Short-Time Work and the Macroeconomy†

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Abstract

This paper analyzes the business cycle effects of short-time work, i.e. government subsidized working time reductions. We identify the automatic response of short-time work to output changes in Germany by using survey data for a cross-section of firms. This allows us to disentangle the rule based effects (i.e. due to the existence of the institution) and the discretionary effects (i.e. due to changes in the accessibility) in a structural VAR and in a DSGE model. First, we show in the structural VAR that discretionary shocks stabilize output, but do not have a statistically significant effect on unemployment. Our model provides a rationale for both effects. Second, we show with a counterfactual analysis in a DSGE model that short-time work acts as an important automatic stabilizer.

Keywords: Short-time work, fiscal policy shocks, search-and-matching, SVAR
JEL Classification: E32, E62, J08

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1 Introduction

Can fiscal policy stabilize output and employment fluctuations? This well-researched question has received new attention in light of the recent Great Recession. So far, the fiscal policy literature has almost exclusively focused on fiscal multipliers of traditional government tax and spending instruments.[1] However, in the Great Recession, many OECD countries have allocated a substantial share of their business cycle programs to short-time work (STW) schemes. STW means that firms can send workers on part-time work and that those are partly compensated by the government for the reduction in income. This measure is meant to stabilize employment. In 2009, between 2 and 5 percent of all employees have been on STW in countries like Germany, Italy, Japan or Turkey (Cahuc and Carcillo, forthcoming). Interestingly, STW is not only used in heavy recessions, but many countries have institutions in place such that firms can apply for STW independently of the business cycle stage. Thus, similar to the tax code, STW is not only used in a discretionary fashion (i.e. due to changes of the STW eligibility), but also in a rule based way (i.e. more firms use STW in recessions, although the legal rules are not changed).[2]

Our paper proposes a methodology of how to disentangle the rule based and the discretionary component of STW. In order to do this, we estimate the automatic response of STW usage to changes in output from microeconomic firm level data. Our microeconometric estimation serves two purposes: First, the estimate is used to identify a structural VAR with a short-run restriction in the tradition of Blanchard and Perotti (2002).[3] Second, we impose this elasticity in a DSGE model with frictional unemployment, endogenous firing and STW. The latter is modeled by assuming that the government defines a STW eligibility criterion and that firms choose an optimal level of STW subject to convex adjustment costs. Our structural VAR allows us to make quantitative statements about the discretionary effects of STW on output and unemployment. Our model then allows us to provide an economic interpretation of the estimated effects of STW and to generate a counterfactual simulation for the rule based effects of STW.

For all these exercises, we use data for Germany due to its very long tradition of STW institutions, as well as the availability of both microeconomic firm-level survey data and long time series of STW usage. In Germany, even in usual times about 200,000 workers are on STW, while the number climbs to roughly 1.5 million in heavy recessions such as the oil price crises and the Great Recession. In addition, Germany is a particulary interesting case study because some observers attribute the German labor market miracle during the Great Recession (i.e. severe GDP drop with stable employment) at least partly to STW (see e.g. Krugman, 2009). A German firm can apply for STW in a fairly simple way. The firm has to announce (on a two page form) to the Federal Employment Agency ("Bundesagentur") that it would like to use STW within three months. In

[1] Blanchard and Perotti (2002), Mountford and Uhlig (2009), and Brückner and Pappa (2010) use structural VARs for this purpose and Cogan et al. (2010) or Christiano et al. (2011) use dynamic stochastic general equilibrium (DSGE) models.

[2] Similarly, the tax bill drops in recessions under a proportional or progressive tax system, without any changes in the tax code. See Mattesini and Rossi (forthcoming) for the role of taxes as automatic stabilizer in a DSGE context.

[3] From Caldara (2010), we know that both the identification of the fiscal policy shocks and the resulting effects on output and hence potentially unemployment are sensitive to the underlying assumptions about the automatic feedback effects.

order to be eligible, it has to prove credibly that it has unavoidable financial difficulties[4], i.e. that the expected demand for the firm's products is lower than the production potential and it would consequently have to reduce its labor input. If the Federal Employment Agency approves the STW application, it partly compensates workers for the hours reduction.[5] STW can only be used for a limited period of time (on average about one year).

We use the Institute for Employment Research (IAB) Establishment Panel dataset for the years 2003-2009 to estimate an elasticity of STW usage to output changes of -5. This elasticity is independent of changes in STW policy and hence only reflects the rule based component. Based on the assumption that there is an implementation lag of policy to changes in output, this elasticity can be used as a short-run restriction on the contemporaneous variation between STW usage and output in the structural VAR. We then use the VAR in order to estimate the dynamic effects of exogenous (i.e. discretionary) changes in STW policy. Interestingly, we document that policy shocks to STW have some stabilizing effect on output, while the effects on unemployment are insignificant.

Our model provides a rationale for both the automatic feedback effects and the effects of discretionary policy shocks. STW allows unproductive matches to reduce their production level and thereby losses. In addition, resource consuming firing costs are reduced. Both effects save aggregate resources and thereby stabilize output. In addition, our model predicts that STW policy changes only generate a substantial effect on unemployment if they have a sufficiently strong effect on the expected future value of a match. Furthermore, we show that the rule based use of STW can stabilize business cycles. We compare a situation where firms choose an optimal level of STW depending on the business cycle stage with a situation where the STW usage is fixed at the steady state level. In the latter case STW cannot act as an automatic stabilizer while in the former case it does. According to our counterfactual simulations, the institution STW stabilizes business cycle and unemployment fluctuations by 4 to 6 percent.

Our paper complements an emerging literature on STW. The theoretical literature is relatively scarce and dates back to Burdett and Wright (1989) and Van Audenrode (1994). These theoretical set-ups rely on an implicit contract model to analyze STW, while they allow for compensation of workers with a reduction in hours worked. In this setting STW may result in an inefficient reduction of hours. Braun et al. (2012) extend this approach in a recent paper. In this paper, we do not address the normative aspect of STW. The few existing examples of a positive analysis of STW in modern business cycle models are Faia et al. (2010) and Krause and Uhlig (2011). Yet, the STW schemes in Faia et al. (2010) and Krause and Uhlig (2011) remain very stylized (e.g. there is no tradeoff between the number of workers in STW, the extensive margin, and the hours reduction per worker, the intensive margin of STW) and may hence be problemativ for quantitative analysis.

On the empirical side, the evidence on STW is broader. Abraham and Houseman (1994) show that the STW schemes in European countries in the 1980s are able to compensate for the otherwise inflexible labor markets compared to the US. Most recent empirical studies use cross country

[4]See Burda and Hunt (2011, p. 297) for an excellent description of German "Kurzarbeit".

[5]The compensation is the same level as the unemployment benefits, which is currently 60% (67%) of the last wage. In particular, if a worker goes on STW for 30%, he would receive 60% of his old wage from the employer plus 30%*60% of his old wage from the government.

estimations (Cahuc and Carcillo, forthcoming, Arpaia et al., 2010, Hijzen and Venn, 2011, IMF, 2010 and OECD, 2010). These studies mostly conclude that STW indeed avoids layoffs of jobs during recessions, but the cross-country approach suffers from some important limitations. The STW arrangements across different countries rely on very different institutional settings (cp. Hijzen and Venn, 2011 for a comparison of STW legislation across OECD countries) and rule based and discretionary components of STW are not sufficiently separated.

An alternative approach is to evaluate the effects of STW by means of microeconometric studies on the firm level. Examples for this approach are Bellmann et al. (2010), Bellmann and Gerner (2011) and Speckesser (2010) for German data or Calavrezo et al. (2010) for French data. These studies provide some interesting insights into the relationship between STW usage and firm characteristics. They do not directly address the effects of STW policy on unemployment. The only paper that tackles these effects in a more macroeconomic context is Burda and Hunt (2011). They use a dynamic labor demand estimation to evaluate the role of different institutions and shocks (e.g., working time accounts, the wage moderation or STW) in the Great Recession in Germany. Our paper is very complementary to this approach, since it disentangles rule based and discretionary effects, uses a completely different methodology and gives results for the effects of STW usage both in the Great Recession, other deep recessions, and normal times. Interestingly, in line with Burda and Hunt (2011), the effects of discretionary STW shocks on unemployment are limited.

The rest of the paper is organized as follows. Section 2 documents the empirical evidence for the elasticity and the VAR. Section 3 describes, calibrates and simulates the model. Section 4 concludes.

2 Empirical evidence

2.1 Descriptive evidence

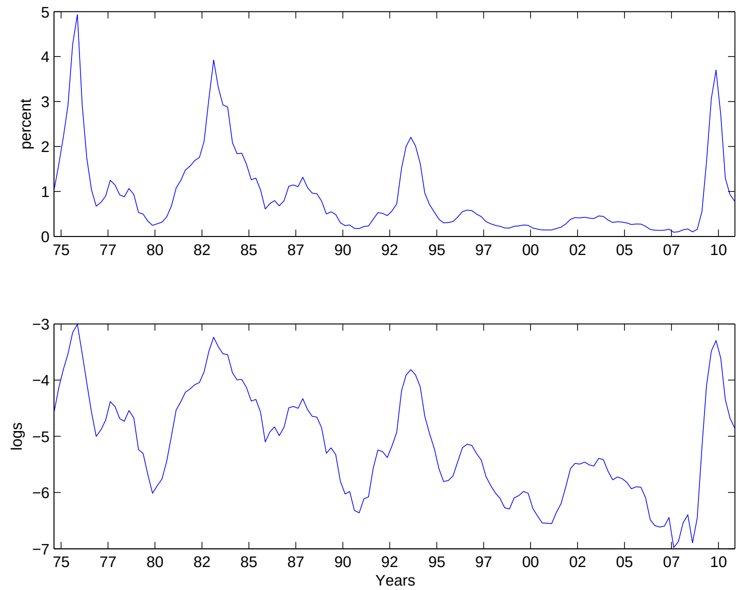
Exploiting the history of STW in Germany, we use German time-series data to estimate the macroeconomic effects of policy changes in STW in a structural VAR. The German Federal Employment Agency provides a long time series of the number of short-time workers in Germany at a monthly frequency. The data consists of numbers for West Germany before and West and East Germany after the reunification in 1991. The data for West and total Germany perfectly co-move except for a short period after the reunification in which STW was heavily used in East Germany to alleviate the transition from a planned to a market economy[6]. Here, we exclusively focus on those STW schemes that were implemented as fiscal policy related to the business cycle ('konjunkturelle Kurzarbeit').

