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WORKING PAPER

Technology Shocks and Robust Sign Restrictions in a Euro Area SVAR

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Abstract

We use a model-based identification strategy to estimate the impact of technology, labor supply, monetary policy and aggregate demand shocks on hours worked and employment in the euro area. The restrictions applied in the SVAR analysis are consistent with a large class of DSGE models and are robust given a sensible range of parametrization. In contrast to most of the existing literature for the United States, our results are in line with the conventional real business cycle interpretation that hours worked rise as a result of a positive technology shock. In addition, we also find an important role for technology shocks in explaining business cycle fluctuations.

JEL classification: E32, E24

Keywords: Technology shocks; Real business cycle models; Sticky price models; Vector autoregressions, DSGE priors.

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1 Introduction

The direction and magnitude of the response of hours worked and employment following a stochastic technology shock is subject to an active contoversy in the academic literature. The debate has its origin in the real business cycle (RBC) research program. The workhorse of this program, as demonstrated in the seminal paper by Kydland and Prescott (1982), has been a flexible price, full-scale structural model with maximizing agents. The motivation behind this approach was to explain aggregate fluctuations in actual economies using the RBC model subject to stochastic technology shocks. In the RBC framework, technology shocks act as labor demand shifters and have therefore a positive impact on both per capita hours worked and output. This prediction has been challenged in Galí (1999). By using United States data and long-run restrictions in a structural VAR, Galí (1999) provides evidence that output increases and hours worked fall as a result of a positive technology shock. The results questioned the suitability of RBC models to mimic the behavior of the economy in several respects. First, the unconditional correlation between output and hours worked is close to zero and even negative in the data, therefore technology shocks cannot play a major role in business cycle behavior. Second, the fact that RBC models predict an increase in hours worked following a positive technology shock questioned also the ability of the model to reproduce the conditional moments in the data. Galí (1999) demonstrates that sticky price models are able to mimic the results of the VAR analysis. Price rigidities imply that aggregate demand cannot change immediately, which forces firms to contract employment after an exogenous increase in productivity. Other papers in the literature e.g., Shea (1998), Basu, Kimball and Fernald (1999), Francis and Ramey (2002), Francis, Owyang and Theodorou (2003), confirm Galí's results.

Recent studies, however, questioned the robustness of the empirical results provided in Galí (1999). First, in Galí's set up, only technology shocks have a long-run impact on labor productivity. Uhlig (2004) shows, however, that capital income taxation shocks or long-run shifts in the social attitudes to the work place can also be a source of changes in long-run labor productivity. In addition, Faust and Leeper (1997) demonstrates that by using long-run restrictions substantial distortions are possible due to small sample biases and measurement errors. In a similar framework as Galí (1999), Christiano, Eichenbaum and Vigfusson (2003) tests the sensitivity of the results to the stochastic specification of the hours worked series. If per capita hours worked is modeled as a difference stationary process the results confirm that hours worked will fall as a result of a positive technology shock. But in case the system is estimated by using the level of the hours worked series, the impulse responses are in line with the predictions of the RBC model.

In this paper we propose an alternative, model-based identification strategy to estimate the effects of technology shocks on hours worked and employment. Our approach searches robust implications of theoretical models that hold, given a range of sensible parametrization and independent of the existence of nominal price rigidities. In particular, we use the common predictions of dynamic stochastic general equilibrium models (DSGE) with flexible and sticky prices, as sign restrictions in a structural VAR. To identify the shocks, however, we use only a minimum set of sign restrictions as our DSGE priors. Since we are mainly interested in the response of hours worked following a technology shock, we do not apply any restrictions on its response. Hence, the estimated reaction of hours worked in our VAR allows us to discriminate between both models. Another innovation of the paper is that we are the first to address this question using euro area data[1] on hours worked[2]. Additionally, we also use the described methodology to identify labor supply, demand, and monetary policy shocks as well as to conduct variance and historical decomposition of aggregate variables in the euro area .

