tax Shocks

Germany **UK**

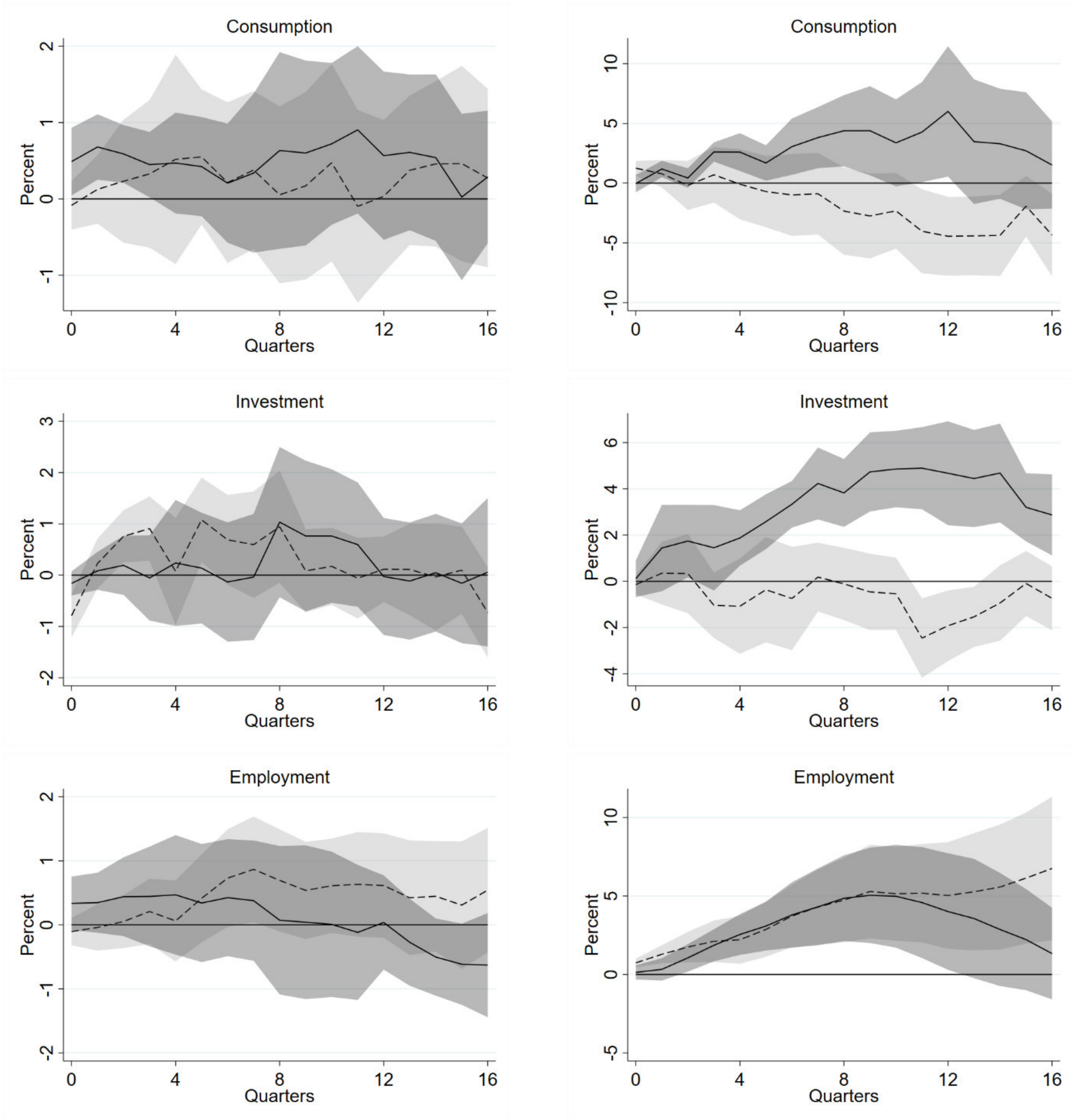


Figure A5: Transmission Channels, State-Dependency, Disaggregated Tax Shocks

Germany | **UK**

Direct | Indirect | Direct | Indirect

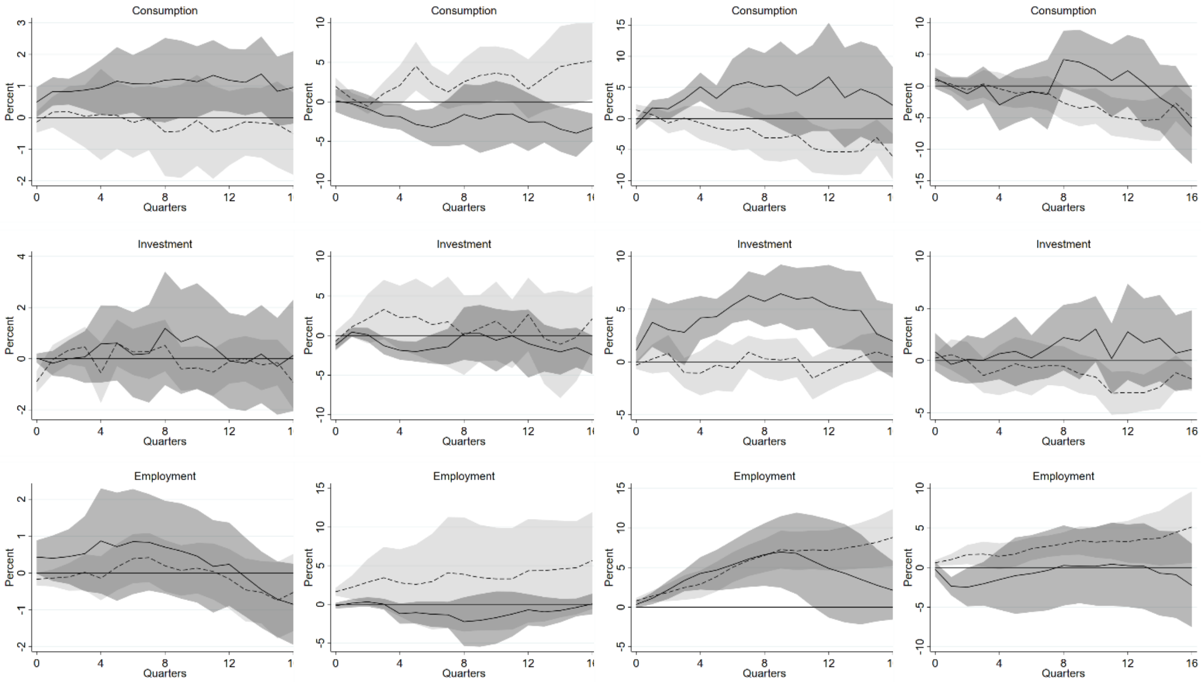


Figure A6: Transmission Channels, State-Dependency, Asymmetric Tax Shocks

Germany | **UK**

Increases | Decreases | Increases | Decreases

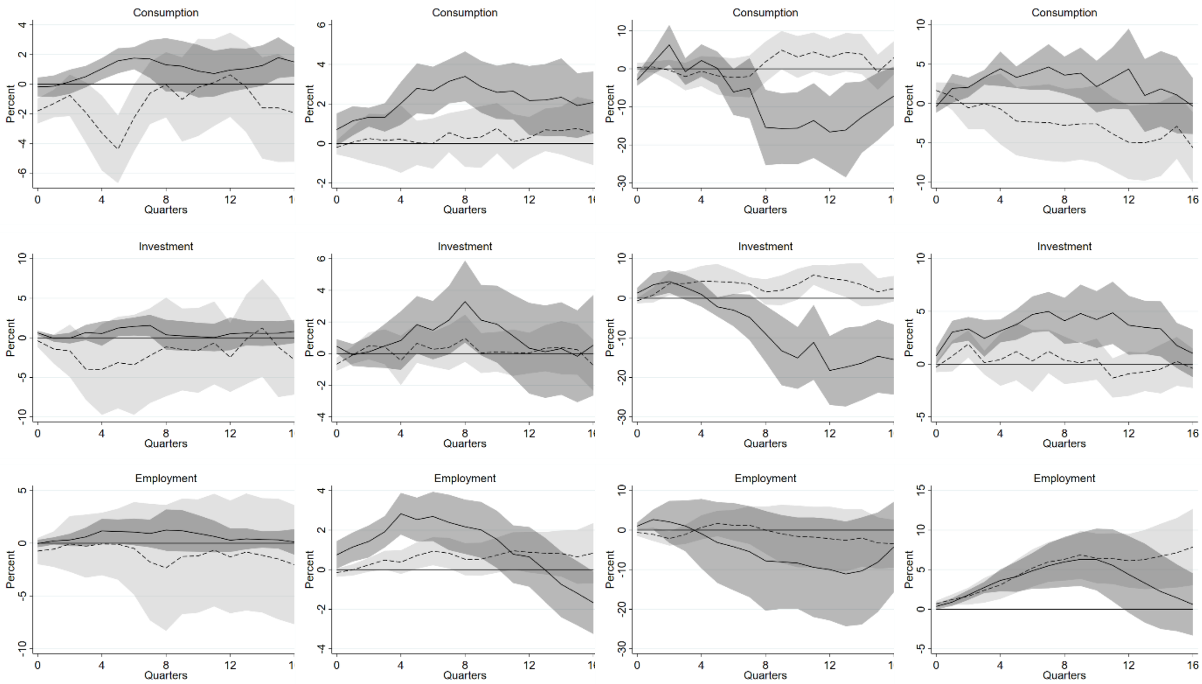


Table A3: Cumulated Multipliers (IV), Aggregated Tax Shocks

	Germany					United Kingdom				
	Non-recessions		**Recessions**		**Difference**	**Non-recessions**		**Recessions**		**Difference**
Steps	Multiplier	F-Stat	Multiplier	F-Stat	p-val	Multiplier	F-Stat	Multiplier	F-Stat	p-val
0	-0.56	49.17	23.02	0.06	0.77	0.61	3.60	-7.33	0.07	0.77
1	-0.40*	22.74	2.10	0.06	0.69	1.28	4.11	-18.02	0.01	0.89
2	-0.55***	56.81	2.04	0.07	0.69	1.45	1.02	5.45	0.07	0.83
3	-0.30^	48.32	2.12	0.22	0.52	2.33	0.41	-7.56	0.03	0.79
4	-0.46*	36.89	1.82	0.16	0.49	3.50	0.07	-4.50	0.09	0.51
5	-0.47**	24.33	1.42	0.44	0.28	6.22	0.02	3.52	0.10	0.92
6	-0.43**	14.29	0.75	0.66	0.09	9.06	0.05	1.89	0.30	0.84
7	-0.37	6.72	0.50	0.85	0.10	77.22	0.00	1.43	0.34	1.00
8	-0.90	3.03	0.56	0.98	0.10	-27.69	0.01	0.62*	2.39	0.92
9	-0.77	1.66	0.16	1.04	0.29	-4.44	0.16	0.39*	3.25	0.58
10	-0.85	1.10	0.03	0.99	0.38	-2.14	0.37	0.32**	5.00	0.36
11	-0.49	1.08	-0.02	0.79	0.52	-1.16	0.73	0.19^	5.44	0.16
12	-0.05	0.99	0.15	0.92	0.70	-1.33	0.63	0.04	5.40	0.26
13	0.03	0.83	0.04	0.99	0.97	-0.70^	1.03	0.04	6.73	0.12
14	-0.01	0.68	-0.17	0.99	0.74	-0.59	0.99	0.07	6.82	0.11
15	0.02	0.57	-0.19	0.95	0.72	-0.50^	1.11	0.11	6.36	0.09
16	-0.19	0.48	-0.35	0.80	0.78	-0.38^	1.10	0.08	4.81	0.09

Notes: For the interpretation as *tax cuts*, multipliers need to be multiplied by (-1). F-Stat indicates the Kleibergen-Paap under-identification test statistic. The column 'Difference' yields the p-value testing coefficients being equal across business cycle states. ^,*,**, and *** indicate significance at the 14, 10, 5, and 1% significance level.