We further obtain the German GDP from Deutsche Bundesbank, deflate nominal data using the CPI index provided by the German Federal Statistical Office and use data for employment and unemployment as reported by the Federal Employment Agency. Since GDP is only available in quarterly frequency, we take quarterly averages of all monthly series. All series are seasonally adjusted using Census' X12-ARIMA procedure. In order to avoid any complications in dealing with the German reunification break in the data and the heavy use of STW schemes in the transition

[6]This refers to STW schemes labeled 'Transfer-Kurzarbeit'.

period right after reunification, we consider a post-reunification sample starting in 1993 as our baseline. We will use the long sample mainly to perform robustness checks of the results.

Figure 1: Short-time work in Germany 1975-2010



Notes: The series depicts the number of short-time workers as a fraction of total employment.

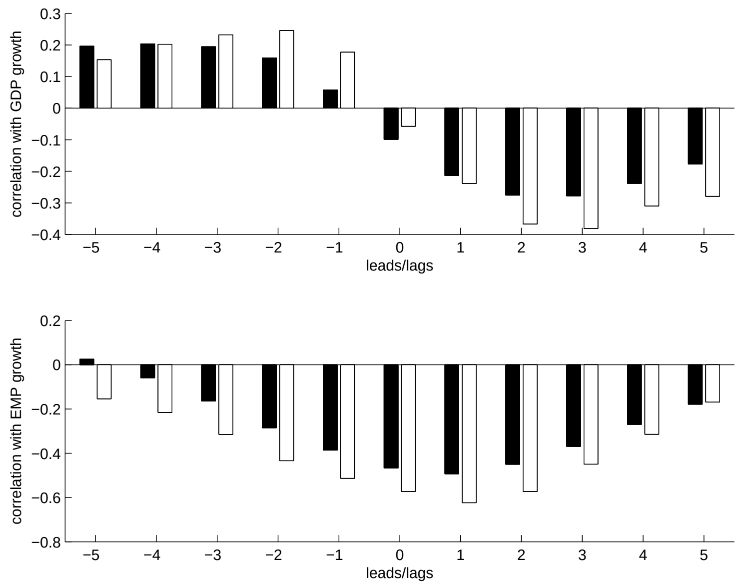
Figure 1 depicts the fraction of workers that are covered by STW schemes relative to total employment from 1975 to today. Even though STW has been used before, the year 1975 marks the beginning of a systematic use of STW schemes in Germany. Certainly being fueled by the oil shocks and the subsequent recession, the German legislator passed a law inscribing the future use of short term work schemes to be targeted explicitly to back employment, not to insure workers against wage cuts. In 1975, the legislator also constituted the reimbursement of workers covered by STW schemes to be 60% of the current wage. This law is still in place today.[7]

Figure 1 shows that since then, STW has been used throughout as it depicts a low, but non-zero average of 0.83% in the long and 0.7% in the post-reunification period. The figure also documents substantial variation in the series, also outside the four severe recessions that are marked with large peaks in the level of STW usage. Figure 2 shows that STW usage is negatively correlated with growth in GDP and employment, hence the business cycle. Since the reunification of East and West Germany in 1991 potentially induces a structural break in these correlations, we also show that these results are robust in a post-reunification sample.

The contemporaneous correlations are potentially driven by two effects that are of interest to us: the rule based and the discretionary component of STW. With respect to the rule based component, the business cycle affects the use of STW even if policy, e.g. the legal requirements connected to the use of STW, remains unchanged. As the business cycle worsens, a larger number of firms becomes eligible to the use of STW and may optimally choose to use it. With respect to

[7] See Flechsenhar (1979) and Will (2010).

Figure 2: Correlation of STW/EMP with GDP and employment



Notes: Leads/lags depict the correlation of STW/EMP in period t with GDP or employment in period $t + i$ / $t - i$. The black bars show the long sample corresponding to 1975-2010, the white bars show the short post-reunification sample corresponding to 1993-2010.

the discretionary component, active fiscal policy affects the use of STW through a change in STW requirements or costs that may vary over the business cycle.

Key to the VAR exercise is to disentangle the effects of business cycle shocks from the effects of discretionary policy changes on the use of STW and other macroeconomic variables such as output and employment. The challenge when identifying these two effects is that we do not explicitly observe exogenous changes in STW policy. The reason for this is that STW policy is effective along many dimensions, e.g. with respect to the eligibility criteria of firms (which are weakly defined and can potentially be interpreted very differently), the legal allowances of the duration of workers in STW, or the degree to which the government can additionally reduce the firms' cost that is related to the use of STW (e.g. through covering social security contributions of workers in STW, see Bundesministerium für Arbeit und Soziales, 2011 and also the discussion in Section 3).

2.2 Identifying short-time work shocks in a structural VAR

In order to identify business cycle and STW policy shocks in the data, we estimate a structural VAR with a short-run restriction in the fiscal VAR tradition of Blanchard and Perotti (2002). The general VAR setup is based on a reduced-form estimation of

$$y_t = B(L)\, y_{t-1} + u_t, \qquad = 1, ..., \;,$$

where y_t is a $\times 1$ vector of endogenous variables, and the lag polynomial $B(L)$ represents $\times$ coefficient matrices for each lag up to the maximum lag length . The reduced-form innovations

are denoted by the $\times 1$ vector u_t, which are assumed to be independent and identically distributed with mean zero and covariance Σ_u. We now seek to identify the underlying structural shocks ϵ_t from transforming the reduced-form innovations u_t using a transformation matrix A such that

$$A u_t = \epsilon_t.$$

The structural innovations ϵ_t are assumed to be orthogonal with Σ_e diagonal and hence allow for an economic interpretation. Without loss of generality, we normalize the diagonal elements of Σ_e to unity. From orthogonality and normalization, we obtain $(\quad + 1)/2$ restrictions to identify the

in absolute value than the negative covariation, the effect of policy shocks on output becomes positive on impact. We show below that this is indeed the case in our baseline specification.

Setting the value of the elasticity is consequently very important for the identification of and the responses to the two estimated shocks. In addition, we want to use the model in section 3 to compare the stabilizing effects of STW schemes to an economy without STW. For this assessment, the value of the business cycle elasticity of STW usage is a crucial calibration target. Similar to Blanchard and Perotti (2002), we estimate this elasticity outside of the VAR. In particular, we will use cross-sectional and panel information from an establishment dataset for Germany. We are the first to use evidence from micro data to derive the short-run restriction for fiscal policy shocks in a VAR. This ensures that our estimate is unaffected by policy differences across countries. In addition, the firms in our sample are all subject to the same legislative framework with respect to STW. Hence, it is straightforward to control for policy changes over time that potentially affect the elasticity estimate.

2.3 Elasticity estimation using micro data

In order to estimate the elasticity of STW usage to changes in output, we employ the Institute for Employment Research (IAB) Establishment Panel, a representative German establishment level panel data set that surveys information from almost 16,000 personal interviews with high ranked managers. This IAB panel contains information on the number of employees in STW in each firm in three years: 2003, 2006 and 2009. Here, the number of short-time workers is measured in the first half of year t in the sample. In order to abstract from firm-size, we denote short-time workers relative to the total number of employees within a firm. This is also consistent with our time-series measure and the definition of STW usage in the model. Note that the fraction of short-time workers in employment can be zero for a given firm. We hence include firms without STW into the sample. Firm-level output is measured as the expected revenue in period t relative to period $t-1$. This variable reflects the notion that firms have to show their need for STW, i.e. a danger of a reduction in labor input due to a fall in revenue, already in their application to the employment agency.[8]

We regress logs of expected revenue $\mathbf{x}_{it}$ on the fraction of short-time workers in employment y_{it} using firm fixed effects

$$y_{it} = \mathbf{x}_{it}\beta_1 + \alpha_i + \gamma_t + \mathbf{z}_{it}\beta_2 + \epsilon_{it}. \tag{1}$$

Hence, we only use within-firm variation over time in order to estimate the effects of changes in log revenue on changes in STW usage. The firm-fixed effects α_i only control for time-invariant firm-specific effects in our estimation. Since time-varying firm-specific effects may also play a role in the estimation, we add the number of employees $\mathbf{z}_{it}$ as a measure of time-varying firm size as an additional control. STW policy in Germany is typically implemented at the federal level. Hence, STW policy changes affect all firms homogeneously over time. In order to rule out that we pick up policy changes in our estimation, we further include time-specific effects γ_t to the specification. The error term ϵ_{it} is white noise. Table 1 documents the estimation results. Across

[8] See http://www.arbeitsagentur.de/zentraler-Content/Vordrucke/A06-Schaffung/Publikation/V-Kug-101-Anzeige-Arbeitsausfall-ab-01-2012.pdf

specifications, the effect of changes in expected revenue on STW usage is significantly estimated to range between -3.11 and -3.44.

Table 1: Elasticity estimates

regressors	baseline	additional controls (1)	additional controls (2)
log exp. revenue	-3.106^{***}	-3.147^{***}	-3.439^{***}
	[0.375]	[0.363]	[0.417]
year fixed effects		Yes	Yes
employees in firm			Yes
observations	29,745	29,745	23,788

Notes: Dependent variable is number of workers in STW over total employees in the firm. *** denotes 1% significance.

2.4 Results

In our baseline estimation of the effects of business cycle shocks and exogenous policy changes, we specify a VAR with three variables: the fraction of short-time workers in employment (in logs), GDP growth and the log unemployment rate. We specify GDP in growth rates, since unit root tests suggest that this variable has a unit root. The fraction of short-time workers in employment is stationary, whereas we find controversial evidence on the properties of the unemployment rate. The latter finding is in line with the literature. As the unemployment rate is a non-integrated variable from a theoretical point of view, we specify the variable in levels in our estimation.[9] In addition, we use GDP growth as measuring the business cycle component of this variable, hence something that we can compare to the output of a model with a constant steady state as the one in Section 3. We estimate the reduced form VAR as described above with four lags in the specification. We then use the formal relationship between the output elasticity of the policy variable and the coefficients in the matrix A derived by Caldara (2010) in order to implement the short-run restrictions. Note that we have estimated the automatic feedback effects of the business cycle on the use of STW in levels rather than logs in the micro data. Hence, we need to transform this estimate into an elasticity by dividing it by the average STW usage in the sample of interest. For our baseline sample of 1993Q1-2010Q4 this elasticity corresponds to -4.91.