Our methodology implies the use of DSGE models as a prior for SVARs. Ingram and Whiteman (1994) and DeJong et al. (1996) were among the first to use DSGE models as a prior to estimate a Bayesian VAR used for forecasting purposes. Del Negro and Schorfheide (2003) utilize the priors from the theoretical model also to estimate a three-variables Bayesian VAR and to do the identification of a monetary policy shock, which seems to be a very promising method. The disadvantage of these approaches, however, is that the modeling of the dynamics of the DSGE model is relatively important, which can have a substantial impact on the results. Misspecifications can lead to biased results and wrong conclusions. In contrast to these studies, our identification strategy is based only on the sign of a minimum set of conditional responses. Sign restrictions are introduced by Faust (1998), Uhlig (1999) and Canova and De Nicoló (2002) to identify monetary policy shocks. Peersman (2004) extended this method to a larger set of shocks.

[1] Dedola and Neri (2004) also use an approach with sign restrictions to identify technology shocks in the US finding a positive effect on hours. We were not aware of this paper, written at the same time, while doing our research. In contrast to their work, we use euro area data and an empirical model with less variables and fewer restrictions.

[2] Galí (2004) finds a confirmation of his results for the euro area. His evidence, however, is based on the reaction of employment, while we use a series of hours worked.

The results presented in the paper are in favor of the RBC paradigm. We observe a significant positive reaction of hours worked following a positive technology shock. The results are robust whether we estimate the model in levels or first differences or when we use total employment instead of hours. We also find an important role for technology shocks in explaining business cycle fluctuations.

The paper is organized as follow. Section 2 describes our model-based identification strategy. First, we set up a baseline RBC and sticky price model and use the model impulse responses to derive a minimal set of robust restrictions for our euro area VAR. Second, we check the robustness of our sign restrictions by using estimated posteriori distribution of structural parameters for the euro area. In section 3, we present the results of the structural VAR. Section 4 tests the robustness of the empirical results by using different stochastic specifications and by replacing the hours worked series by employment. Section 5 discusses the importance of technology shocks for the euro area business cycle and shows a historical decomposition of hours worked into the contribution of all identified shocks. Section 6 concludes the analysis.

2 Identification

In this section we discuss the choice of the DSGE priors and the corresponding sign restrictions derived from the impulse responses of a standard RBC and sticky price model. We will use the sign restrictions to identify aggregate demand, monetary policy, technology and labor supply shocks in a euro area SVAR. To discriminate between monetary policy and aggregate demand shocks on one hand and the two supply side shocks on the other hand, we will use the conventional result that expansionary supply side shocks lead to a decrease in the price level, while expansionary monetary policy and aggregate demand shocks generate an increase. To discuss the identification strategy in detail, we present, first, the properties of the DSGE models. Since the models are standard, we do not present and discuss the properties in detail. Instead, we will focus on those parts that are important later for the empirical exercise.

2.1 Real Business Cycle Model

In this section we present a textbook RBC model augmented by labor supply shocks. Recent literature presents empirical evidence for the importance of labor supply shifts in explaining business cycle fluctuation. Chang and Schorfheide (2003) e.g., shows that labor supply shocks account for about 30 percent of the cyclical fluctuation in the US hours worked series. Smets and Wouters (2003) estimates that after two and half years about 33 percent of the variation of euro area output is caused by labor supply shocks.

The representative household in the economy maximizes the following utility function:

$$\max E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} C_t^{1-\sigma} - \epsilon_t^{ls} \frac{N_t{}^{1+\eta}}{1+\eta} \right) \right] \tag{1}$$

where C_t is consumption, N_t is labor supply and ϵ_t^{ls} represents the weight of hours worked in the utility function. Expansionary labor supply shocks are modeled as a corresponding negative shock to ϵ_t^{ls}. As usual, β stands for the time preference rate, σ for the inverse of the intertemporal elasticity of substitution and η for the inverse of the elasticity of labor supply. The maximization problem of the agent is constrained by the following budget constraint:

$$C_t + \frac{B_{t+1}}{R_t} = W_t N_t + B_t \tag{2}$$

where R_t is the real interest, B_t is a one period bond and W_t is the real wage. The production function of the economy has the standard Cobb Douglas form:

$$Y_t = (A_t N_t)^{\alpha} K_t^{1-\alpha} \tag{3}$$

where Y_t is output, A_t is technology, K_t is capital and N_t is labor input. The capital accumulation process is described by the following function:

$$K_{t+1} = (1-\delta) K_t + I_t \tag{4}$$

We abstract at this stage from government spending, so the aggregate resource constraint of the economy equals to:

$$Y_t = C_t + I_t \tag{5}$$

Optimization by households and firms and the log-linearization of the corresponding equilibrium conditions leads to a system of dynamic equations. In the following, we present some of the conditions to highlight the impact of the deep parameters on the evolution of the equilibrium dynamics. The standard Euler condition has the form:

$$c_t = E(c_{t+1}) - \frac{1}{\sigma} E_t(r_{t+1}) \tag{6}$$

where small letters characterize percentage deviations form the steady state. The linearized production function corresponds to:

$$y_t = \alpha a_t + \alpha n_t + (1-\alpha) k_t \tag{7}$$

The log-linearized capital accumulation follows:

$$k_{t+1} = (1-\delta) k_t + \delta i_t \tag{8}$$

The labor supply curve is described by :

$$w_t = \eta n_t + \epsilon_t^{ls} + \sigma c_t \tag{9}$$

We additionally specify the technology and the labor supply shocks to follow an AR(1) process.

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \tag{10}$$

$$\epsilon_t^{ls} = \rho_{\epsilon^{ls}} \epsilon_{t-1}^{ls} + \varepsilon_t^{ls} \tag{11}$$

In order to calculate the theoretical impulse responses to both shocks, we use the parameter values as reported in Table 1. We will discuss the robustness of the predictions with respect to the a range of sensible parameter values in section 2.3. In line with the majority of the RBC literature, we specify the intertemporal elasticity of substitution and the inverse of elasticity of hours worked to the real wage to be one (i.e., a log utility specification). The discount factor, β, is calibrated to be 0.99, which implies an annual steady state real interest rate of 4 percent. The depreciation rate, δ, is set to equal to 0.025. The steady state share of capital income in total output, α, is set to 0.7. The AR(1) term of the labor supply shock is calibrated to be 0.89 while for the technology shock 0.93 (see also section

2.3).

Table 1: Parameter Values for RBC model

Description	**Symbol**	**Value**
Intertemporal elasticity of substitution	σ^{-1}	1
Inverse of elasticity of N with respect W/P	η	1
Discount factor	β	0.99
Capital depreciation rate	δ	0.025
Steady state share of capital income	α	0.7
AR(1) term labor supply	ρ^{ls}	0.89
AR(1) term technology	ρ^{a}	0.93

The theoretical impulse responses based on the above parameter values are shown in the first two columns of Figure 1. Technology shocks act as labor demand shifters and result in an increase of the equilibrium real wage. The jump in labor and technology leads, see equation (7), to an increase in output and real interest rate (through the rise in the marginal rate of capital). In contrast, the excess supply on labor, as a result of the labor supply shock, will decrease the real wage on impact, but will also increase the equilibrium value of output and interest rate. Therefore, we can potentially exploit the asymmetric responses of real wages to discriminate between labor supply and technology shocks. In the next step, however, we need to analyze whether similar properties hold also in a sticky price model.