Table A4: Cumulated Multipliers (IV), Direct and Indirect Tax Shocks, Germany

	Shock to Direct Taxes					Shock to Indirect Taxes				
	Non-recessions		**Recessions**		**Difference**	**Non-recessions**		**Recessions**		**Difference**
Steps	Multiplier	F-Stat	Multiplier	F-Stat	p-val	Multiplier	F-Stat	Multiplier	F-Stat	p-val
0	-1.38*	24.46	6.72	0.92	0.14	1.98**	23.61	1.69^	9.10	0.95
1	-0.52*	15.27	0.40	1.09	0.50	0.55	12.10	0.57	3.79	0.89
2	-0.62***	21.67	-0.36	0.23	0.93	0.27	8.78	-0.31	1.97	0.72
3	-0.50**	27.34	-1.01	0.10	0.92	1.14*	6.92	1.61	1.43	0.70
4	-0.67**	38.80	0.33	0.11	0.69	1.05	4.56	1.80	0.58	0.70
5	-0.73***	27.81	47.04	0.00	1.00	0.85	3.03	3.62	0.29	0.71
6	-0.58**	14.51	-0.01	0.08	0.80	0.12	2.13	4.26	0.07	0.85
7	-0.37	6.64	-0.21	0.26	0.91	-0.37	2.14	19.22	0.00	0.97
8	-0.62	3.48	0.07	0.35	0.40	-1.64	1.81	-27.74	0.00	0.90
9	-0.38	2.20	-0.68	0.48	0.79	-1.40	2.71	374.57	0.00	0.94
10	-0.43	1.64	-1.03	0.43	0.69	-0.91*	6.67	52.02	0.00	0.97
11	-0.14	1.86	-1.12	0.33	0.64	-0.63**	5.56	14.59	0.00	1.00
12	0.10	2.05	-0.60	0.51	0.53	-0.22	3.77	7.65	0.02	0.93
13	0.19	1.73	-0.83	0.63	0.47	-0.18	4.02	4.57	0.04	0.86
14	0.13	2.17	-1.35	0.62	0.50	-0.10	3.99	2.63	0.10	0.79
15	0.11	1.57	-1.58	0.49	0.57	-0.01	4.02	1.62	0.18	0.73
16	-0.03	1.43	-2.53	0.29	0.74	0.16	4.42	3.01	0.30	0.61

Notes: See Table A1

Table A5: Cumulated Multipliers (IV), Direct and Indirect Tax Shocks, United Kingdom

	Shock to Direct Taxes					Shock to Indirect Taxes				
	Non-recessions		**Recessions**		**Difference**	**Non-recessions**		**Recessions**		**Difference**
Steps	Multiplier	F-Stat	Multiplier	F-Stat	p-val	Multiplier	F-Stat	Multiplier	F-Stat	p-val
0	0.47	0.27	1.20	3.58	0.61	-0.23	2.10	0.10	7.03	0.74
1	3.70	0.41	0.51	2.61	0.55	-1.03	0.06	-0.26	15.83	0.89
2	2.34	0.47	0.37^	1.55	0.51	-11.45	0.00	-0.09	17.49	0.94
3	2.11	0.85	0.26	1.35	0.39	-0.27	0.18	-0.15	8.23	0.96
4	1.23*	2.48	0.27	1.52	0.32	0.30	0.08	-0.22	6.09	0.91
5	0.97	2.03	0.31	0.98	0.64	4.03	0.01	-0.15	5.62	0.91
6	1.45^	1.73	0.38^	1.23	0.53	8.85	0.01	0.04	5.00	0.90
7	1.02*	2.08	0.46^	1.12	0.81	-23.26	0.00	0.30	2.14	0.95
8	0.82**	2.62	0.40*	1.14	0.84	2.76	0.38	0.54	1.35	0.53
9	0.76**	2.55	0.37*	1.20	0.83	2.95	0.19	0.94	0.85	0.69
10	0.44***	3.22	0.37**	1.28	0.77	4.43	0.04	1.10	0.78	0.86
11	0.40**	3.74	0.33**	1.41	0.80	9.67	0.01	2.39	0.31	0.95
12	0.77^	2.07	0.30**	1.58	0.68	1.32	0.15	3.75	0.28	0.68
13	0.39^	3.44	0.31**	1.85	0.90	1.46	0.17	6.04	0.17	0.71
14	0.42	2.34	0.31**	2.03	0.96	0.64	0.24	10.74	0.05	0.82
15	0.33	2.62	0.27***	2.21	0.90	0.42	0.22	-6.91	0.03	0.76
16	0.23	3.67	0.15***	2.45	0.97	0.01	0.48	-8.11	0.01	0.91

Notes: See Table A1

Table A6: Germany, Cumulative Multipliers (IV), Asymmetric Tax Shocks

	Tax Hikes					Tax Cuts				
	Non-recessions		**Recessions**		**Difference**	**Non-recessions**		**Recessions**		**Difference**
Steps	Multiplier	F-Stat	Multiplier	F-Stat	p-val	Multiplier	F-Stat	Multiplier	F-Stat	p-val
0	0.81**	23.25	0.79***	9.10	0.99	-3.82*	4.67	2.78**	23.18	0.01
1	0.13	11.55	0.61*	4.06	0.11	-1.42	5.64	0.32	11.38	0.22
2	0.11	12.51	0.24	1.93	0.69	-1.40***	13.07	-0.56	3.38	0.29
3	0.56**	10.15	0.68*	1.82	0.73	-0.94**	18.29	-0.48	1.75	0.43
4	0.49**	5.35	0.79^	1.08	0.56	-1.28**	12.41	-0.39	1.05	0.20
5	0.58**	3.83	0.65	0.94	0.84	-1.48***	10.95	-0.52	0.68	0.17
6	0.58**	2.79	0.70**	0.97	0.69	-1.39**	7.23	-0.18	0.41	0.11
7	0.89*	1.80	0.44*	1.11	0.37	-1.61**	3.90	-0.64	0.19	0.21
8	0.20	0.77	0.25	0.90	0.92	-1.78^	2.12	-1.93	0.08	0.59
9	0.35	0.24	0.26	0.89	0.98	-1.16	1.71	-1.06	0.04	0.47
10	1.20	0.03	0.16	0.85	0.91	-1.04	1.41	-1.13	0.03	0.57
11	89.73	0.00	0.06	0.77	0.98	-0.53	1.81	-0.82	0.04	0.88
12	-3.16	0.05	0.11	0.73	0.81	-0.27	2.32	-1.90	0.02	0.88
13	-2.23	0.10	0.09	0.77	0.75	-0.16	2.28	-1.01	0.02	0.90
14	-1.78	0.11	-0.01	0.79	0.74	-0.13	1.98	0.17	0.02	0.81
15	-1.33	0.17	0.03	0.81	0.67	-0.12	1.63	0.50	0.02	0.80
16	-1.20	0.19	0.14	0.74	0.65	-0.26	1.37	1.44	0.03	0.79

Notes: See Table A1.

Table A7: UK, Cumulative Multipliers (IV), Asymmetric Tax Shocks

	Tax Hikes					Tax Cuts				
	Non-recessions		Recessions		Difference	Non-recessions		Recessions		Difference
Steps	Multiplier	F-Stat	Multiplier	F-Stat	p-val	Multiplier	F-Stat	Multiplier	F-Stat	p-val
0	1.03	0.02	0.37	0.50	0.89	1.21	1.71	4.25	0.69	0.44
1	-1.15	0.00	-0.96	0.25	0.99	2.20	1.36	3.82	1.01	0.73
2	1.87	0.15	-4.37	0.01	0.87	2.22	0.85	2.18	0.77	0.95
3	0.31	0.04	6.37	0.00	0.95	2.72	0.39	6.03	0.08	0.91
4	0.19	0.22	0.41	0.63	0.87	2.76	0.37	-4.67	0.09	0.51
5	-0.30	0.24	0.14	1.62	0.47	3.23	0.21	-9.69	0.01	0.81
6	-1.78	0.18	-0.02	2.67	0.64	6.03	0.09	-4.70	0.03	0.16
7	-1.15	0.43	-0.08	3.68	0.52	11.89	0.02	-3.39	0.05	0.75
8	-1.98	0.38	-0.13	4.17	0.53	-7.44	0.03	-9.76	0.01	0.95
9	-1.36	0.62	-0.13	4.39	0.45	-2.55	0.19	49.48	0.00	0.98
10	-0.89	1.00	-0.11	4.49	0.37	-1.93	0.20	2.57	0.05	0.66
11	-0.62	1.67	-0.15^	4.39	0.36	-1.41	0.22	1.33	0.08	0.54
12	-0.40	2.32	-0.17	3.79	0.46	-2.74	0.09	0.63	0.25	0.68
13	-0.36*	3.14	-0.17	3.48	0.43	-1.02	0.22	0.44	0.46	0.46
14	-0.27*	3.47	-0.19^	3.52	0.62	-0.90	0.19	0.48	0.56	0.47
15	-0.24*	3.69	-0.13*	3.53	0.46	-0.63	0.20	0.50	0.56	0.44
16	-0.19*	4.11	-0.12*	3.24	0.56	-0.47	0.14	0.42	0.35	0.49