Figure 3 shows the quarterly responses of output, STW usage and unemployment to positive one-standard-deviation shocks in output and policy.[10] The confidence intervals show 90% bootstrapped bands that were calculated in line with Kilian (1998). The left column of Figure 7 shows the responses to a positive business cycle shock. After this shock, output increases, while STW falls reflecting the imposed short-run restriction of the automatic feedback effects along the business cycle. Unemployment falls in a boom. The right column of Figure 7 depicts the responses to a positive STW policy shock. After a positive policy shock, STW usage increases. Since we

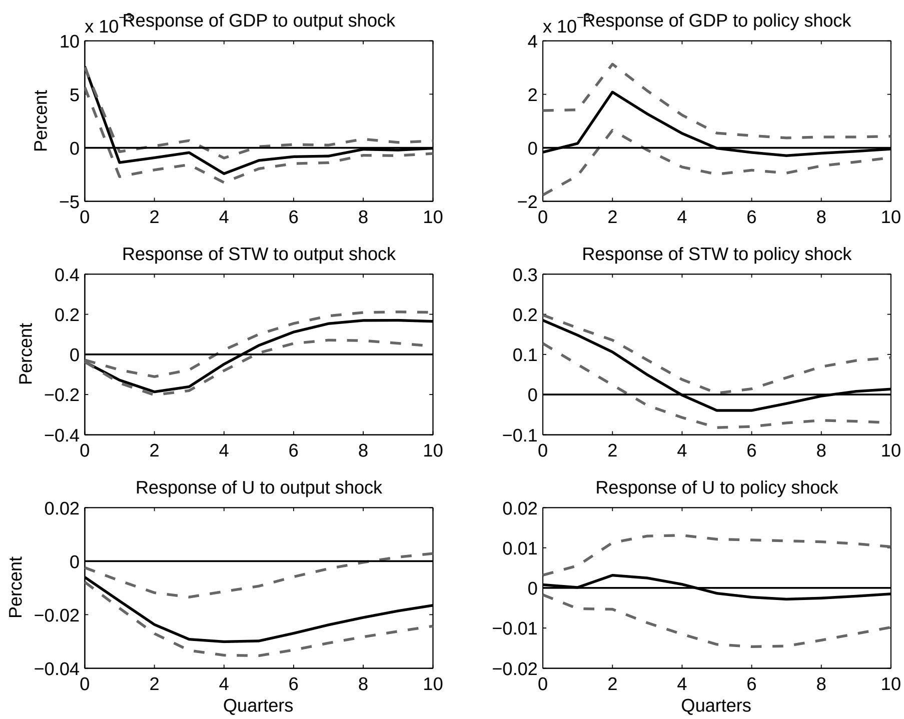
[9] Treating the unemployment rate as non-stationary, we do not find any evidence on cointegration.

[10] Figure 7 in the Appendix plots the corresponding estimated shocks over time.

have not imposed any restriction on this response, it is reassuring that it is in fact positive. Output significantly increases in response to a policy shock, at least after two quarters. We interpret this response in favor of a positive output multiplier of the policy change.

Strikingly, the unemployment rate does not significantly react to a STW policy shock. This is a surprising result, as a fiscal policy that is officially aimed at supporting employment does not seem to have an significant effect on this variable. Statistically, this result reflects the fact that the business cycle shocks do not explain enough of the negative covariation of unemployment with output and the positive covariation of unemployment with STW usage. As a consequence, policy shocks do have a negative effect on unemployment which is in contrast to the explicitly stated goal of this policy. We document robustness of this result below and propose a theoretical interpretation of the result in section 3.

Figure 3: Impulse responses to output and STW policy shocks



Notes: SVAR estimated with log STW per employed workers, GDP growth and the log unemployment rate for 1993Q1 to 2010Q4. Quarterly responses to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Above, we have discussed the importance of the imposed short-run restriction about the output elasticity of the policy variable. Given this, we would like to know how different assumptions about this elasticity affect the results, in particular the estimated responses of output and unemployment after a policy shock. Figure 8 in the Appendix compares these responses for various values of the elasticity. Varying the elasticity does not affect the significant positive increase of

GDP after two quarters, but it does affect the impact response of GDP to the policy shock[11]. In line with our intuition from above, the more of the negative correlation between output and STW usage is explained by the automatic feedback effects, the larger and possibly positive are the effects of the policy shocks on output. In fact, if the automatic feedback effects are relatively large (elasticity of -15), output significantly increases on impact. If there are zero or positive, output significantly falls. The effect of policy shocks on unemployment behave similarly when varying the elasticity. Unemployment falls for relatively large negative elasticities and increases for zero or

severe recessions in the short sample, and four recessions in the long sample, reflect different dynamics in the response to policy shocks than more normal times. In other words, there may be business cycle asymmetries that affect our identification of the dynamics. In order to address this, we estimate our baseline specification including recession dummies for the following periods: 1973Q1-1975Q2, 1980Q1-1982Q2, 1991Q1-1993Q1 and 2008Q1-2009Q2[13]. Figure 11 in the Appendix shows that including these dummies does not affect the results. This holds also true in the long sample.

As argued above, identification of STW policy shocks is difficult, as it potentially works along many dimensions and we do not directly observe policy changes. One exception is the legal maximum period of eligibility for a particular worker in STW. We have information about this for our baseline sample, Figure 12 in the Appendix shows a plot. One may associate periods with legal changes to this maximum period as episodes of particular political focus on STW schemes. In order to exclude the possibility that STW policy was conducted in a systematically different way together with these legal changes, we incorporate a dummy controlling for these changes into our VAR. This is similar in spirit to Blanchard and Perotti (2002) who incorporate a dummy for particularly large tax reforms into their fiscal VAR. Figure 13 in the Appendix shows that our results are robust to controlling for legal changes this way.

In line with the model, business cycle shocks are measured by changes in output and labor productivity. Figure 14 shows that our results are robust to replacing GDP with GDP per employed worker in the specification.This result may reflect the fact that relatively unproductive workers will be working short-time, while relatively productive workers continue to work full time or even increase their labor input. Hence their weight in aggregate productivity increases. We will interpret this result further in the model in section 3. In order to consider the robustness of the unemployment response to policy shocks, we replace the unemployment rate by employment and total hours worked respectively. As unemployment, both variables react insignificantly to the policy shock. Clearly, policy shocks do not have a significantly positive effect on hours or employment.

One may wonder whether our identified shocks pick up the effects of other shocks that are important for the macro-economy. One candidate are shocks that cover future information about the business cycle, so-called news shocks. In order to control for the presence of news shocks or any type of anticipation effects in the economy, we include a business confidence indicator (the ifo business climate index published monthly by the ifo Institute for Economic Research) into our specification.Another candidate shock that may be captured in the business cycle shock is a monetary policy shock. In order to control for these shocks, we further include the interest rate as measured by the 3-months money market rate into the specification. Figure 15 shows that including these two controls does not change our baseline results. As one last robustness check, we redo our results based on monthly time-series data on STW usage and industrial production. Several studies showed that STW in Germany is mostly applied in the manufacturing sector (e.g. Bellmann et al., 2010). Hence, industrial production should be a good indicator for output in our analysis. Using industrial production has two advantages: First, we can obtain an additional estimate for the output elasticity of the policy variable using cross-industry variation of STW work usage and industrial production. Second, since our short-run restriction implies an implementation lag of policy to the business cycle, we can estimate our VAR in monthly frequency.

[13]These periods are measured as peak to trough of the GDP series that is HP-filtered with $\lambda = 1600$.

However, this VAR will be relatively short. As before, we first estimate the output elasticity of STW keeping STW policy fixed. We do this using STW data on the industry level as defined by WZ2008 industry classification from the Federal Employment Agency. We merge this data with the industrial production index on the industry level as reported by the Federal Statistical Office. This data is available in monthly frequency starting from 1998M1 to 2010M12. Similar as before, we use industry fixed effects together with time fixed effects in order to estimate the elasticity. As an alternative to the time fixed effects, we include a dummy that controls for changes in the legal eligibility periods of STW ('Bezugsfrist') in this time period. Using monthly data on industrial production, we are not able to estimate an elasticity that is significantly different from zero.[14] This indicates that the automatic response of STW usage to variations in industrial production is very small. In other words, the automatic adjustment of STW usage to variations in industrial production is, if it exists, slower than a month.

We now use an elasticity of zero in a VAR with aggregate monthly time series for STW, industrial production and unemployment that ranges from 1993M1 to 2010M12. We use 4 lags in the specification and logs of all variables. Industrial production is smoothed with HP ($\lambda = 1$) in order to account for measurement error in the series. We have checked that this does not affect the results, however. Figure 16 in the Appendix documents the results. Even though the underlying elasticity estimates and the variables in the VAR are very different, the results from this VAR are very similar to the ones presented above. We again find a positive effect on output, accompanied with no significant effect in unemployment in response to a STW policy shock. We view this as a strong robustness check of our results.

3 A Labor Market Model with Short-Time Work

3.1 The Model

3.1.1 Intuitive Description

The purpose of building a theoretical model is twofold. First, in contrast to the structural VAR, the model provides economic rationale and intuition. We discuss below under which circumstances a theoretical model can replicate the results found in the structural VAR. Specifically, we will consider various forms of using STW as a policy instrument, where only one of them is consistent with the empirical results. Second, the theoretical model allows us to tackle questions which the structural VAR is unable to answer. We do a counterfactual analysis and compare a situation where STW usage is fixed exogenously with endogenous STW usage over the business cycle (without policy changes). This allows us to make statements about the degree to which STW acts as an automatic stabilizer.