2.2 Sticky Price Model

The sticky price model presented in this section is based on Ireland (2002). To keep things simple, we use the same notation and basis set up as in the RBC model. The representative agent follows the following utility function:

$$\max E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} C_t^{1-\sigma} - \epsilon_t^{ls} \frac{{N_t}^{1+\eta}}{1+\eta} \right) \right] \tag{12}$$

subject to to the budget constraint:

$$P_t C_t + \frac{B_{t+1}}{R_t} = W_t N_t + B_t \tag{13}$$

where P_t is the aggregate price level. Monopolistic competitive firms in the intermediate good sector, indexed by i, have a linear production function in labor and technology:

$$Y_t(i) = A_t N_t(i) \tag{14}$$

The final good is produced by aggregating the output in the intermediate good sector using constant returns to scale technology:

$$Y_t = \left(\int_0^1 Y_t(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \tag{15}$$

where θ is the elasticity of demand for the intermediate goods. Sticky prices are introduced by assuming quadratic cost of nominal price adjustment as in Rotemberg (1982):

$$\frac{\phi}{2} \left[\frac{P_t(i)}{\pi P_{t-1}(i)} - 1 \right]^2 Y_t \tag{16}$$

where ϕ represent the degree of nominal price rigidity. Optimization and log-linearization lead to the system of dynamic equilibrium conditions. The New Keynesian IS-Curve has the standard form:

$$y_t = E(y_{t+1}) - \frac{1}{\sigma}(r_t - E(\pi_{t+1})) \tag{17}$$

The pricing decision of the firm under the Rotemberg-type of nominal adjustment delivers the following forward looking equation for inflation:

$$\pi_t = \beta E(\pi_{t+1}) + \frac{\theta - 1}{\phi\theta} \left[(\sigma + \eta) y_t + \epsilon_t^{ls} - (\eta + 1) a_t \right] \tag{18}$$

The equilibrium real wage follows :

$$w_t = (\sigma + \eta) y_t + \epsilon_t^{ls} - \eta a_t \tag{19}$$

As in the RBC model, we specify technology and labor supply shocks to follow an AR(1) process, where:

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a$$

$$\epsilon_t^{ls} = \rho_{\epsilon^{ls}} \epsilon_{t-1}^{ls} + \varepsilon_t^{ls}$$

Finally, monetary policy is described by a standard Taylor rule:

$$r_t = \rho_r r_{t-1} + (1 - \rho_r) \left(\phi^y y_t^{gap} + \phi^\pi \pi_t \right) \tag{20}$$

In order to derive the theoretical impulse response functions, we use the parameter values as shown in Table 2. Most of the coefficients are in line with the estimated parameters for the euro area in Rabanal and Rubio-Ramirez (2003).[3] In addition, we set the price adjustment costs at $\phi = 50$, which implies that 95% of the price has adjusted four periods after a shock. The elasticity of demand for the intermediate good θ is set to 6. Finally, we impose the coefficients of the Taylor rule to be respectively 0.26, 1.30 and 0.73 for ϕ^y, ϕ^π and ρ^a.

Table 2: Parameter Values for Sticky Price Model

Description	**Symbol**	**Value**
Intertemporal elasticity of substitution	σ^{-1}	0.19
Inverse of elasticity of N with respect W/P	η	0.95
Discount factor	β	0.99
AR(1) term labor supply	ρ^{ls}	0.89
AR(1) term technology	ρ^a	0.93
Price adjustment costs	ϕ	50
Elasticity of demand for intermediate good	θ	6
Taylor rule/ reaction to output gap	ϕ^y	0.26
Taylor rule/ reaction to inflation	ϕ^π	1.30
Taylor rule/ smoothing term	ρ_r	0.73

The third and fourth column of Figure 1 show the theoretical impulse responses of the sticky price model. As in the RBC model, technology shocks act as labor demand shifters. However, given the price adjustment costs, the transmission mechanism will alter significantly. Though all firms will experience a decline in their marginal cost, they will adjust prices downwards only partially in the short run. Aggregate demand will rise less than proportionally to the increase in productivity and hours worked will decrease. Given our parametrization, real wages increase since technology shocks induce a strong wealth effect and the corresponding labor supply shift is dominating the labor demand effect. The impact response of the real wage is therefore sensitive to the parametrization of the model.