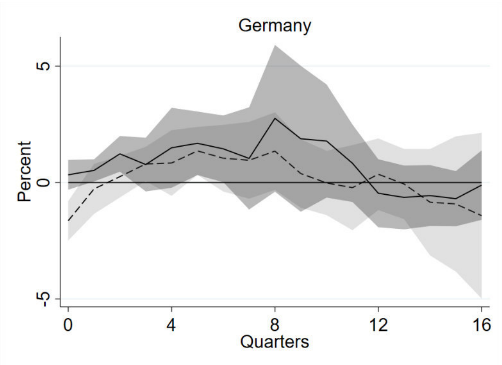
Notes: See Table A1

With Quadratic and Cubic Trend

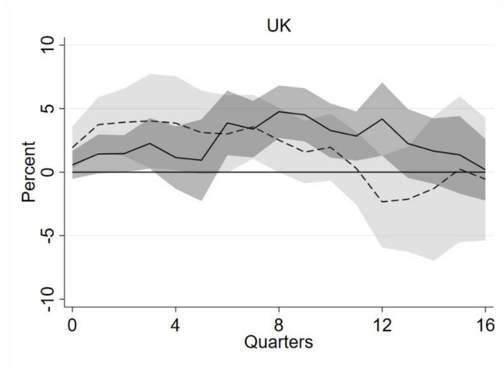
Aggregated Tax Shocks

Figure A 7: Aggregated Tax Shocks

Germany



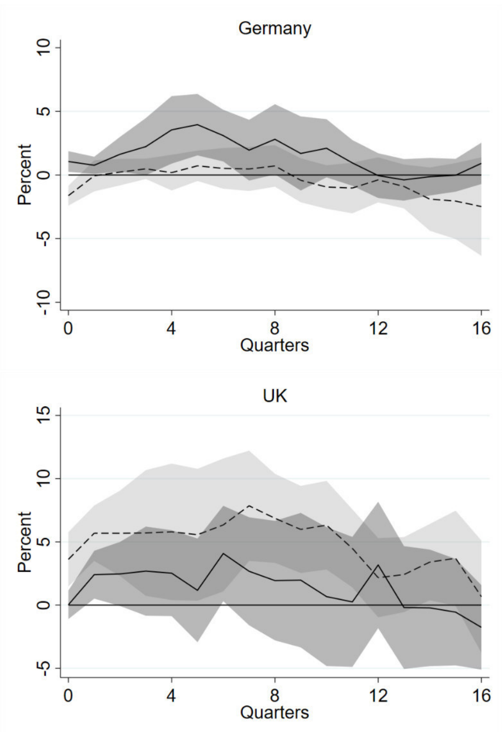
UK



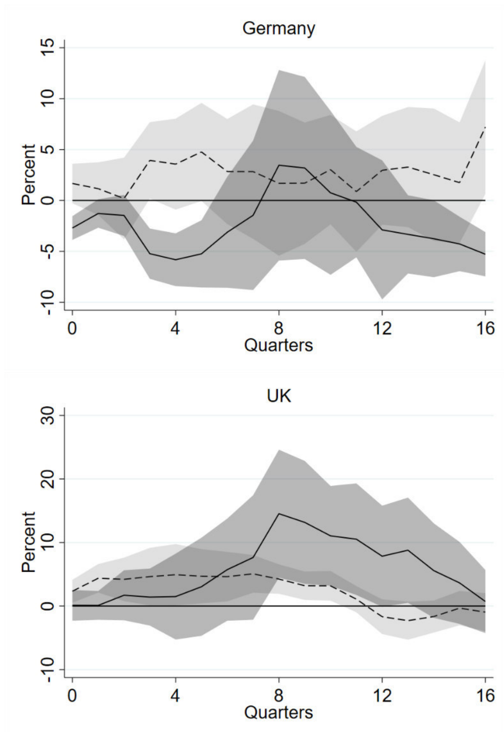
Disaggregated Tax Shocks

Figure A 8: Disggregated Tax Shocks

Direct



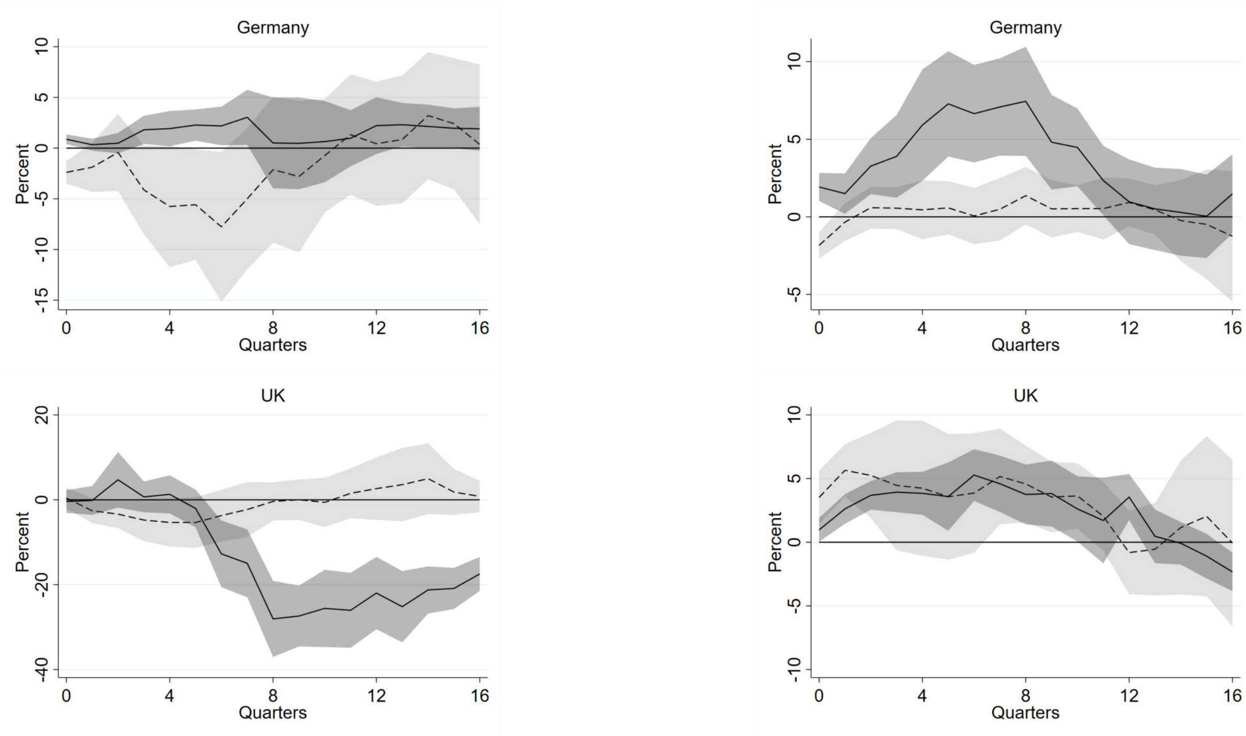
Indirect



Asymmetric Tax Shocks

Figure A 9: Asymmetric Tax Shocks

Tax Hike | Tax Cut

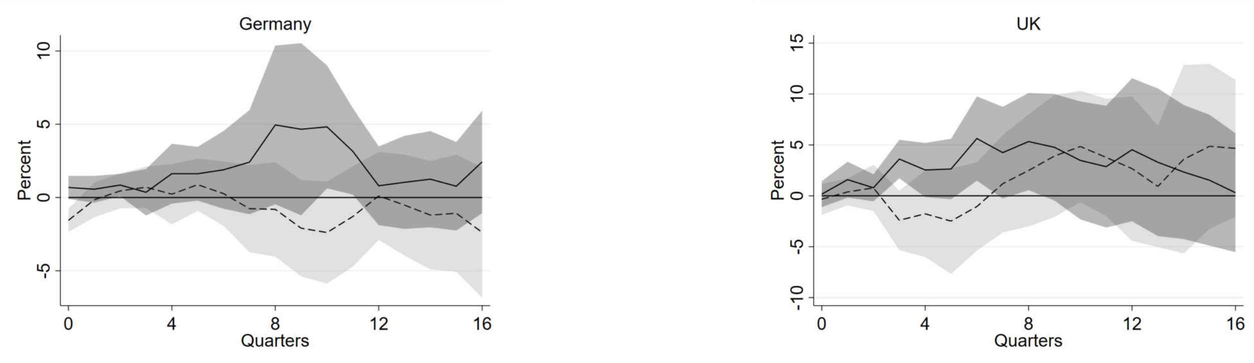


A&G (2012) Recession Indicator