To be able to do so we construct a model which covers the various margins that we need for our analysis. Specifically, we need a model featuring unemployment. For this we take use of the search and matching framework of Diamond (1982) and Mortensen and Pissarides (1994), the most prominent model of unemployment. Since STW is meant to reduce firings, we need a model of endogenous separations. We endogenize separations by assuming that the profits generated by

[14] More detailed results are available on request.

worker-firm pairs are subject to idiosyncratic profitability shocks. Workers with bad shocks can be fired at an exogenously given firing cost.

Additionally, workers, fulfilling an eligibility criteria determined by the government, can be sent on STW. This reduces their working time and wage income. The government partially compensates the worker for the loss in wage income. As argued in the introduction, this is well in line with the institutional features of STW. To avoid corner solutions, we assume that the take-up of STW is subject to convex costs, i.e., the more STW a firm uses the more expensive it gets. Nevertheless, matches with sufficiently bad profitability shocks will use STW, because it reduces their losses and allows to avoid some firings. Finally, we assume that wages are bargained collectively, the bargaining regime which is dominant in continental Europe, where STW is most prevalent but which is also relevant, e.g., for the manufacturing sector in the US.

We have a general equilibrium model, i.e., we model the household's intertemporal consumption decisions and we have a government budget constraint, assuming that unemployment benefits and STW are financed by lump-sum taxes. To keep the model tractable, we abstract from capital accumulation since the dynamics of search and matching models are fairly similar with and without this margin.

The timing in the model is as follows: First, the aggregate productivity realization is revealed. Second, the wage is determined via collective bargaining between the median worker and the firm. Third, unemployed workers from the previous period search for a job and firms post vacancies. Fourth, the matching function establishes a contact between certain workers and firms. Fifth, new contacts and incumbent workers are hit by an idiosyncratic operating cost shock. Finally, firms make their endogenous separation and STW decisions, based on the idiosyncratic shock realization (i.e. workers with larger operating costs will be fired).

3.1.2 Households' Consumption Decisions

We assume that households have a standard utility function of the form:

$$\ _t = \ _t \sum_{j=t}^{\infty} \beta^{j-t} \frac{\ _j^{1-\sigma}}{1-\sigma}, \tag{2}$$

where β is the household's discount factor, σ is the elasticity of intertemporal substitution, is aggregate consumption and is the expectation operator under rational expectations.

As is common in the literature, we assume that each household consists of a large number of individuals, each individual supplies one unit of labor inelastically and shares all income with the other household members (see, e.g., Merz, 1995 or Andolfatto, 1996). This implies that consumption does not depend on a worker's employment status. Thus, the representative household maximizes its utility subject to the budget constraint:

$$B_t + \ _t = w_t n_t (1-\chi_t) + n_t \chi_t w_t^{stw} + b\, u_t + (1 + i_{t-1}) B_{t-1} + \Pi_t - \ _t, \tag{3}$$

where B are nominal bond holdings, are lump-sum taxes, i is the nominal interest rate and Π are aggregate profits, which are transferred in lump-sum manner, w is the regular wage under full time work, χ is the share of workers who are on STW, w^{stw} is the average compensation for a worker

who is on short-time work[15], n is the employment rate, b the income of unemployed workers and u the unemployment rate. The intertemporal utility maximization yields the standard consumption Euler equation:

$$c_t = \beta E_t c_{t+1}(1+i_t)^{-\frac{1}{\sigma}}, \tag{4}$$

3.1.3 Matching on the Labor Market

Matches m_t are determined by a Cobb-Douglas matching function

$$m_t = \mu u_t^{\alpha} v_t^{1-\alpha}, \tag{5}$$

where u_t is unemployment, v_t are vacancies and α is the matching elasticity with respect to unemployment. The parameter $\mu > 0$ determines the matching efficiency. We assume free entry of vacancies. The worker-finding rate q_t (i.e., the probability of a firm to fill a vacancy) is

$$q_t = \mu \theta_t^{-\alpha}, \tag{6}$$

where $\theta_t = v_t / u_t$ is the labor market-tightness. Consequently, the job-finding rate p_t (i.e., the probability of an unemployed worker to find a job) is

$$p_t = \mu \theta_t^{1-\alpha}. \tag{7}$$

The present value of a vacancy is defined as

$$V_t = -\kappa + E_t \Lambda_{t+1} q_{t+1} J_{t+1} + E_t \Lambda_{t+1} (1 - q_{t+1}) V_{t+1} \tag{8}$$

where Λ_{t+1} is the stochastic discount factor ($\Lambda_{t+1} = \beta c_{t+1}^{-\sigma} / c_t^{-\sigma}$), J_t is the value of a job and κ are the vacancy posting costs. Free entry implies $V_t = 0 \, \forall t$ which simplifies the above equation to

$$\kappa = E_t \Lambda_{t+1} q_{t+1} J_{t+1}. \tag{9}$$

Thus, in equilibrium the vacancy posting cost has to equal the expected payoff of the vacancy, which consists of the probability to find a worker and the value of a successful match. Once workers and firms are matched, matches experience idiosyncratic operating cost shocks, which are denoted by ε_{it} with $\varepsilon_{it} \sim f(0, \sigma)$. [16] Since ε_{it} is i.i.d. across workers and time, we skip the

[15] Note that this compensation consists of the wage paid by the employer for the remaining working time and the compensation by the government for the STW part. For analytical convenience (since the full expression contains several integrals and since some variables will be defined latter), we summarize these elements as w^{stw}.

[16] An additive shock has the advantage that the sum of aggregate and idiosyncratic component of productivity of each worker-firm pair may be positive or negative. The latter seems in line with the official eligibility criterion of STW ("unavoidable financial difficulties"). See Lechthaler et al. (2010) for a similar modeling strategy.

subscript i for different worker-firm pairs. The value of a filled job J before the operating costs ε_t are realized, is

$$
\begin{aligned}
J_t &= (1- {}^{x}) \int_{-\infty}^{v_t^k} ({}_t - w_t - \varepsilon_t) g(\varepsilon_t) d\varepsilon_t \\
&+ (1- {}^{x}) \int_{v_t^k}^{v_t^f} [({}_t - w_t - \varepsilon_t)(1 - h(\varepsilon_t)) - \phi(\varepsilon_t)] g(\varepsilon_t)\, d\varepsilon_t \\
&- (1- {}^{x})\, c - {}_t^{e} f + (1 - {}_t) \; {}_t\Lambda_{t+1} J_{t+1} \qquad (10)
\end{aligned}
$$

where ^{x}, ^{e} and are the exogenous, endogenous and overall separation rates respectively. $h(\varepsilon_t)$ is the working time reduction due to STW of a worker with operating costs realization ε_t. $\phi(\varepsilon_t))$ is a cost function for STW to be defined below, ${}_t$ denotes the average productivity level, w denote wages, which is the same for all workers due to the collective bargaining agreement, and c is a fixed cost of production

We introduce fixed costs of production to generate stronger amplification effects (i.e. responses of labor market variables to aggregate productivity shocks). It is well known from the literature that the standard calibration of the search and matching model has trouble to be in line with the aggregate data (Shimer, 2005). We choose fixed costs as proposed by Christoffel et al. (2009) to solve this problem because it seems the most innocuous assumption in the context of our approach (the alternative of larger unemployment benefits would, for example, show up in the government budget constraint and thereby distort cost estimates of STW).

3.1.4 Separation and Short-Time Work Decisions

The overall firing rate consists of an exogenous part ^{x}, (e.g. quits) and an endogenous part, ^{e} (firings) according to:

$$ {}_t = {}^{x} + (1 - {}^{x}) \; {}_t^{e}. \qquad (11)$$

Firms have to pay linear firing costs f for endogenous separations.

In order to determine the endogenous separation rate as well as the average probability to use STW χ, we need to determine the thresholds for STW v_t^k and firing v_t^f. The STW threshold is given by v_t^k and to be interpreted as the realization of operating costs at which the firm is indifferent between using and not using STW. We assume that the government defines the following STW condition

$$ {}_t - w_t - \varepsilon_t + \; {}_t\Lambda_{t+1} J_{t+1} - c < \; {}_0. \qquad (12)$$

This implies that STW can be used whenever a worker would generate an expected loss larger than ${}_0$ without the use of STW. By choosing ${}_0$ the government restricts the usage of STW and can avoid excessive usage. Consequently, the STW threshold is

$$ v_t^k = {}_t - w_t + \; {}_t\Lambda_{t+1} J_{t+1} - c - \; {}_0. \qquad (13)$$

Workers with lower operating costs than this threshold value work full time, while workers with higher operating costs go on STW (if they are not fired). In steady state, we set ${}_0 = -f$. Thus,

a worker can be sent on STW if he was fired in the absence of STW. However, in the numerical section we will show the effects of a loosening of this condition.

In addition to the extensive margin of labor adjustment, there is an intensive margin of STW. The extent of short-time work K can be chosen by the firm given that it is eligible for STW (i.e., if the condition above is fulfilled). In our model, $K = 0$ corresponds to zero percent STW, while $K = 1$ corresponds to 100% STW. The firm chooses the contemporaneous optimal level of K by maximizing the contemporaneous profit of a worker on STW:

$$\max_{K(\varepsilon_\mathbf{t})} \pi_t = (a_t - w_t - \varepsilon_t)(1 - K(\varepsilon_t)) - C(K(\varepsilon_t)), \tag{14}$$

with $\frac{\partial C(K(\varepsilon_\mathbf{t}))}{\partial K(\varepsilon_\mathbf{t})} > 0$ and $\frac{\partial C(K(\varepsilon_\mathbf{t}))^2}{\partial^2 K(\varepsilon_\mathbf{t})} > 0$ to assure interior solutions.[17] There are various motives to use convex short-time costs. First, convex costs are necessary to replicate the empirical finding that the degree of STW usage varies a lot across firms.[18] Second, although the employer can reduce its labor costs, the reduction is not necessarily proportional to the working hours reduction because the employer also has to pay the social security contributions for STW share K.[19] Third, there are fixed costs within the firm (e.g., rent costs, capital depreciation). And fourth, the implementation of STW must be approved by the workers' council. [20] As long as there is no approval, workers have the right to obtain their full wage. Workers' councils are of course more willing to approve small working time reductions than larger working time reductions because employees only receive a partial compensation for their wage loss (see also household's budget constraint, equation (3)).