In contrast, the sign of the impact response of hours worked, output and real wages following a labor supply shock are insensitive to the existence of nominal price rigidities. Notice that after both technology and labor supply shocks, the price level decreases on impact.

[3] See section 2.3 for details and the robustness with respect to alternative parameter values.

2.3 Sign Restrictions and Robustness Analysis

In this section we present the choice of the DSGE priors. To be eclective our priors will be based on conditional responses that are robust across both theoretical models for a wide range of sensible parametrization.

Table 3: Sign Restrictions

	output	prices	interest rate	hours	wages
monetary policy	↑	↑	↓		
aggregate demand	↑	↑	↑		
technology	↑	↓			↑
labor supply	↑	↓			↓

As indicated before, the real wage response in a model with nominal price rigidities is sensitive to the choice of the parameters. To conduct a sensitivity analysis we use, therefore, the estimated posteriori distribution of structural parameters in the euro area presented in Rabanal and Rubio-Ramirez (2003)[4]. The relevant parameters are depicted in Table 4. Notice that the value of the price adjustment costs is set to $\phi = 100$ to be approximately in line with the Calvo parameter estimated in Rabanal and Rubio-Ramirez (2003)[5]. Since the standard deviation, that is the uncertainty around the parameters $\rho^a, \phi^y, \phi^\pi, \rho_r, \phi$ are relatively low, we will focus on the impact response of output, inflation and real wages by varying σ^{-1} (the intertemporal elasticity of substitution) and η (inverse of the elasticity of hours worked with respect to the real wage)[6]. We use two standard deviations from the posteriori mean as a sensible range for our simulation exercise. We emphasize that

[4]Notice that the production and preference structure of the discussed sticky price model is similar to the baseline New-Keynesian model estimated by Rabanal and Rubio-Ramirez (2003). The comparison of the marginal likelihoods show that the baseline model is not significantly worse in explaining the data than the extension with sticky wages.

[5]Note that in the empirical literature the degree of price stickyness is estimated to be rather high. For example Smets and Wouters (2004) estimate that the average duration of price contracts is two and half years in the Euro Area. The results of Rabanal and Rubio-Ramirez (2003) indicates a price duration of six and half quarters. One possibility why the degree of price stickyness is potentially overestimated lies in the specification of the marginal cost curve. While the marginal disutility of labor is upward sloping the marginal cost curve for the firms is usually assumed to be flat due to constant returns to scale production functions. Gali, Gertler and Lopez-Salido (2001) shows that by assuming decreasing returns to scale and an upward sloping marginal cost curve the degree of price stickyness decrease significantly.

[6]Notice also that according to equation (19), these parameters have the most significant direct impact on the equlibrium real wage.

the variation of the remaining parameters according to the same principle would not significantly alter the results. The impact responses of output, prices, real wages and hours worked are presented in Figure 2.

Table 4: Posterior Distribution of Estimated Structural Parameters for the Euro Area

Parameter	**Mean**	**Standard Deviation**
σ^{-1}	0.19	0.08
η	0.95	0.20
ρ^a	0.93	0.01
ϕ^y	0.26	0.06
ϕ^π	1.30	0.12
ρ_r	0.73	0.03

Source: Rabanal and Rubio-Ramirez (2003)

The results confirm that for a wide range of parameters output and real wages increase on impact, while prices and hours decrease. There is, however, one exception. If at the same time $\eta > 1.30$ and $\sigma > 30.60$ ($\sigma^{-1} < 0.03$), then we find a contemporaneous negative effect on real wages. This joint probability is, however, smaller than 0.001. We therefore consider our imposed condition as robust. These restrictions are also consistent with the empirical evidence on the reaction of real wages to technology and labor supply shocks. Specifically, Francis and Ramey (2002) and Fleischmann (1999) find a positive effect of technology shocks and a negative effect of labor supply shocks on hours worked using an identification strategy in the spirit of Galí (1999).