Aggregated Tax Shocks

Figure A 10: Aggregated Tax Shocks

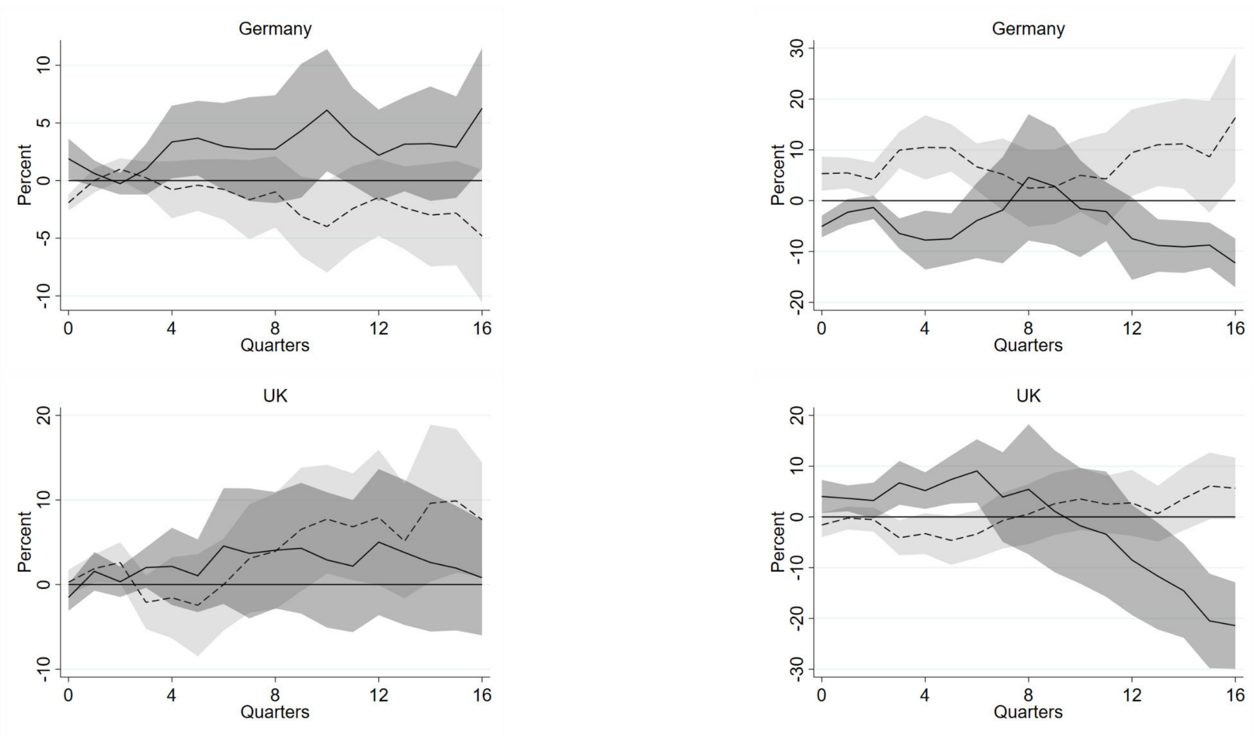
Germany UK



Disaggregated Tax Shocks

Figure A 11: Disggregated Tax Shocks

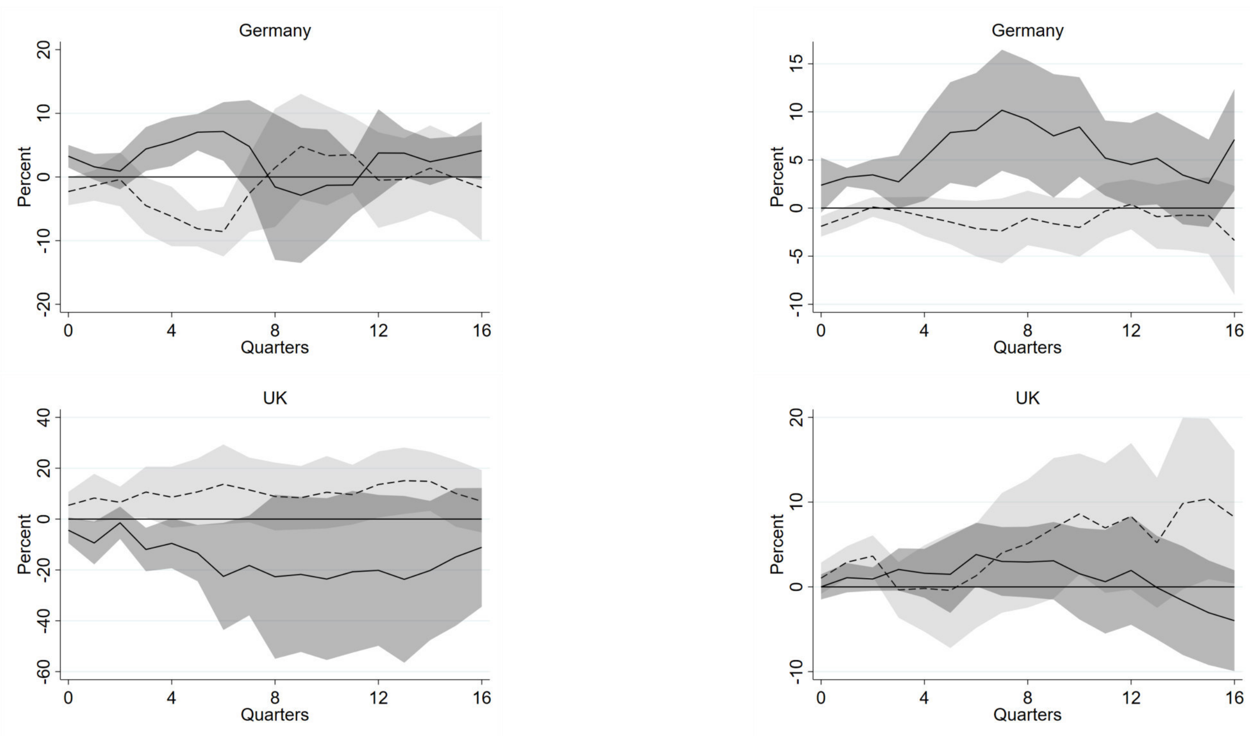
Direct Indirect



Asymmetric Tax Shocks

Figure A 12: Asymmetric Tax Shocks

Tax Hike | Tax Cut



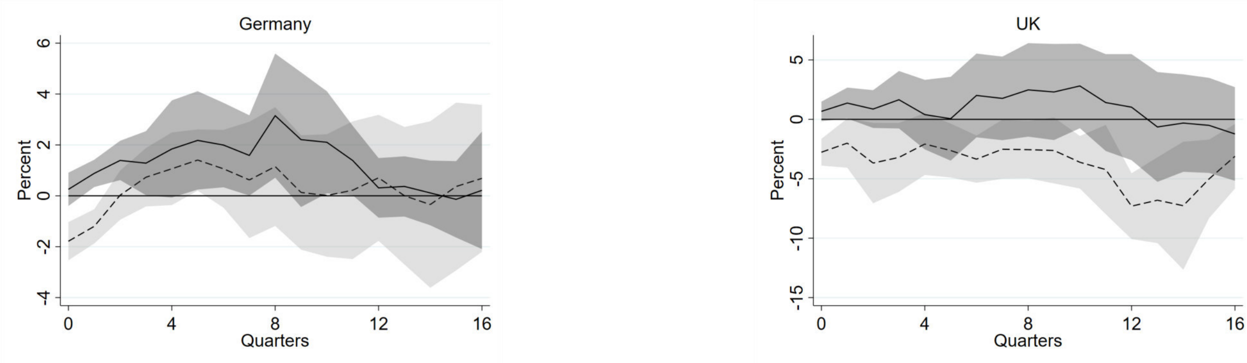
ECRI Recession Indicator

Aggregated Tax Shocks

Figure A 13: Aggregated Tax Shocks

Germany

UK

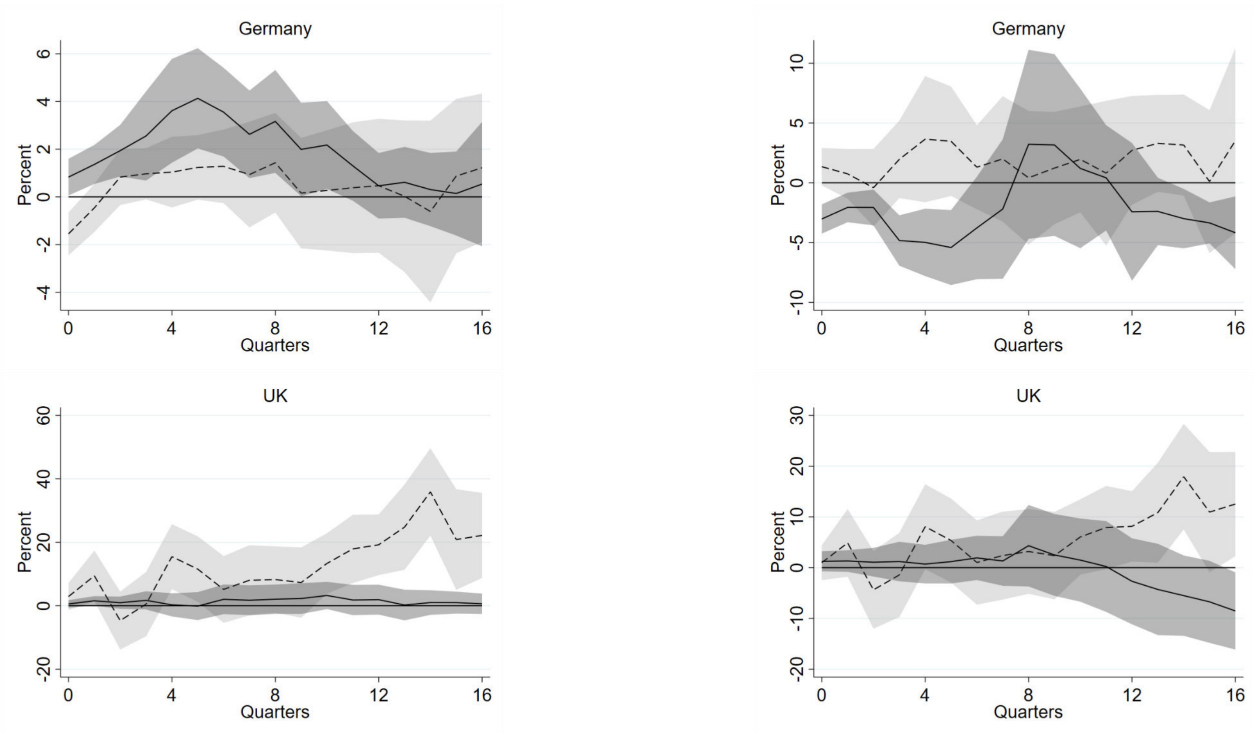


Disaggregated Tax Shocks

Figure A 14: Disaggregated Tax Shocks

Direct