We impose a quadratic functional form for the usage costs of STW $C(K(\varepsilon_t))$, i.e.

$$C(K(\varepsilon_t)) = c_K \frac{1}{2} K(\varepsilon_t)^2 . \tag{15}$$

Optimization of profits gives the optimal degree of STW for a given ε for $\tilde{\varepsilon}_t^k < \varepsilon < \tilde{\varepsilon}_t^f$.

$$K^*(\varepsilon_t) = -\frac{a_t - w_t - \varepsilon_t}{c_K} \tag{16}$$

Workers are fired if the losses they generate to the firm are higher than the cost of firing the worker, i.e., if

$$(a_t - w_t - \varepsilon_t)(1 - K(\varepsilon_t)) - C(K(\varepsilon_t)) - c + \beta_t \Lambda_{t+1} J_{t+1} < -f. \tag{17}$$

This defines a firing threshold $\tilde{\varepsilon}_t^f$ at which the firm is indifferent between firing and not firing a worker:

$$\tilde{\varepsilon}_t^f = a_t - w_t - c + \frac{\beta_t \Lambda_{t+1} J_{t+1}}{1 - K\left(\tilde{\varepsilon}_t^f\right)} + \frac{f}{1 - K\left(\tilde{\varepsilon}_t^f\right)} - \frac{C\left(K(\tilde{\varepsilon}_t^f)\right)}{1 - K\left(\tilde{\varepsilon}_t^f\right)}. \tag{18}$$

[17] Assuming a linear cost function would imply corner solutions, i.e. workers either work full time or reduce hours by 100%.

[18] From 1993-2010, 44% of all employees who used STW reduced their working time up to 25%, 33% between 25 and 50%, 8% between 75-99% and 8% to 100% (Source: Federal Employment Agency).

[19] See Bach et al. (2009) who show that these institutional features may generate a convexity in the cost of STW.

[20] German labor law makes it mandatory for firms from a certain size onwards to allow their employees to elect representatives ("Betriebsrat," in English: workers' council).

This then defines the endogenous separation rate as

$$ {}_t^e = \int_{v_t^f}^{\infty} (\varepsilon_t)\, d\varepsilon_t. \tag{19}$$

and the rate of workers on STW as

$$ \chi_t = \int_{v_t^k}^{v_t^f} (\varepsilon_t)\, d\varepsilon_t \tag{20}$$

Note that STW exists in this economy if $v_t^f > v_t^k$. This is the case as long as STW costs are not prohibitively high. If c_K approaches infinity, then from equation 16 it follows that $= 0$, i.e., firms do not use STW. In this case the STW cutoff and the firing cutoff are identical, $v_t^f = v_t^k$. Otherwise, positive values of shift v_t^f upwards while v_t^k stays the same so that $v_t^f > v_t^k$. This implies that firing rates in an economy without STW are higher and employment rates are lower compared to an economy with STW.

3.1.5 Employment Evolution

We describe the evolution of employment n_t in this economy by

$$ n_t = (1 - {}_t (1 - {}_t) - {}_t)\, n_{t-1} + {}_t (1 - {}_t) \tag{21}$$

Note that workers on STW are treated as employed, corresponding to the official German employment statistics (although they only work part-time). Also note that we assume instantaneous firing, i.e. workers that get in contact with a firm may not remain with the firm, and instantaneous production, i.e. workers who get matched start production immediately.

3.1.6 Wage Bargaining

Finally, we specify wage formation. Here we assume that the wage is bargained between the firm and the incumbent worker for whom the realization of the operating costs equals its expectation of zero. Hence, wages are set collectively and not individually for each ε_t. The median firms' profit[21] (with operating costs zero) of a match is

$$ {}_t = {}_t - w_t - c + {}_t \Lambda_{t+1} (1 - {}_{t+1})\ {}_{t+1} \tag{22}$$

In case of disagreement, production will come to a halt, and bargaining will resume in the next period. Thus, the fallback options $\tilde{J}_t$ is

$$ \tilde{}_t = -c + {}_t \Lambda_{t+1} (1 - {}_{t+1})\, J_{t+1} \tag{23}$$

The median workers' surplus W from a match is

$$ W_t = w_t + {}_t \Lambda_{t+1} (1 - {}_{t+1})\, W_{t+1} + {}_t \Lambda_{t+1}\ {}_{t+1}\ {}_{t+1} \tag{24}$$

[21] Note that the median firm does not use STW (empirically, only 0.7% of firms use STW on average).

where   is the value of unemployment. The workers' fall-back option under disagreement is

$$\tilde{W}_t = b + \; _t\Lambda_{t+1} (1 - \; _{t+1}) W_{t+1} + \; _t\Lambda_{t+1} \; _{t+1} \; _{t+1} \tag{25}$$

i.e., in case of no production, workers are assumed to obtain a payment b, which is equal to the unemployment benefits in the economy.

Defining as workers' bargaining power and maximizing the Nash product yields the following wage equation:

$$w_t = \; _t + (1 - \;) b \,. \tag{26}$$

In this economy, households always want to work, because their income from work is higher than their income from unemployment and because there is no disutility from work. Finally, the average compensation of a worker on STW is given by:

$$w_t^{stw} = \int_{v_t^k}^{v_t^f} \frac{(1 - \; (\varepsilon_t)) w_t + b \; (\varepsilon_t) f(\varepsilon_t)}{\chi_t} d\varepsilon_t, \tag{27}$$

depending on the realization of ε the worker is sent on STW for a share of (ε) of her working time. For that fraction she only receives unemployment benefits. For the remainder she receives the collectively bargained wage. Since being on STW is a convex combination of full employment and unemployment, workers always prefer STW to being layed-off.

3.1.7 Government Budget Constraint

The government has a balanced budget and finances STW expenses and unemployment benefits by a lump-sum tax, i.e.

$$b \, n_t \int_{v_t^k}^{v_t^f} \; (\varepsilon_t) f(\varepsilon) d\varepsilon_t + b \, u_t = \; _t . \tag{28}$$

3.1.8 Equilibrium and Aggregation

The general equilibrium is defined by the bond market equilibrium (equation (4)), the labor market equilibrium (equations (19),(11), (13), (18), (19), (20), (21) and (26)) and the product market equilibrium. The latter requires that consumption equals production minus frictional costs, i.e.

$$\begin{aligned} _t &= (1 - \; ^x) \\ & - n_t^B (1 - \chi_t - \; _t^e) \frac{\int_{-\infty}^{v_t^k} \varepsilon_t f(\varepsilon_t) \, d\varepsilon}{1 - \chi_t - \; _t^e} - n_t^B \chi_t \frac{\int_{v_t^k}^{v_t^f} (1 - \; (\varepsilon_t)) \, \varepsilon_t f(\varepsilon_t) \, d\varepsilon}{\chi_t} \end{aligned} \tag{29}$$

with $n_t^B = n_{t-1} + \; _t (1 - n_{t-1})$. Aggregate consumption equals production minus resource costs. When determining production we need to take account of the reduction in working time of workers on STW and the idiosyncratic shock. The resource costs include vacancy posting costs, firing costs, fixed costs of production and STW costs.

3.2 Calibration

Parameter		Value
β	discount factor	0.99
κ	cost of posting a vacancy	0.41
ξ	matching elasticity w.r.t unemployment	0.6
μ	matching efficiency	0.43
f	linear firing costs	2
σ	std. dev. of operating cost distribution	0.64
c_K	shift parameter in STW cost function	12.6
	productivity	1
Steady state targets		**Value**
q	worker finding rate	0.7
	overall job destruction rate	0.03
	endogenous 1/3, exogenous 2/3	
	job finding rate	0.312
u	unemployment rate	0.09
χ	short-time work rate	0.007

Table 2: Calibration.

To illustrate the properties of our model, we parameterize the model to the German economy. The quarterly discount factor β is 0.99, which matches an annual rate of 4.1%. Following Christoffel et al. (2009) we target a steady state value for the quarterly worker finding rate q of 70% and a separation rate of 3%. As in Krause and Lubik (2007) one third of separations is endogenous, whereas two thirds are exogenously determined. We target the quarterly job-finding rate to 31.2% to obtain a steady state unemployment rate of 9%. The matching elasticity ξ is set to 0.6.[22] This implies that the cost of posting a vacancy κ, the efficiency of matching μ and the standard deviation of the operating cost shock σ have to equal 0.41, 0.43, and 0.64 resp., in order to match the targeted flow rates. We calibrate b to 65% of the wage and set $\eta = 0.5$.
The steady state STW rate χ is targeted to 0.7%, which is in line with German data. Note that this implies a relatively high value of c_K which corresponds to costs of about 30-40% of a worker's productivity who uses STW. Such relatively high costs are necessary to avoid extensive use of STW. Note, however, that in the aggregate the resource costs are tiny relative to GDP, as only a small fraction of workers uses STW. These figures match the respective budget of the Federal Employment Agency to conduct STW schemes. The elasticity of STW with respect to changes in aggregate output depends crucially on the level of fixed cost c. Choosing $c = 0.253$ yields an elasticity of -5 which matches the results of our empirical analysis. The remaining parameters are in accordance to the literature and the targeted steady state values. Table 2 summarizes our calibration.

[22] We are aware of the contentious debate about the right scaling of the matching elasticity. For a discussion compare Christoffel et al. (2009).

3.3 Results

Our model allows for two types of shocks: a business-cycle shock and a change in government policy concerning STW. In the first subsection, we discuss the model reaction to a productivity shock and evaluate the model performance. After having established that the model can replicate several stylized facts, we analyze how large the automatic stabilizing effects of STW are. In the second subsection, we analyze the effects of an (unanticipated) policy shock. And in third subsection, we discuss anticipation effects.