So far, we have only disentangled technology from labor supply shocks. For a proper identification, we also have to distinguish both shocks from demand side shocks. Specifically, in the empirical part, we also estimate the effects of monetary policy shocks and aggregate demand shocks. To do so, we introduce some generally accepted sign conditions in Table 3 that are based on a typical aggregate supply and demand diagram which are also consistent with a large class of general equilibrium models. We assume that after both, an expansionary monetary policy and positive demand shock, the responses of output and prices are positive. In contrast, average prices fall following a technology and labor supply shock. To disentangle monetary policy and an aggregate demand shock, we assume further that a positive demand shock generates an increase in the nominal interest rate whilst an expansionary monetary policy shock a fall of the same.[7] This strategy is

[7] Notice that the response of the nominal interest rate following a monetary policy shock in a micro

in line with the method applied in Faust (1998), Uhlig (1999) and Peersman (2004). All sign restrictions are summarized in Table 3.

3 Empirical evidence

In this section we present the results of our structural VAR using euro area data for the sample period 1982:1-2002:4. All data are taken from the area-wide model (Fagan et al., 2001). Hours Worked is a series constructed by the ECB Euro Area Department. The latter is only available from 1981 onwards, which determines our sample period.

Consider the following specification for a vector of endogenous variables Y_t:

$$Y_t = c + \sum_{i=1}^{n} A_i Y_{t-i} + B\varepsilon_t \tag{21}$$

where c is an $(n \times 2)$ matrix of constants and linear trends, A_i is an $(n \times n)$ matrix of autoregressive coefficients and ε_t is a vector of structural disturbances. The endogenous variables, Y_t, that we include in the VAR are real GDP (y_t), the GDP deflator (p_t), short-term nominal interest rate (i_t), hours worked (h_t) and real wages (w_t). We estimate this VAR-model in levels with three lags. By doing the analysis in levels, we allow for implicit cointegration relationships in the data, and still have consistent estimates of the parameters (Sims et. al., 1990).[8] Within this VAR, we identify four types of underlying disturbances, a monetary policy, aggregate demand, technology and labor supply shock respectively. In order to identify these shocks, we use the restrictions reported in Table 3. For the implementation of these restrictions, we refer to Peersman (2004) or the appendix of this paper. All restrictions are imposed as $\leq$ or $\geq$. This means that a restrictive monetary policy shock is identified as a shock which has a positive effect on the interest

founded New Keynesian model depends crucially on the monetary policy rule. In contrast to sticky price models, in a standard RBC model monetary policy has no real effects. Note, however, that we also allow for a possible zero impact of monetary policy shocks in our empirical approach, because restrictions are imposed as $\geqslant$ or $\leqslant$. Our identification scheme for a demand shock (modeled, for example as a government consumption shock in a structural model) is in line with both sticky and flexible price models.

[8] In section 4.1, we check the robustness of our results when we use a first differences specification of the VAR. We can, however, not reject the hypothesis of the existence of a cointegration relation in the level specification when we perform the tests on the reduced form point estimates using the procedure of Johansen and Juselius in CATS.

rate and a negative (or zero) impact on output and prices. After a positive demand shock, output, prices and the interest rate do not fall. A positive technology shock is a shock with a non-negative effect on output, prices do not rise and there is no decrease in real wages. In contrast, an unexpected increase in labor supply has not a negative impact on output, not a positive effect on prices and there is not an increase in real wages. These limited number of restrictions allow us to compare the estimated impulse responses of the other variables with the expectations from the theoretical models. In particular the responses of hours to all the shocks. No restrictions are imposed for the latter, which allows us to compare the theoretical responses with the data. For all variables except the interest rate, the time period over which the sign restriction is binding is set equal to four quarters. The response of the interest rate is only restricted for one quarter. We only select decompositions which produce impulse responses that are consistent with the restrictions of all four shocks. Specifically, the responses of four identified shocks should be consistent with a monetary policy, aggregate demand, technology and labor supply shock. Decompositions that match only the criteria of three or less shocks are rejected. Impulse responses and error bands are computed based on Monte Carlo integration with 1000 draws from the posterior. In all figures, we report the median of the responses together with 84th and 16th percentiles error bands.