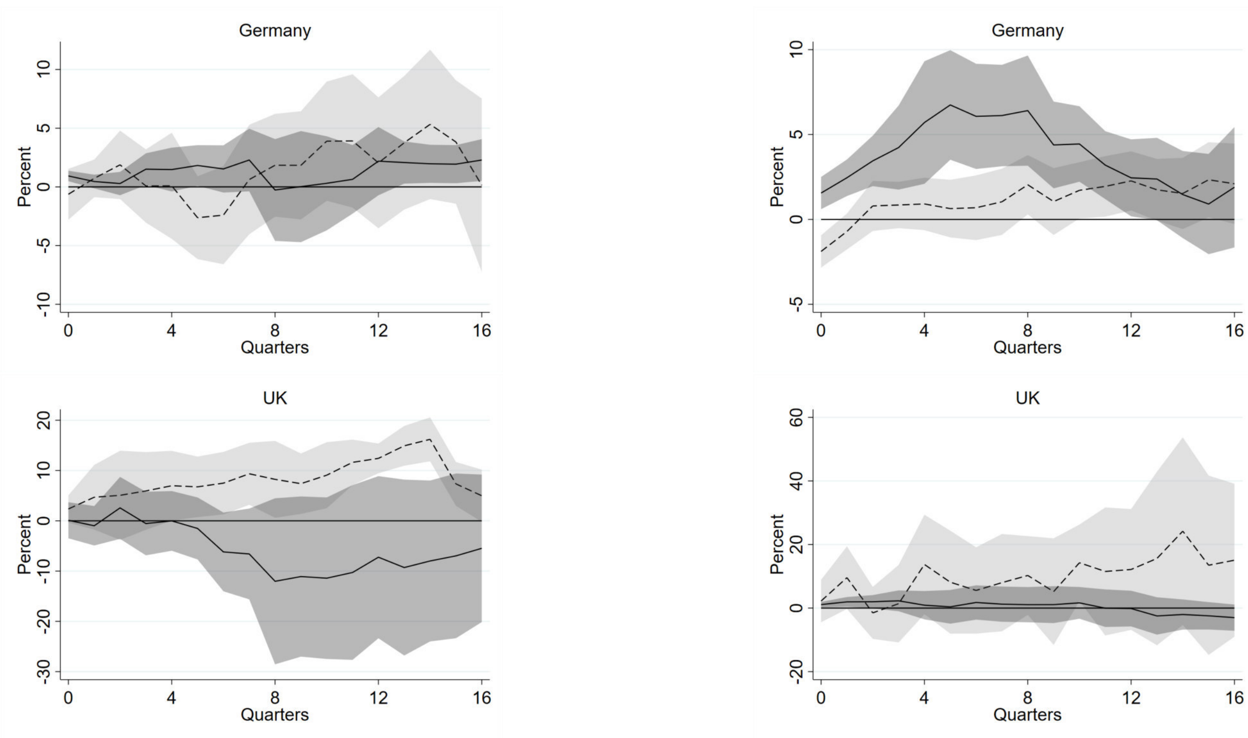
Indirect



Asymmetric Tax Shocks

Figure A 15: Asymmetric Tax Shocks

Tax Hike | Tax Cut



With Varying Lag Length of Exogenous Tax Shocks

Aggregated Tax Shocks

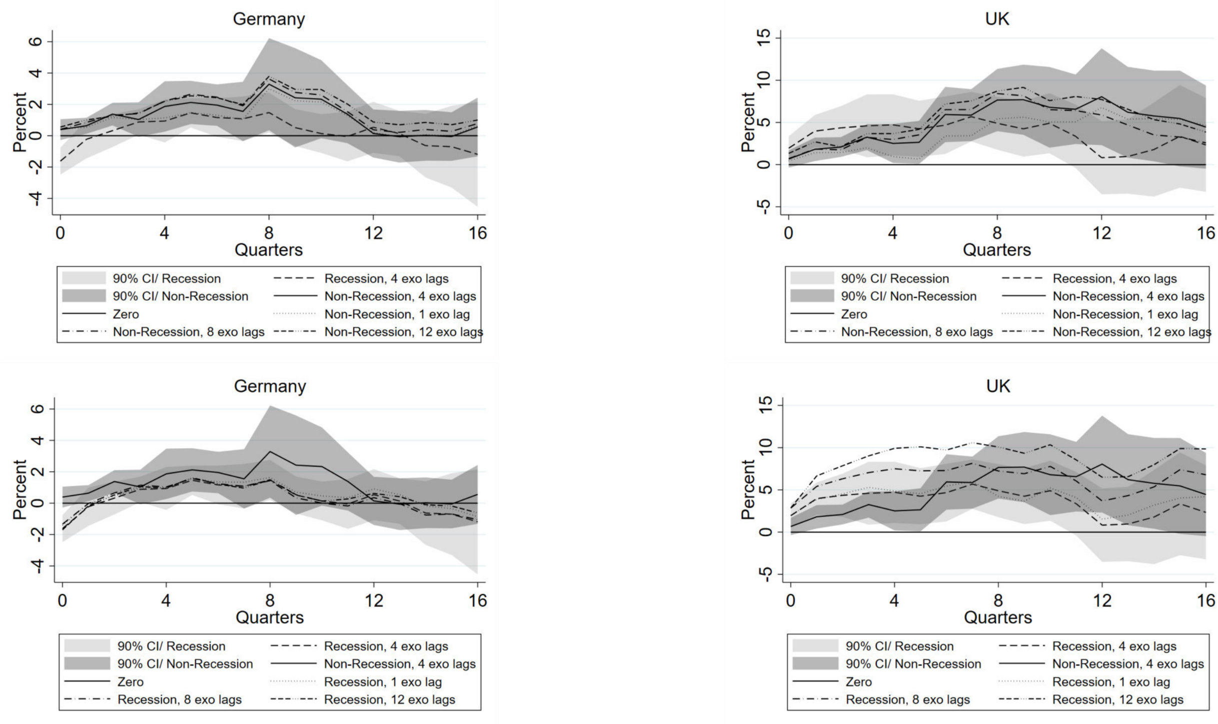
Figure A 16: Aggregated Tax Shocks

Germany

UK

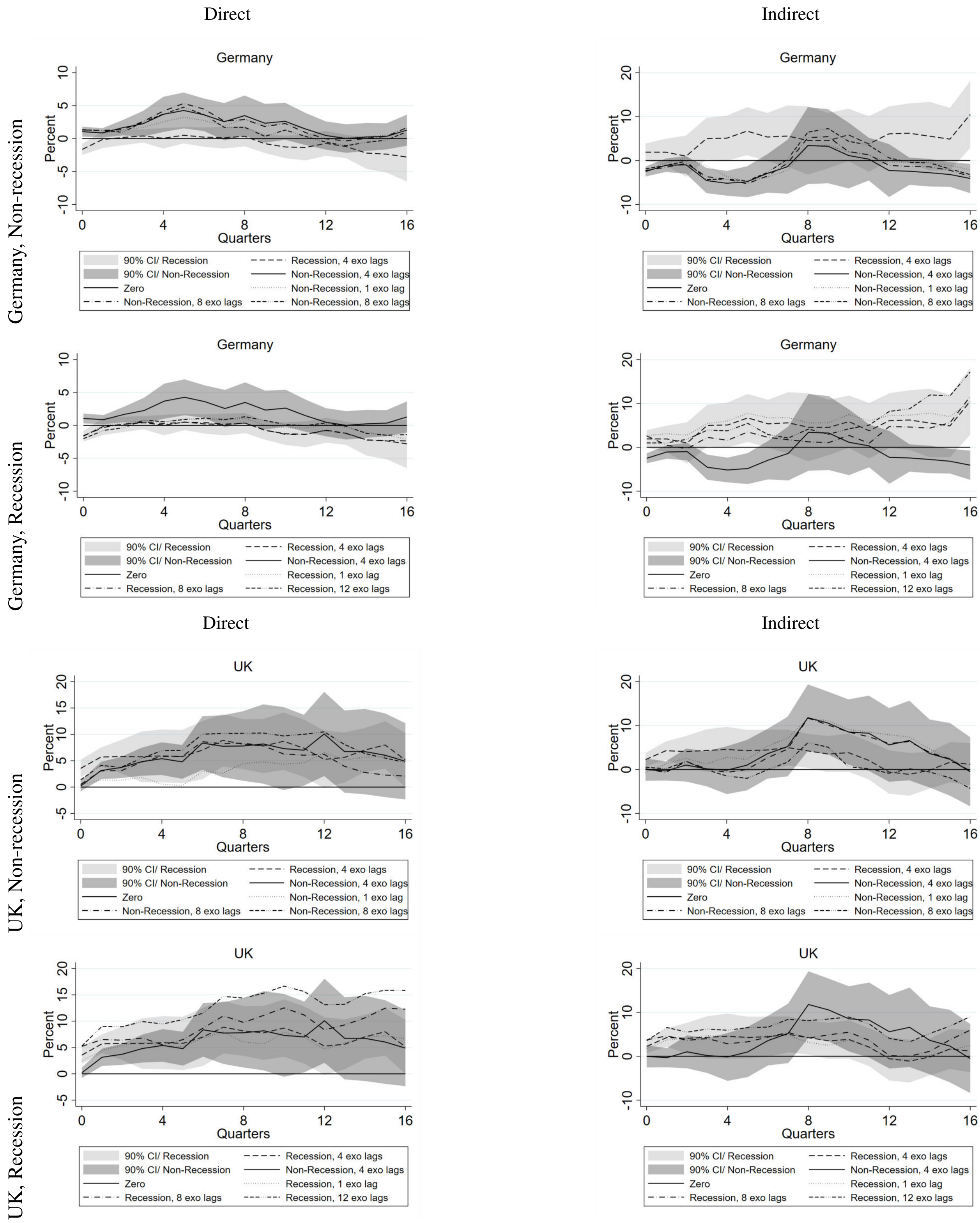
Non-recession

Recession



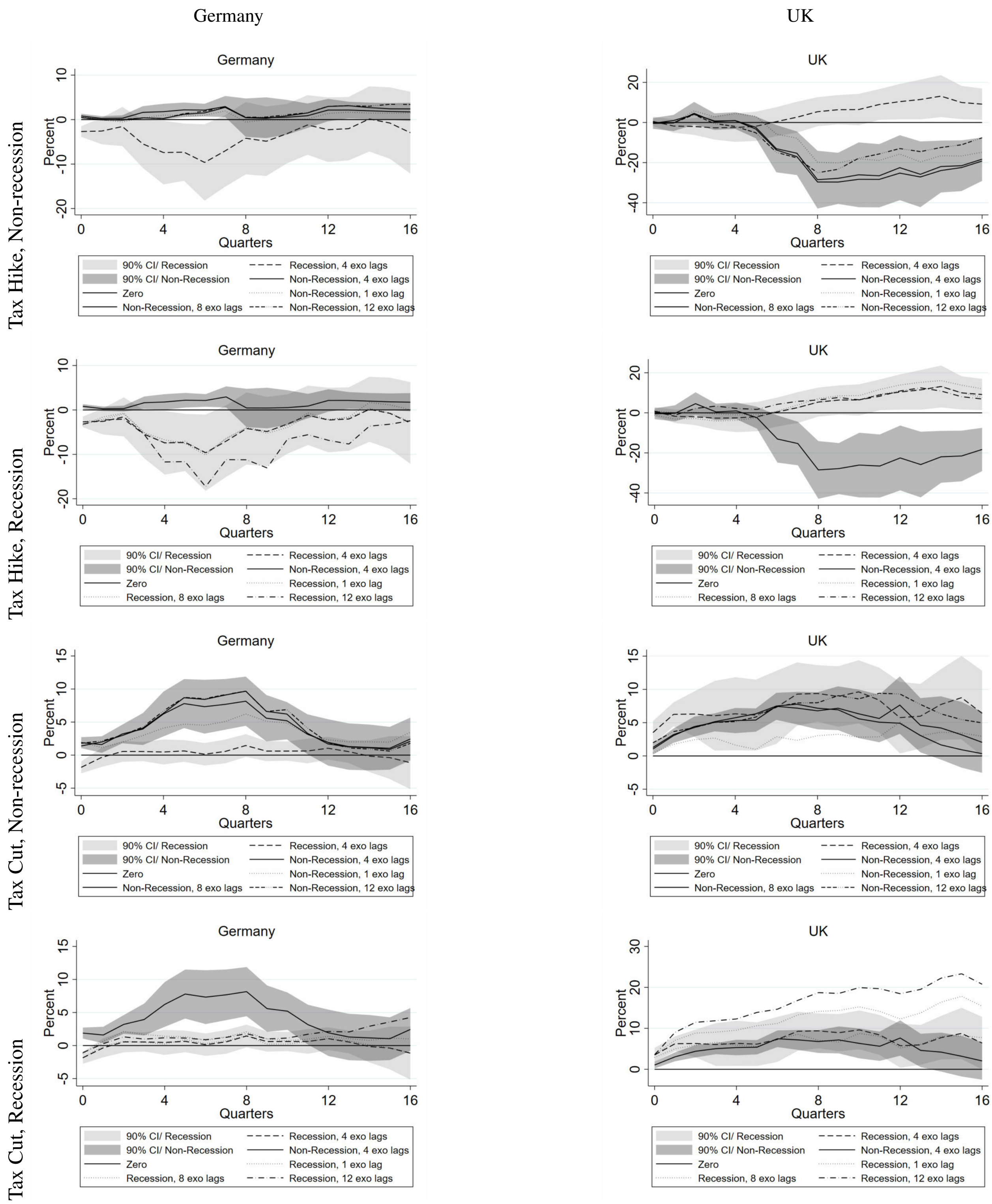
Disaggregated Tax Shocks

Figure A 17: Disaggregated Tax Shocks



Asymmetric Tax Shocks

Figure A 18: Asymmetric Tax Shocks



Varying Lag Length of Controls

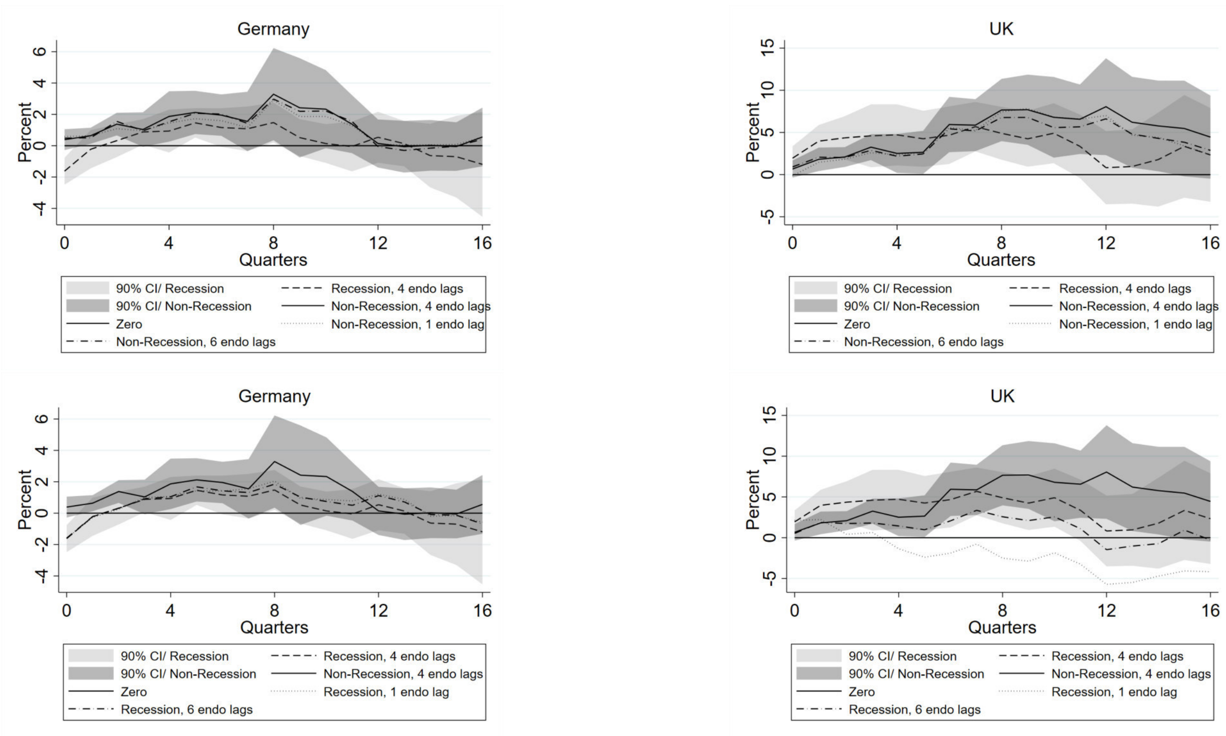