3.3.1 Automatic Stabilizers

The impulse responses of a one standard deviation shock to productivity , with autocorrelation 0.95, are given in Figure 4. Since wages respond less than one-to-one to the increase in productivity, the value of a filled job J increases which implies that firms post more vacancies. Consequently, the labor market tightness θ and the hiring rate also go up. The increase in productivity has a direct positive effect on the firing cutoff ε_t^f, and an indirect positive effect via the increased value of a job, so that endogenous firings ^e_t go down. The reduction in firing and the increase in hiring lead to an increase in employment and output and a decline in unemployment. Overall, due to our assumption of fixed costs of production, our model can replicate the two main stylized facts of the business cycle. First, our model shows a Beveridge curve, i.e. a negative correlation between unemployment and vacancies of -0.83. Second, labor market variables are more volatile than productivity and output. The standard deviation of unemployment in our simulation is for example roughly eight times larger than the standard deviation of the underlying productivity shock. Gartner et al. (2009) show for the time period from 1977-2004 in Germany that the unconditional standard deviation of unemployment was 18 times larger than the unconditional standard deviation of productivity. Thus, our model generates roughly 40% of the aggregate unemployment volatility with one aggregate shock. Note that the standard calibration of the search and matching model (Shimer, 2005) generates less than 5% of the aggregate unemployment volatilities in the United States (which are smaller than in Germany) in response to a productivity shock.

What happens to STW? Due to the increase in productivity, workers in general become more profitable and so firms want to increase working time. Due to a direct effect through and an indirect effect through J, the STW threshold ε_t^k increases. The percentage of workers in STW denoted by χ_t falls if the two cutoffs move such that the area under the distribution function $f(\varepsilon)$ decreases. We have calibrated the contemporaneous STW reaction to output to 5.

In order to assess the role of STW as automatic stabilizer on the labor market and the macroeconomy, we compare the reaction in an economy with and without STW. Table 3 shows business cycle statistics for an economy with STW and for an economy where the marginal level of STW, $f^*(\varepsilon_t)$, the STW take-up rate, χ_t, and the cutoff point for STW, ε_t^k, are fixed exogenously, i.e. STW does not vary over the business cycle in the latter case. We consider this as the best reference point, as this exercise does not change the steady states of the model and thereby it does not distort the log-deviations (which depend on the steady level). The presence of STW reduces business cycles and labor market fluctuations by roughly 4-6 percentage points (see Table 3).

3.3.2 Policy Shock

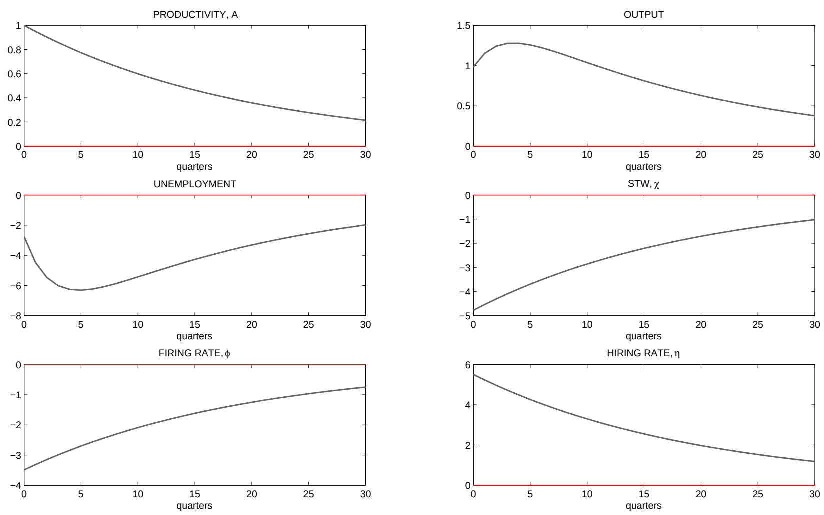


Figure 4: Impulse responses of a positive shock to aggregate productivity. Impulse responses are given in percentage deviations from steady state. The shock is implemented as a temporary autoregressive increase in aggregate productivity.

Table 3: Standard deviation of output, unemployment, firing and hiring rates relative to productivity

Standard deviation	y	u		
With STW	1.57	7.82	3.49	5.51
Without STW	1.64	8.23	3.61	5.86

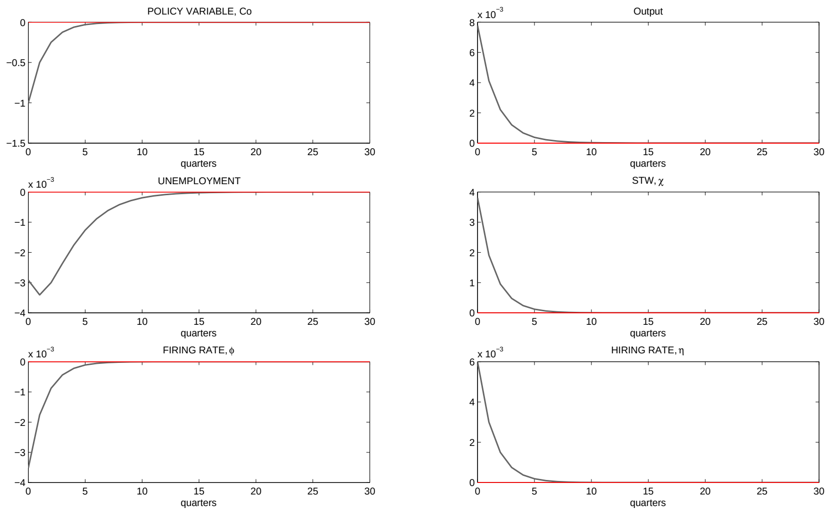


Figure 5: Impulse responses of a negative shock to C_0. Impulse responses are given in percentage deviations from steady state. The shock is implemented as a temporary autoregressive decrease in the costs of STW.

Next, we simulate the responses of the model economy to a change in government policy. Two different alternatives are considered. On the one hand the government could just weaken the eligibility criteria for STW, i.e., increase the level of $_0$. On the other hand, the government could subsidize the cost of STW, c_K. In both cases we consider a policy that increases the number of workers on STW on impact by 1 percent and then slowly converges back to the steady state with a coefficient of autocorrelation of 0.45.

Figure 5 shows the impulse responses of an increase in $_0$. The only direct effect of an increase in $_0$ is to decrease the STW threshold ϑ_t^k (see equation 13), which implies that more workers are sent on STW. Note, however, that there are also indirect effects through an increase in the profitability of firms. Reducing $_0$ allows firms to send more workers on STW reducing the losses generated by these workers. Consequently, the value of job J goes up, firing goes down and vacancy posting goes up (see equations 8 and 18).

Both the decrease in firing and the increase in vacancy posting tend to decrease unemployment, while output goes up. While the latter result is in line with the results from our VAR, the former result is not. Note, however, that the decrease in unemployment hinges on the indirect effect just described. This indirect effect in turn depends crucially on the expectations about the future value of a job (vacancy creation and firings depend only on J_{t+1} and not on J_t). If the policy change is expected to not last long (i.e. if the coefficient of autocorrelation is low), then the impact on expected future profits will be low and the effects on unemployment will be low, too. In the extreme case of an uncorrelated shock the effects on unemployment vanish altogether, as demonstrated by Figure 6. Note, however, the positive effects on output remain. This reason for this is that the policy allows unproductive matches to reduce their working time without the need to incur the firing cost.

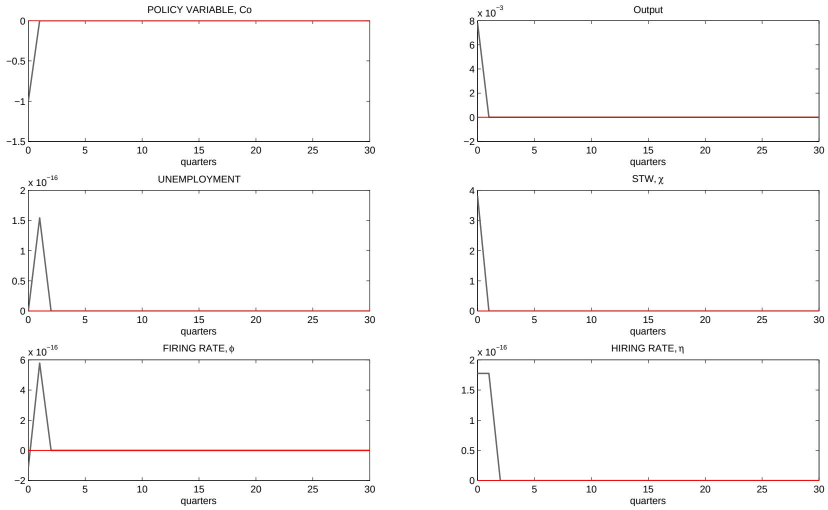


Figure 6: Impulse responses of a negative shock to C_0. Impulse responses are given in percentage deviations from steady state. The shock is implemented as a temporary autoregressive decrease in the costs of STW.

4 Conclusion and Outlook

This paper used the IAB establishment panel to disentangle German short-time work into a rule based and discretionary component. We show with a structural VAR that discretionary shocks do not affect unemployment. However, the counterfactual in the DSGE model shows that the rule based component stabilizes unemployment. The discretionary and rule based component both stabilize output.