Figure 3 shows the results. After a restrictive monetary policy shock, we find a significant negative response of output and prices. Output returns to baseline after five years while the effect on prices is more persistent. These monetary policy effects are qualitative similar to the results of Peersman and Smets (2001). We observe a significant decrease in hours worked and real wages. Both variables seem to be pro-cyclical after a monetary policy shock. Following an aggregate demand shock, we find a positive response of output up to 12 quarters. The effect on prices is also more persistent and the interest rate returns to baseline together with output. Hours worked and real wages react pro-cyclically, but the uncertainty around the estimates are relatively high for the latter. The third row of Figure 3 presents the results for a technology shock. The positive and significant reaction on impact of hours worked is striking. Notice that the variable hours worked is unrestricted in our set up. The results are in favor of the RBC model and stand in contrast to the results of Galí (1999) and others for the US. The last row depicts the results after a labor supply shock. As expected, the response of hours worked is positive and very significant.[9]

[9] Notice that the response of output returns to baseline in the long-run after a technology and labor-

4 Robustness of the Empirical Results

We now want to check the robustness of our empirical results. In particular, following the results of Christiano, Eichenbaum and Vigfusson (2003), we investigate whether the specification of the variables in levels or first differences matters for the results. Furthermore, we run a VAR in both specifications by replacing the hours worked series by the employment series. Finally, we evaluate the exogeneity of the identified technology shocks as in Francis and Ramey (2002).

4.1 Difference Specification

Christiano, Eichenbaum and Vigfusson (2003) show that the results of Galí (1999) are highly sensitive to the stochastic specification of the VAR. The negative response of hours worked of Galí (1999) are obtained with a VAR in first difference specification. If the model is estimated in levels, the results do not hold any longer. In contrast, a positive effect on hours is found. Since we also estimate our basic model in levels, we check whether we still find a positive effect using a first difference specification. We are aware of the problem that our empirical model is misspecified in first differences in the case of cointegration. Nevertheless, we run this exercise as a robustness check. All variables included in the VAR are now measured as first differences. The impulse response function are reported in Figure 4. Results are very similar at first sight. However, there are some differences for technology and labor supply shocks. We now find a permanent effect of both shocks on the level of output and prices. This is not surprising given the stochastic specification of the VAR. There is also a puzzling permanent effect of both shocks on the level of the nominal interest rate. However, we still find a positive (and permanent) effect of a technology shock on hours worked. The reaction of the latter variable to all shocks is also still procyclical. The results show that the positive response of hours worked after a technology shock is independent of the stochastic specification of the series, in contrast to the results of Christiano, Eichenbaum and Vigfusson (2003).

supply shock. This finding is not surprising given our de-trended level specification.

4.2 Specification with Employment

As a second robustness check, we re-estimate the basic model and the first differences model with employment included instead of hours worked. The latter was also done by Galí (1999). Results are reported in Figures 5 and 6. The magnitude of the effects is slightly smaller for employment, but there are no significant differences between the estimated impulse response functions of the employment and the hours worked specification. The results in this subsection are therefore also in favor of the RBC model. We find a positive reaction of employment to a technology shock.

4.3 Exogeneity of the Identified Technology Shocks

Francis and Ramey (2002) argue that technology shocks could be correlated with other exogenous shocks that are not related to technology. They therefore test whether other exogenous variables are correlated with the shocks. Accordingly, they regress the identified technology shock on three sets of dummy variables, in particular monetary policy indicators, oil shock dummies and war dates. Given that we also identify monetary policy shocks, there is no correlation with technology shocks by construction. In addition, our sample period does not include important war dates for the euro area. To check the potential correlation with oil price shocks, we perform two robustness checks. First, we calculate a simple correlation between the identified technology shocks and pure oil price shocks obtained from the study of Peersman (2004). This correlation varies between -0.17 and -0.20 depending on the specification and is always insignificant. Second, we re-estimate all VAR-models with oil prices (or commodity prices) as an additional exogenous variable. This never has an effect on the quality of the results. We still find a significant positive effect of technology shocks on hours worked for all specifications.[10] As a consequence, these results provide additional support for the plausibility of the shocks being technology shocks.