Aggregated Tax Shocks

Figure A 19: Aggregated Tax Shocks

Germany UK

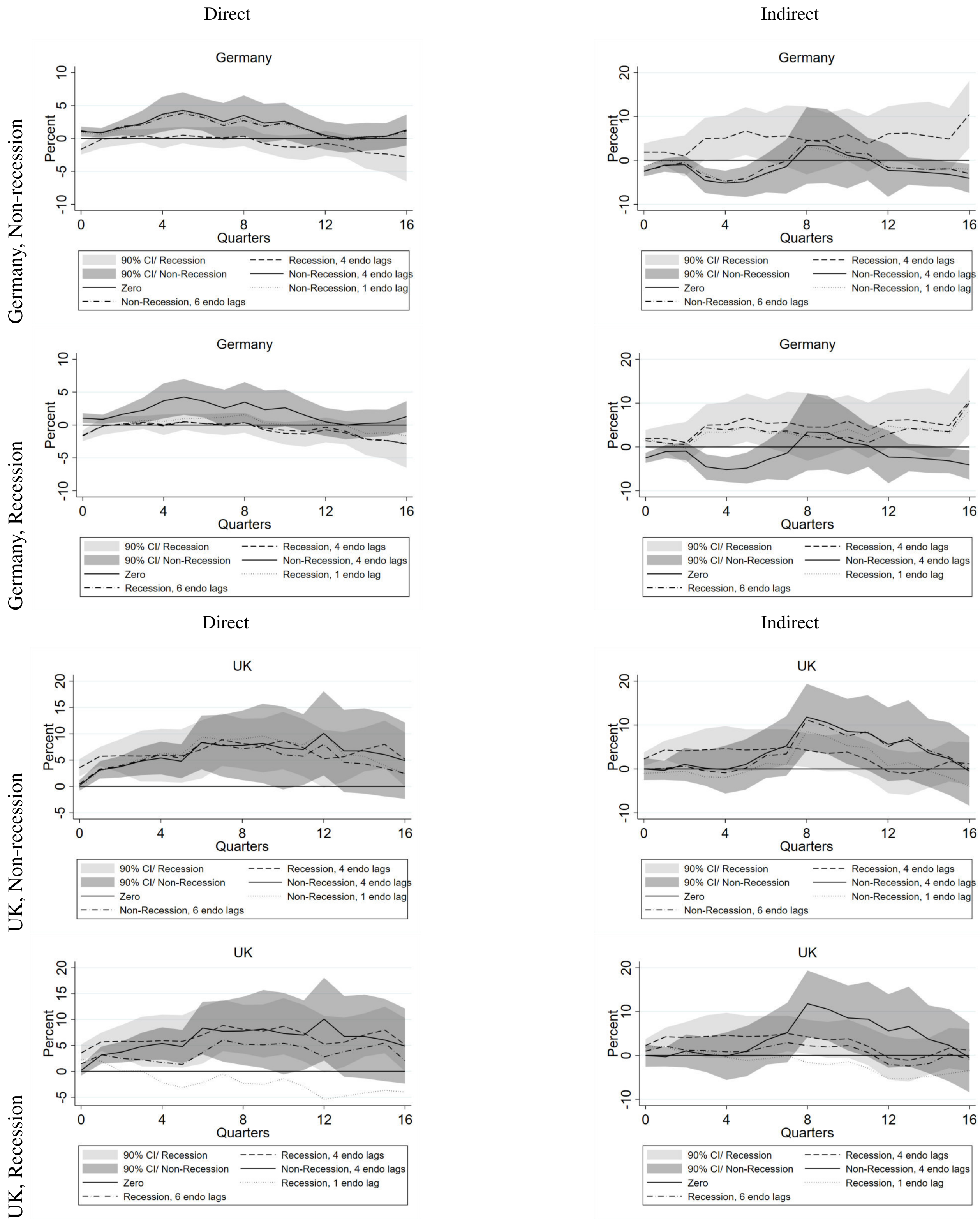
Non-recession

Recession



Disaggregated Tax Shocks

Figure A 20: Disaggregated Tax Shocks



Asymmetric Tax Shocks

Figure A 21: Asymmetric Tax Shocks

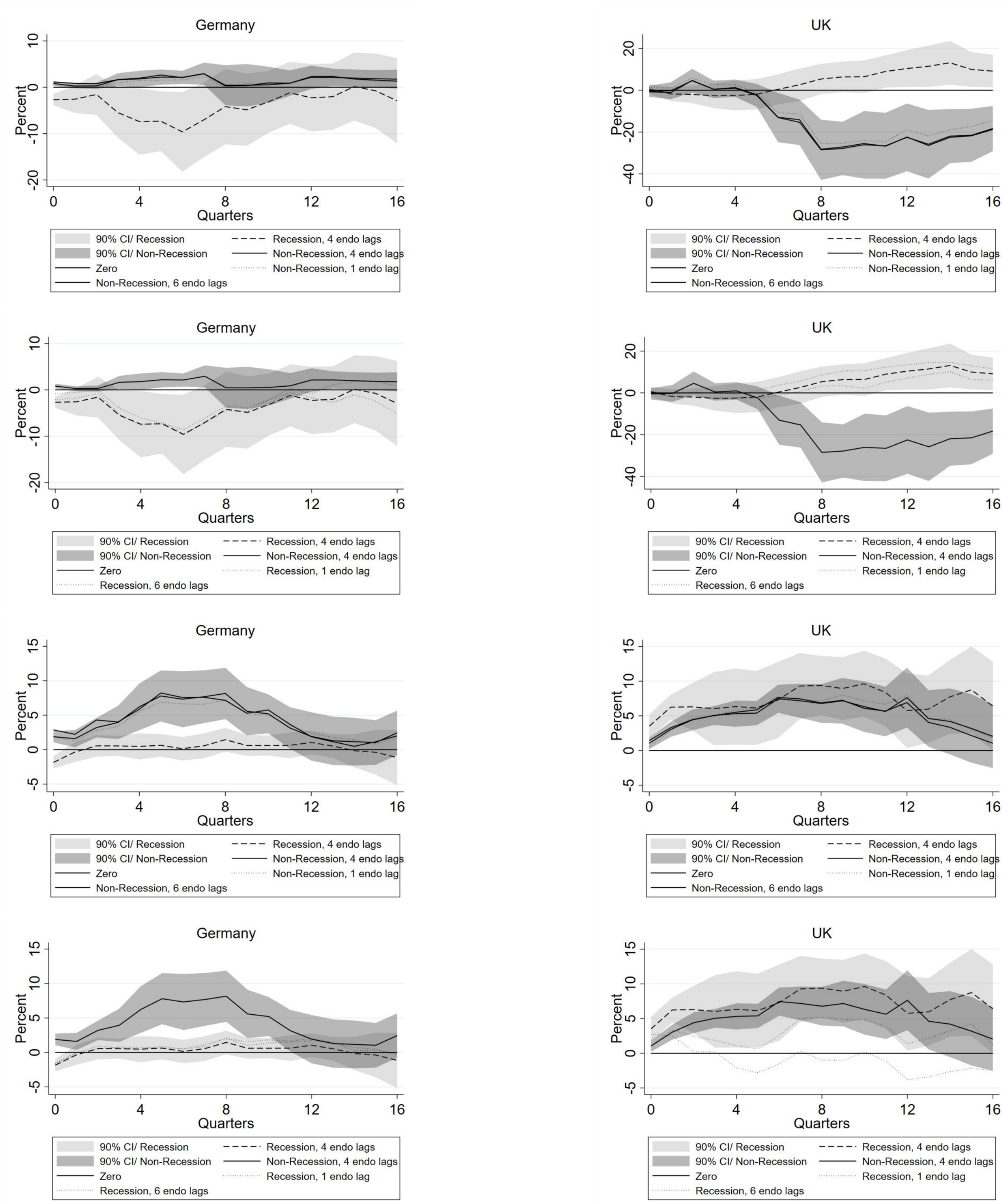
Germany UK

Tax Hike, Non-recession

Tax Hike, Recession

Tax Cut, Non-recession

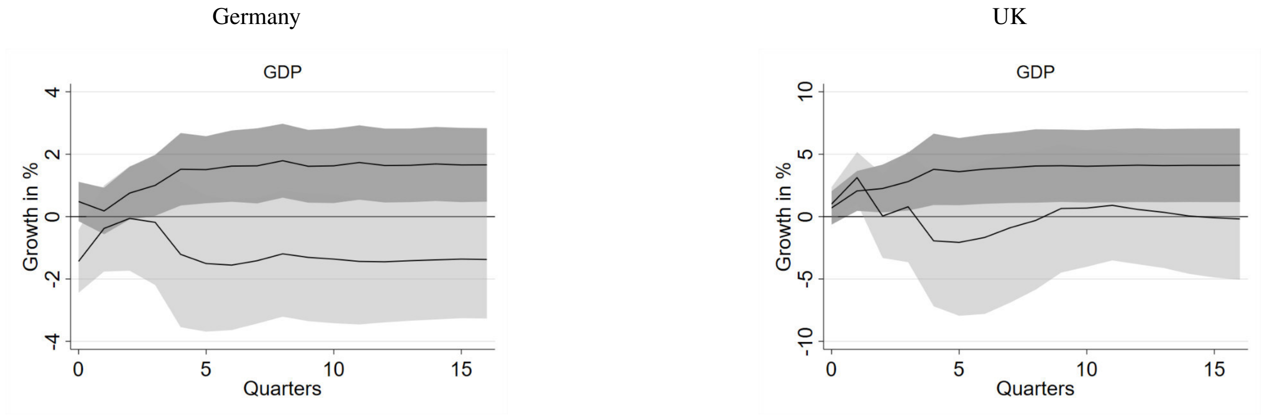
Tax Cut, Recession



Treshold VAR

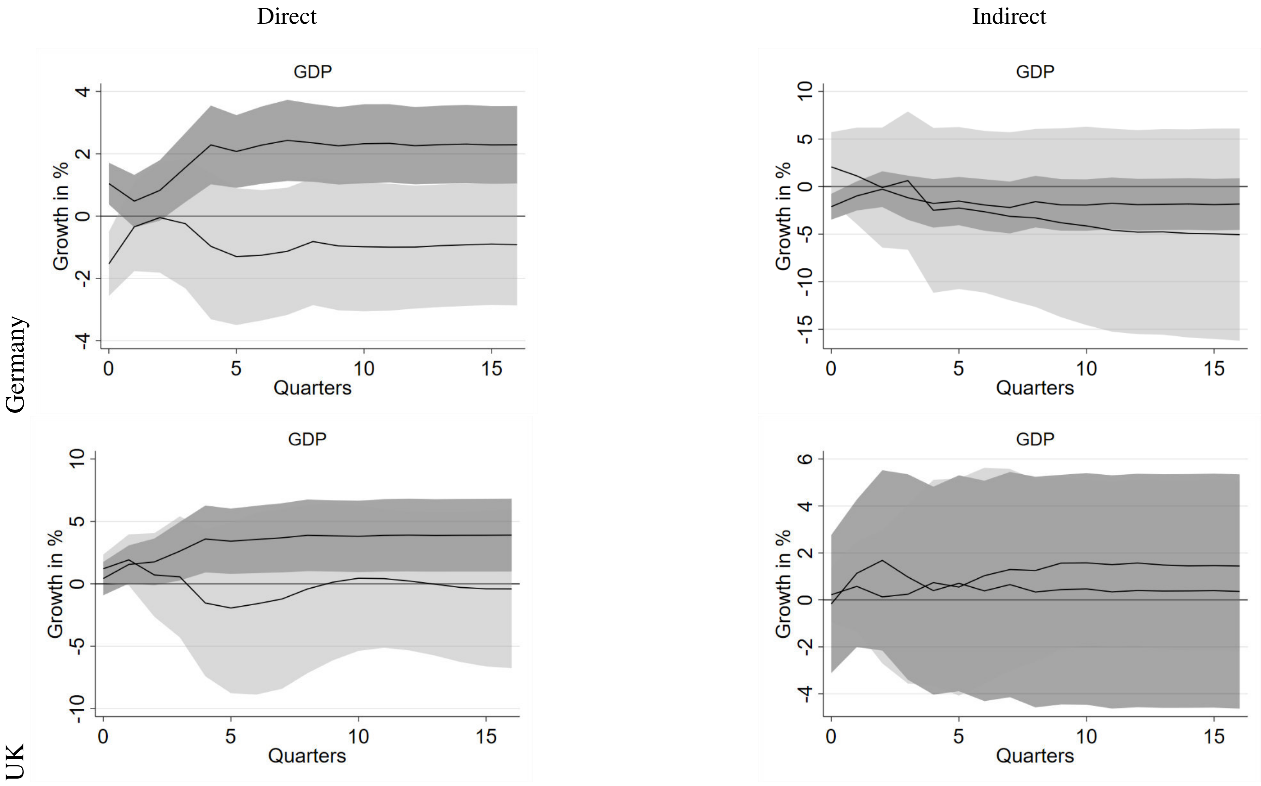
Aggregated Tax Shocks

Figure A 22: Aggregated Tax Shocks