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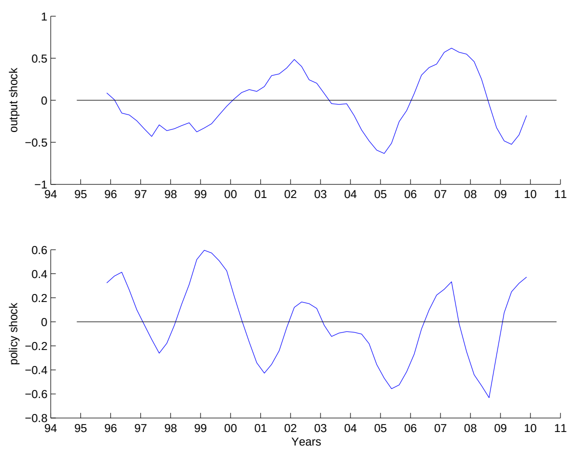
Appendix

Table 4: Elasticity estimates excluding the year 2009

Dependent variable	baseline	additional controls (1)	additional controls (2)
log exp. revenue	-1.191***	-1.175***	-1.579***
	[0.370]	[0.368]	[0.442]
Year fixed effects	NO	YES	YES
Employees in firm	NO	NO	YES

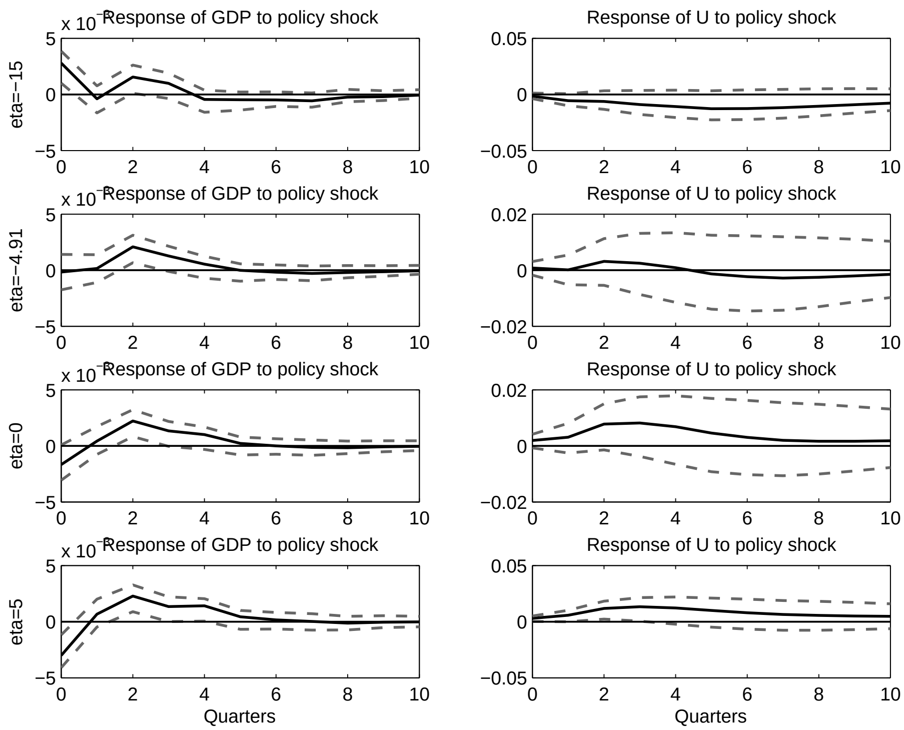
Notes: Dependent variable is number of workers in short-time work over total employees in the firm. *** denotes 1% significance.

Figure 7: Estimated output and STW shocks



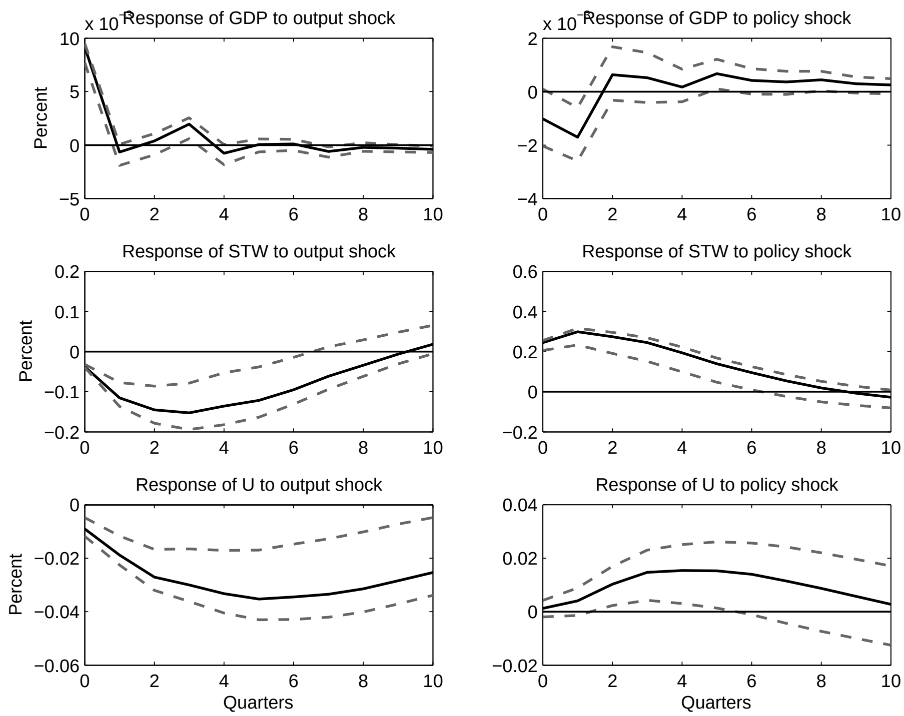
Notes: SVAR estimates with STW per employed workers, GDP growth and unemployment (all in logs) for 1993Q1 to 2010Q4. The shock series is smoothed with a centered moving average with four leads and lags and triangularly declining weights.

Figure 8: Impulse responses to policy shocks for different elasticities



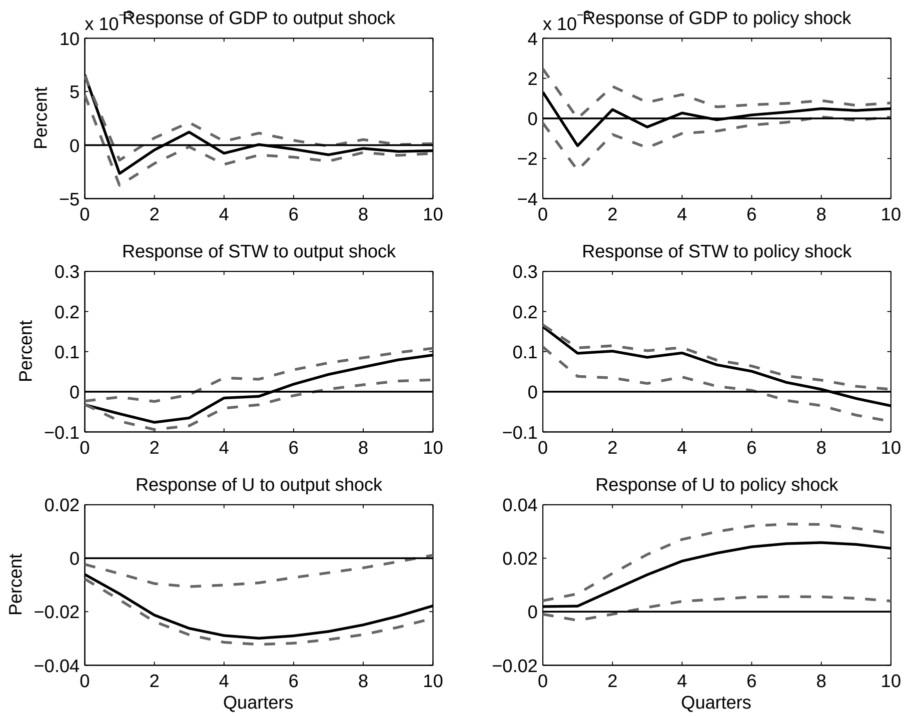
Notes: SVAR estimated with STW per employed workers, GDP growth and unemployment (all in logs) for 1993Q1 to 2010Q4. Quarterly responses to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 9: Impulse responses to output and STW policy shocks in the long sample



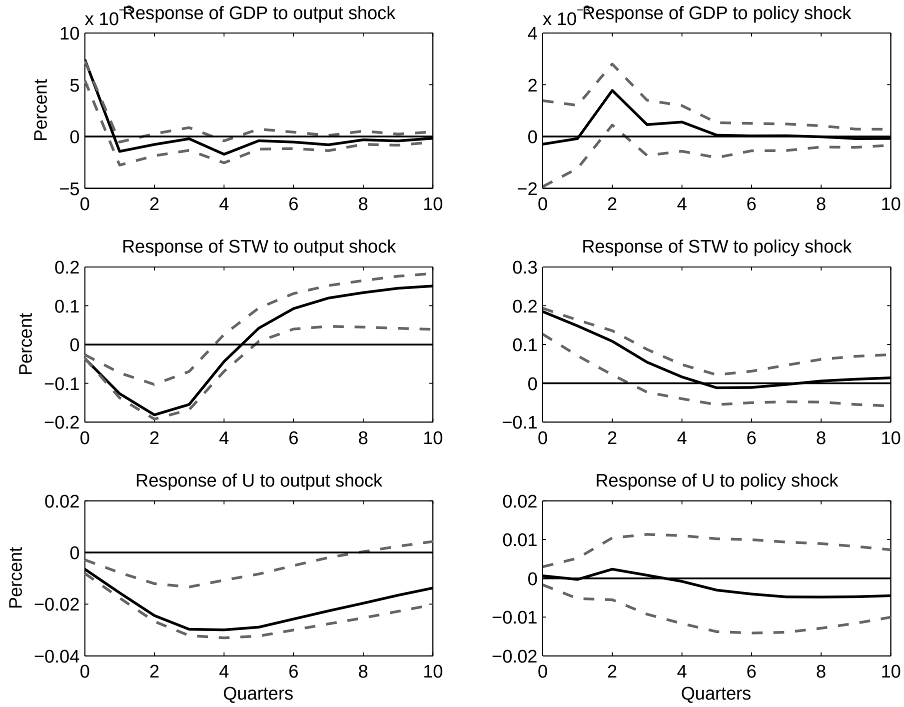
Impulse responses of SVAR with GDP growth, STW over employment and the unemployment rate (all in logs) for 1975Q1 to 2010Q4. Quarterly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 10: Impulse responses to output and STW policy shocks excluding 2009-2010



Impulse responses of SVAR with GDP growth, STW over employment and the unemployment rate (all in logs) for 1993Q1 to 2008Q4. Quarterly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 11: Impulse responses to output and STW policy shocks with recession dummies



Impulse responses of SVAR with GDP growth, STW over employment and the unemployment rate (all in logs) for 1975Q1 to 2010Q4 with recession dummies. Quarterly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 12: Legal changes in duration of eligibility of short-time work