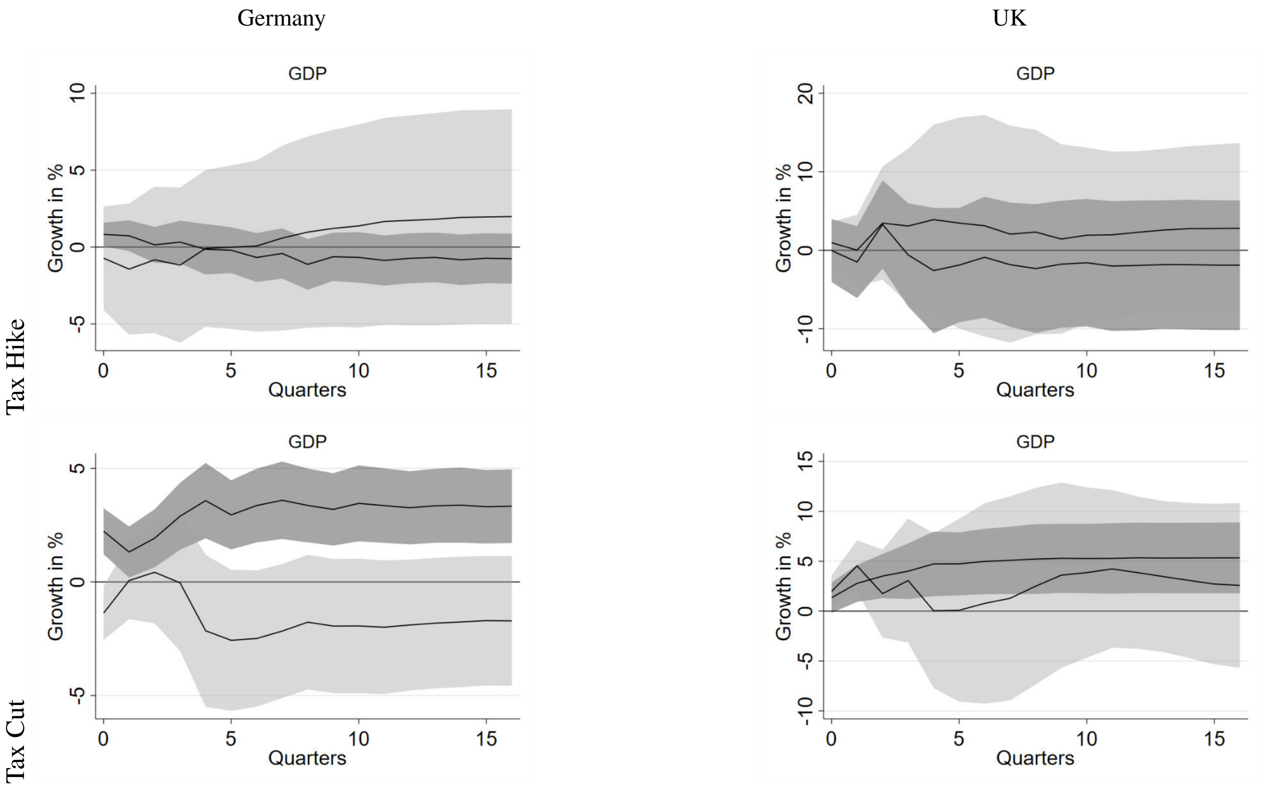
Disaggregated Tax Shocks

Figure A 23: Disaggregated Tax Shocks



Asymmetric Tax Shocks

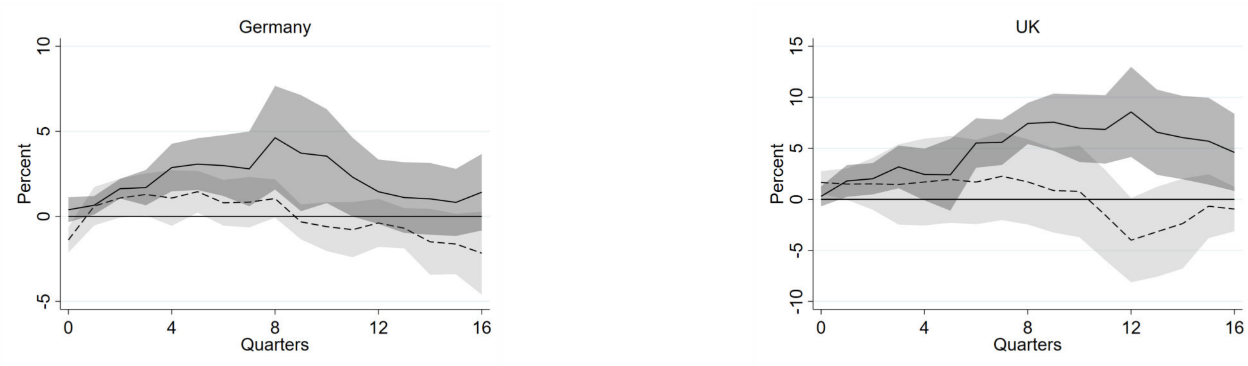
Figure A 24: Asymmetric Tax Shocks



Estimated with Inflation and Interest Rates

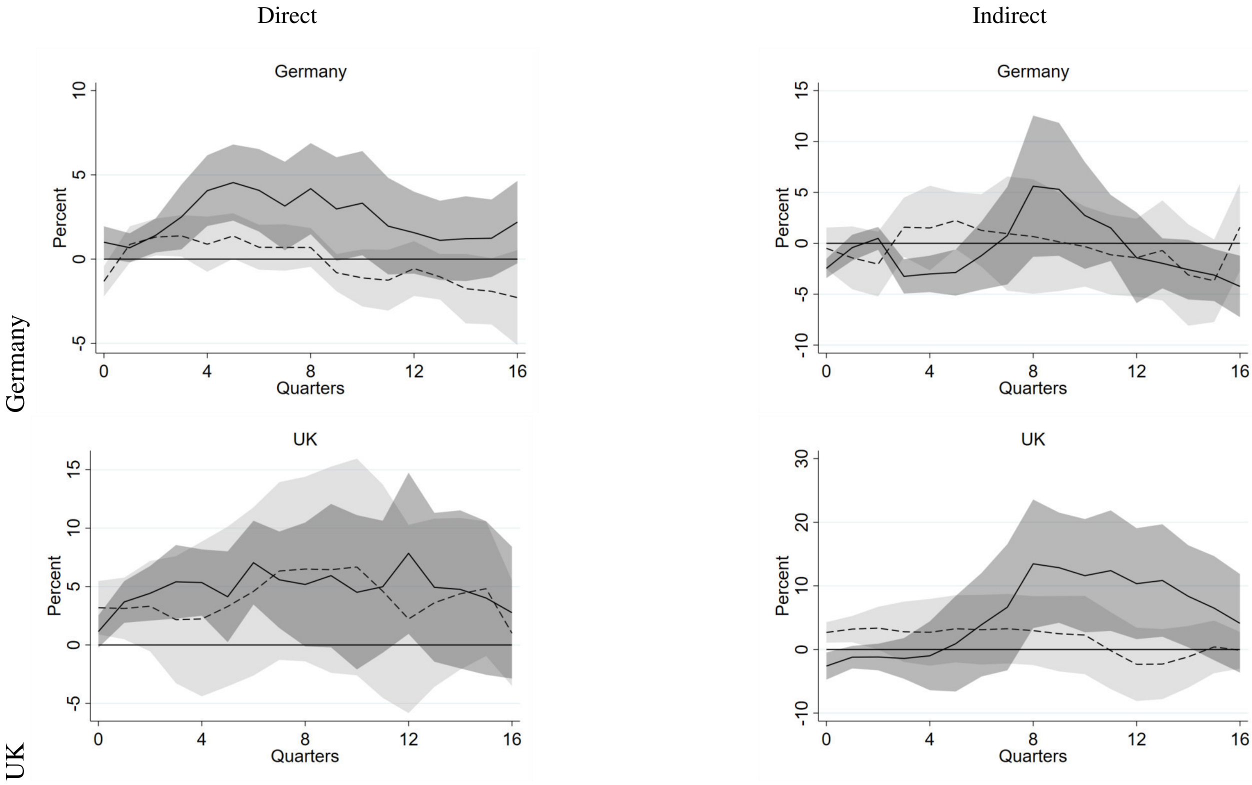
Aggregated Tax Shocks

Figure A 25: Aggregated Tax Shocks



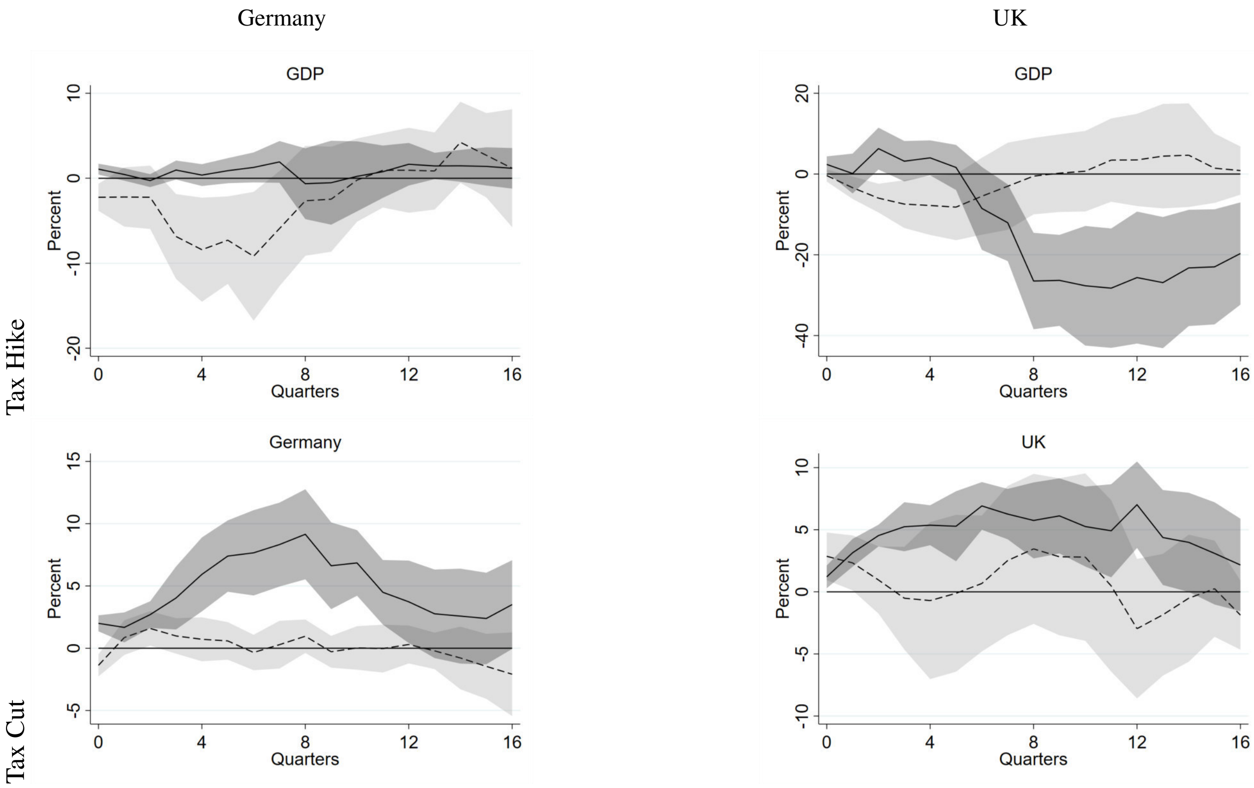
Disaggregated Tax Shocks

Figure A 26: Disaggregated Tax Shocks



Asymmetric Tax Shocks

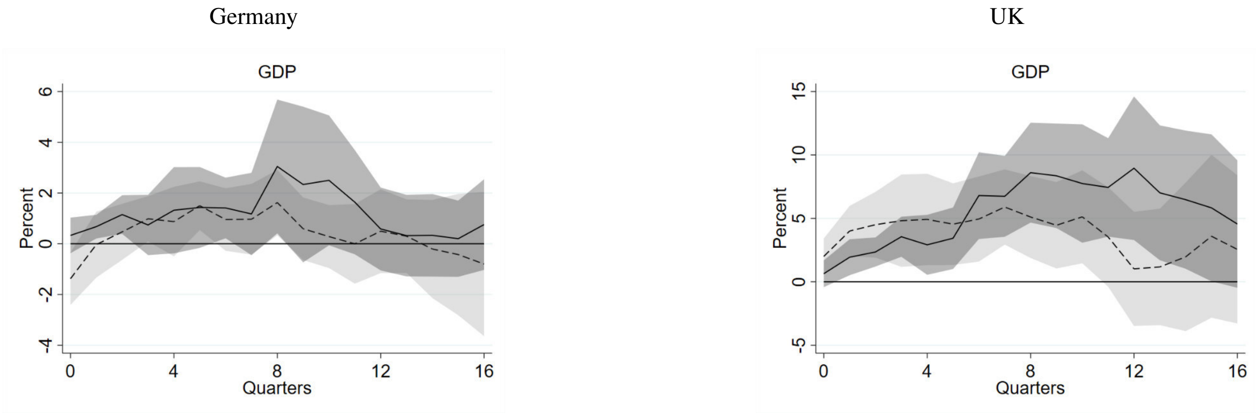
Figure A 27: Asymmetric Tax Shocks



Only Permanent Tax Shocks

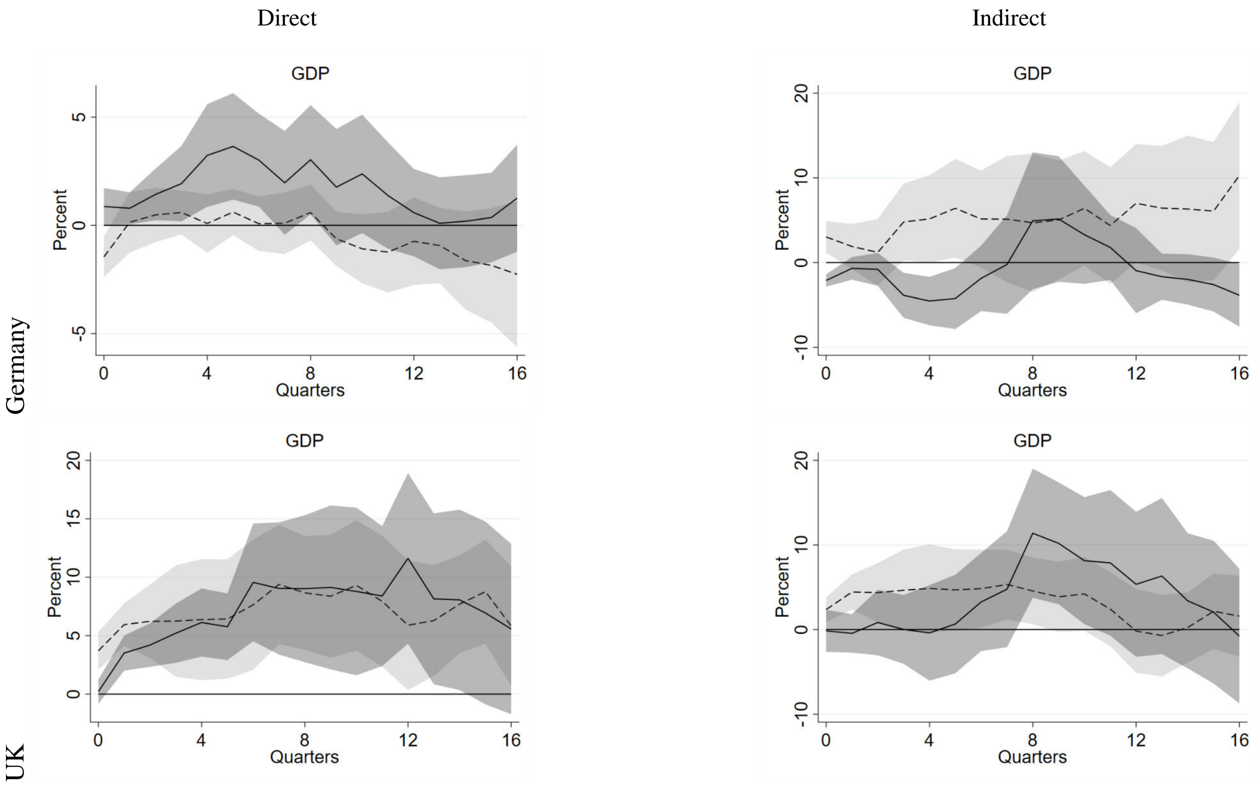
Aggregated Tax Shocks

Figure A 28: Aggregated Tax Shocks



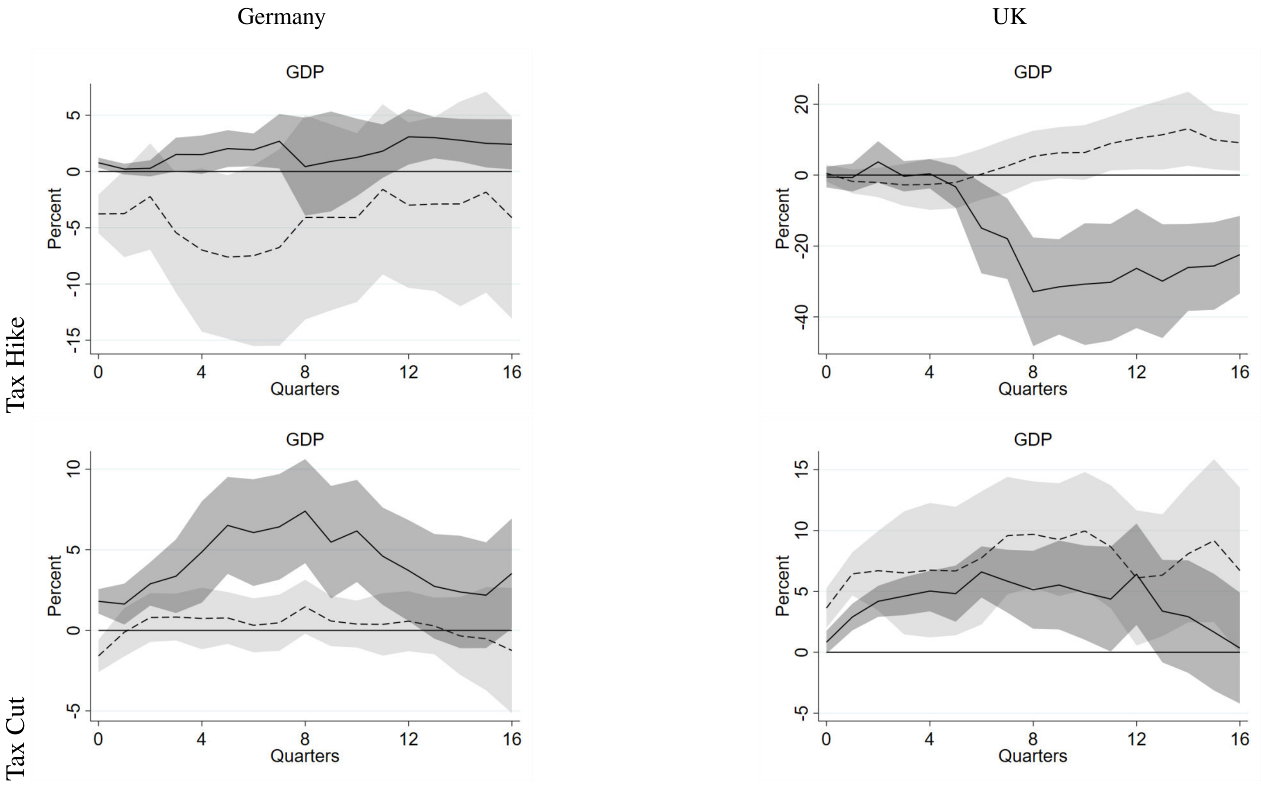
Disaggregated Tax Shocks

Figure A 29: Disaggregated Tax Shocks



Asymmetric Tax Shocks

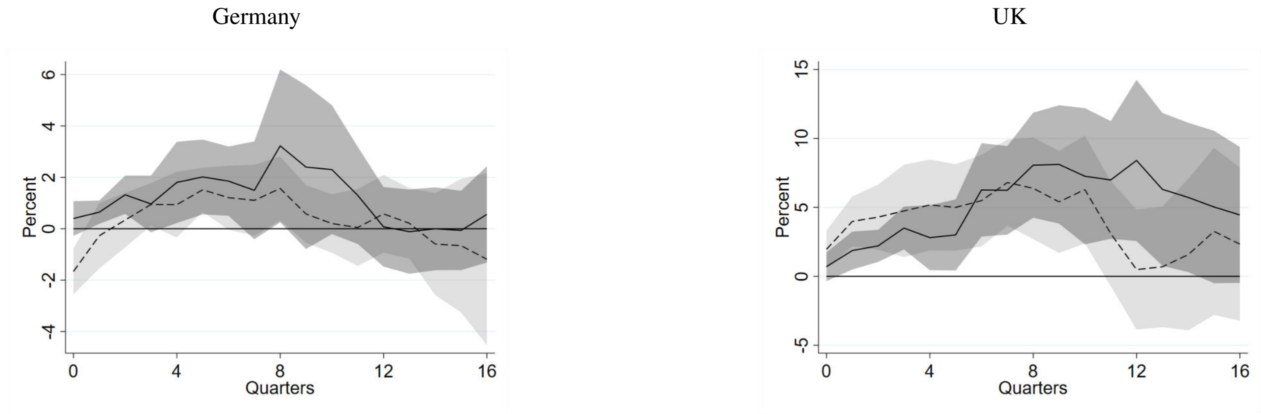
Figure A 30: Asymmetric Tax Shocks



Varying Sample Size

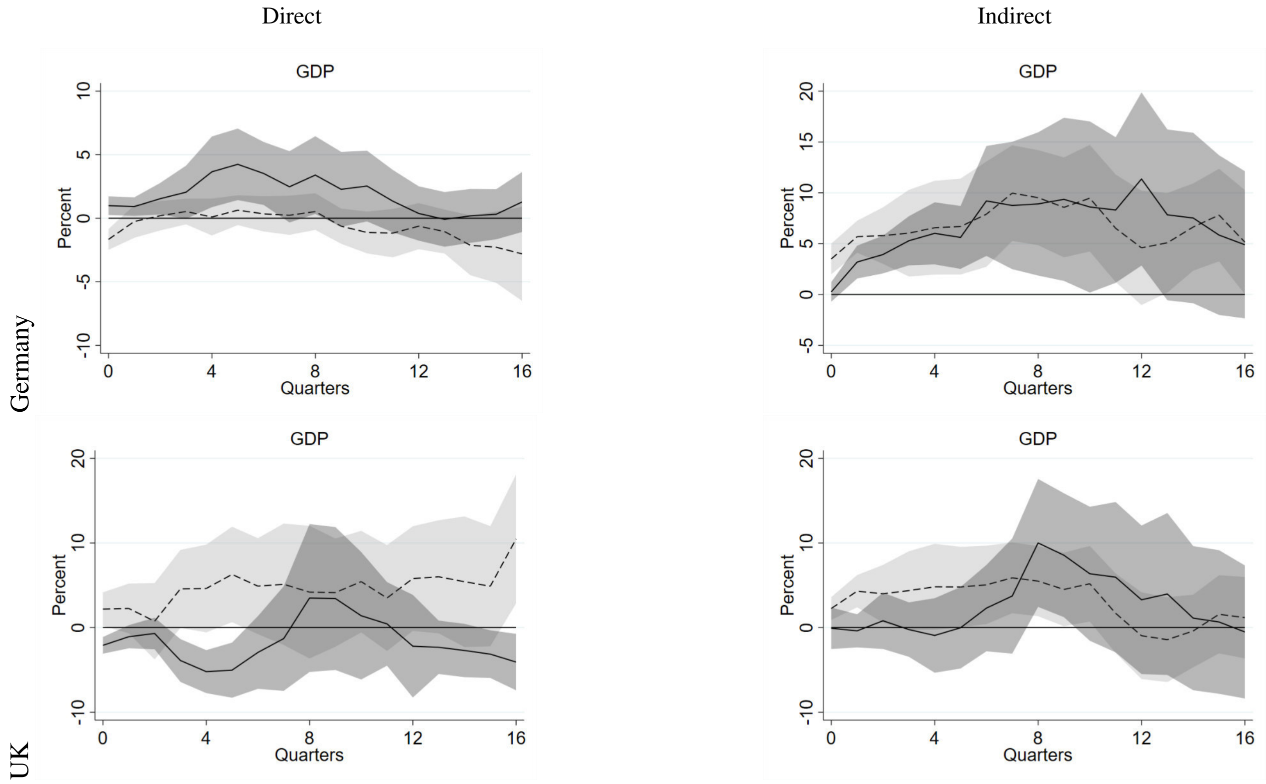
Aggregated Tax Shocks

Figure A 31: Aggregated Tax Shocks



Disaggregated Tax Shocks

Figure A 32: Disaggregated Tax Shocks



Asymmetric Tax Shocks

Figure A 33: Asymmetric Tax Shocks