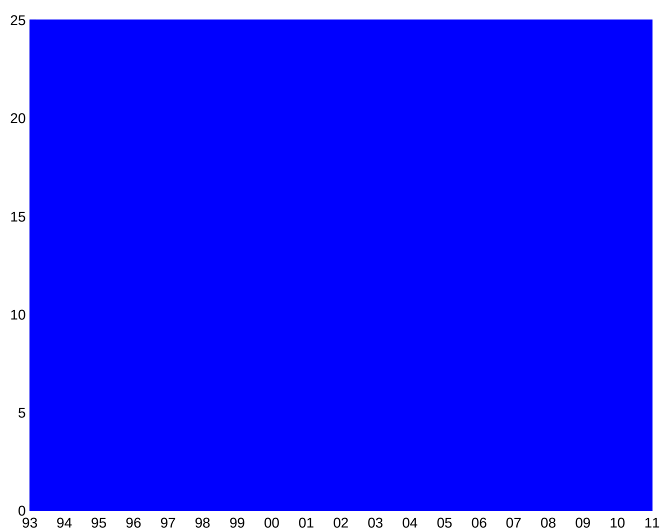
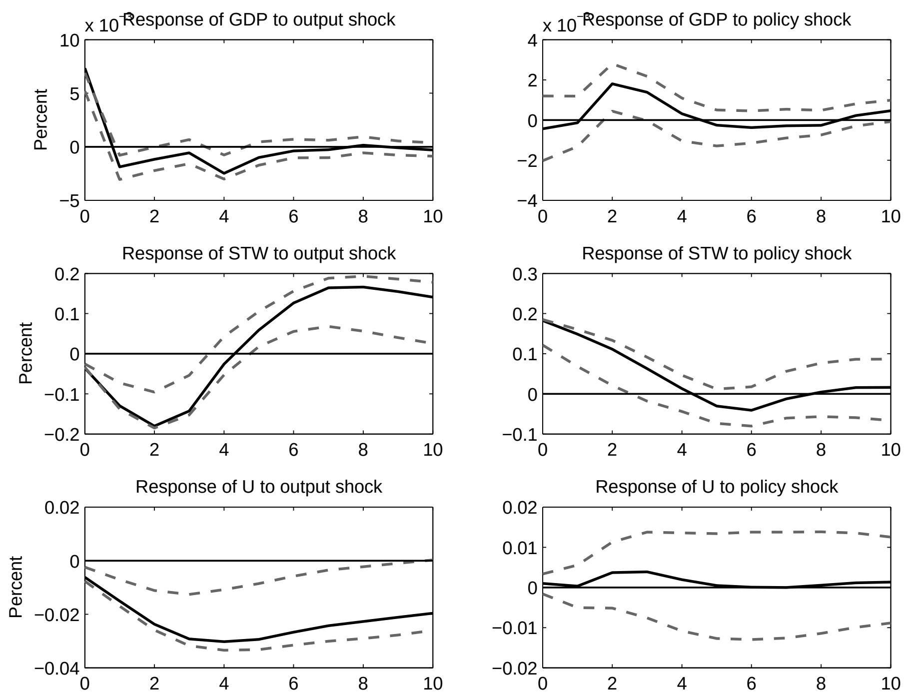
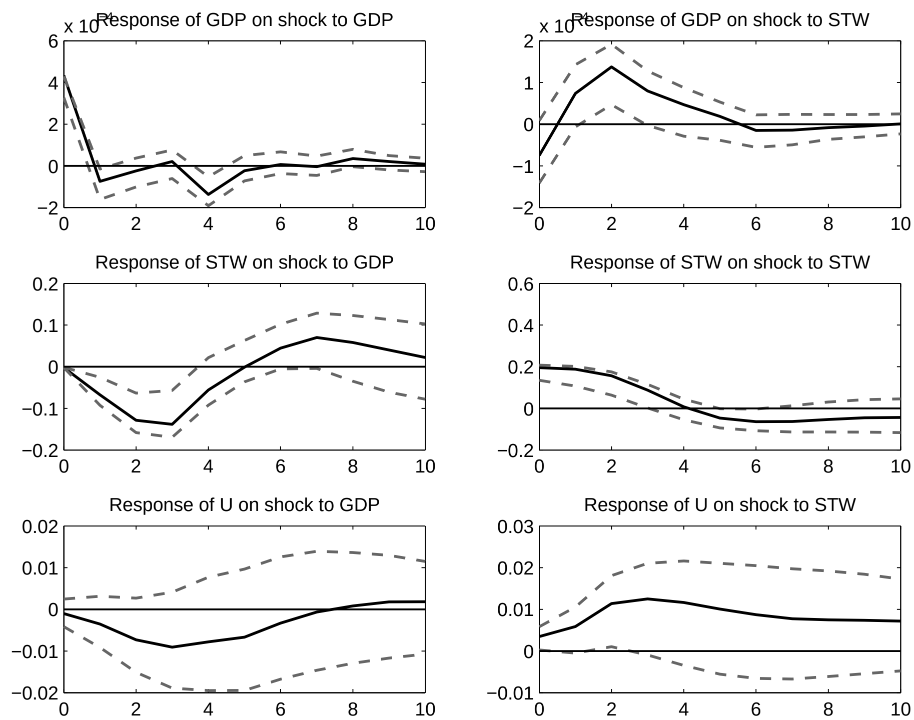


Figure 13: Impulse responses to output and STW policy shocks with legal change dummies



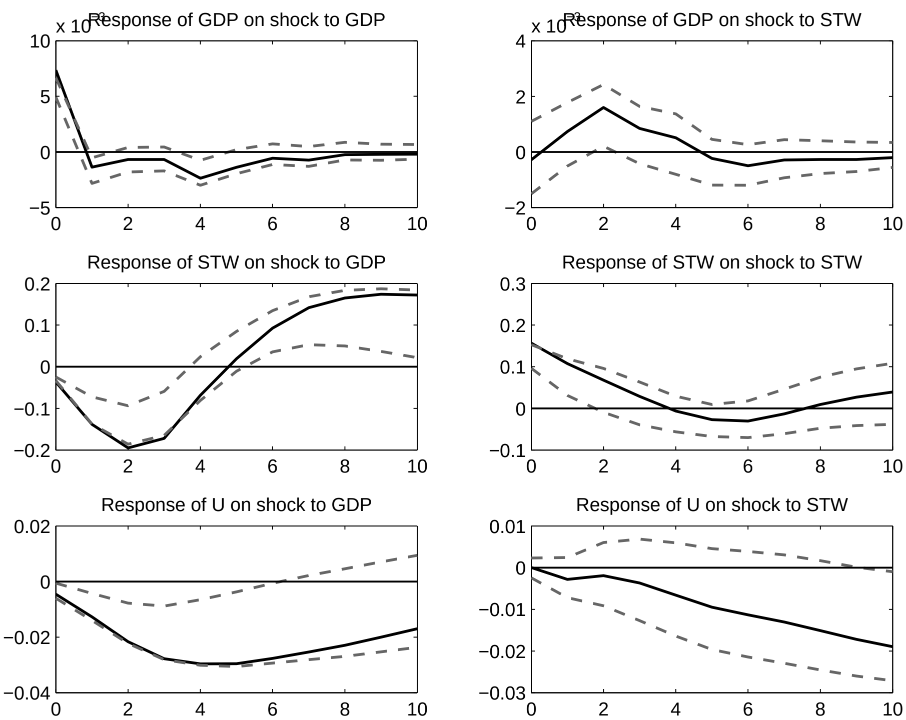
Impulse responses of SVAR with GDP growth, STW over employment and the unemployment rate (all in logs) for 1975Q1 to 2010Q4 with dummies for legal changes regarding the maximum eligibility period. Quarterly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 14: Impulse responses to labor productivity and STW policy shocks



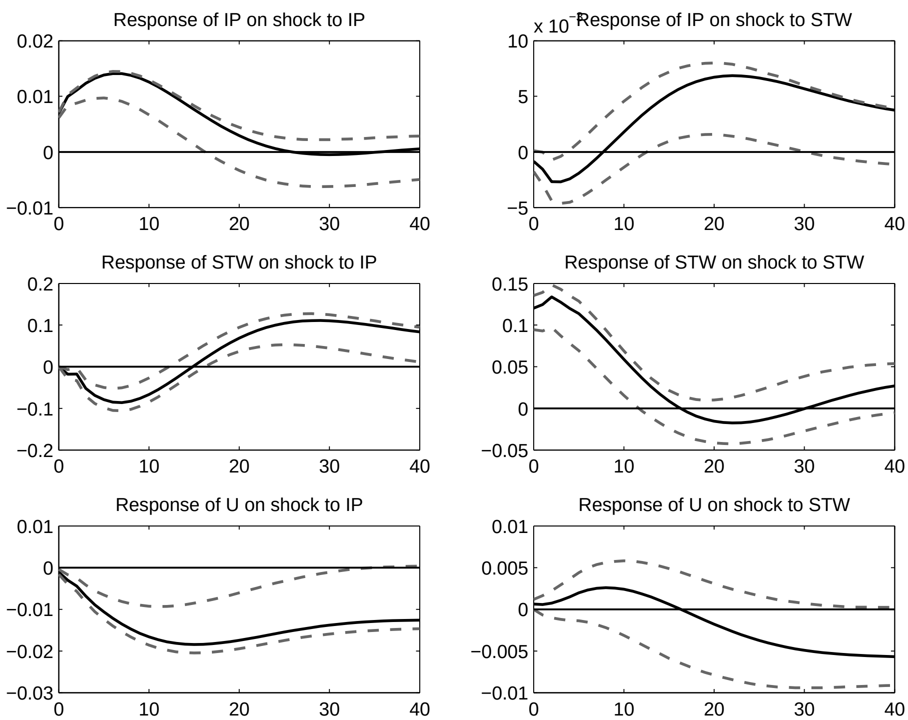
Impulse responses of SVAR with GDP/EMP growth, STW over employment and the unemployment rate (all in logs) for 1993Q1 to 2010Q4. Quarterly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 15: Impulse responses to output and STW policy shocks with ifo and interest rate



Impulse responses of SVAR with GDP/EMP growth, STW over employment, the unemployment rate, the interest rate and the IFO business confidence indicator (all in logs) for 1993Q1 to 2010Q4. Quarterly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.

Figure 16: Impulse responses to industrial production and STW policy shocks



Impulse responses of SVAR with industrial production growth, STW over employment and unemployment (all in logs) for 1998 to 2010. Monthly responses in percent to a positive one-standard deviation shock. Confidence intervals are 90% bootstrapped bands with 10,000 draws.