[10] These results are not reported but available upon request.

5 How important Are Technology Shocks for Aggregate Fluctuations?

In Figure 7, we report the contribution of technology shocks to the forecast error variance of output and hours worked series for the two specifications. In contrast to the work of Galí (1999), who finds almost no role for technology shocks in explaining business cycle fluctuations, we find a substantial impact on the output and hours worked series. Error bands are, however, very wide which is typical for this type of exercise in VARs. On the other hand, the impact based on the median estimate is still smaller than in the bivariate model of Christiano et al. (2003). We find a value around 25% at a five-year horizon while they find that more than 40% of variation in hours worked can be explained by technology shocks.

In Figure 8, we plot the actual time series of hours worked and employment, together with the contribution of all shocks to hours worked as percentage points deviations from the baseline. This means that hours worked can be written as the sum of a deterministic component (baseline) and the contribution of current and past shocks. For reasons of legibility, we only show the median estimates. From this figure, it is clear that technology shocks also played an important role in explaining fluctuations of hours worked at some periods in time. There was a negative contribution of technology shocks between 1983 and 1987, and again between 1992 and 1999. On the other hand, there was a persistent positive contribution in between these two periods. The magnitude and timing is rather similar for the levels and first differences specifications. There is only a difference of some quarters in identifying the turning points. Focusing on the more recent period, we find a significant positive contribution between 1999 and 2001. A sequence of positive technology shocks made a positive contribution to hours worked of more than 1 percent for the levels specification. For the differences specification, this is, however, only around 0.5 percent. Between 2001 and the end of the sample period, there is again a substantial negative impact on hours worked of the same magnitude. This is consistent with the results of Peersman (2003) who finds an important role for negative aggregate supply shocks in explaining the early millennium slowdown.

It is interesting to mention that the significant rise in hours worked between 1995 and 2001, often called the New Economy period, is also mainly the result of positive labor supply shocks. This effect is even more pronounced for the differences specification. The positive labor supply shocks are actually the only significant source of the rise until 1999. In addition, we also find a positive effect of demand shocks between 1987 and 1991 and in 2000. The contribution is negative between approximately 1991 and 1997. Monetary policy shocks, on the other hand, made a negative contribution in 1992 and 1993, after which there was a slight upward effect until 2001.

6 Conclusions

This paper has provided empirical evidence for the effects of technology, labor supply, monetary policy and aggregate spending shocks on hours worked in the euro area economy. The structural shocks are identified building on sign restrictions obtained from DSGE models. This model-based identification takes seriously the fact that the predictions of the models are only appropriate in few dimensions. Consequently, the suggested procedure only uses robust restrictions derived from both RBC and sticky price models. The remaining unrestricted responses of the variables can then be used to discriminate between the models. The results presented in the paper are in favor of the RBC paradigm. First, hours worked increases significantly after a positive shock to technology. Second, we find also an important role for technology shocks as a driving force of cyclical fluctuations in the euro area. The results are in contrast to Galí (1999) and others who find a negative reaction of hours worked to a technology shock in the US, but is consistent with Christiano et al. (2003) and Uhlig (2004) who use an alternative strategy.

However, our findings do not necessarily imply that sticky price models are not a good representation of reality. But the results indicate that sticky price models are at least in one particular aspect not in line with the empirical results for the euro area, namely the transmission of technology shocks to the aggregate labor market. Hence, reconsidering the discussed transmission mechanism and introducing new properties into the sticky price framewok might be a worthwhile exercise[11]. Also, the structural shocks in our empirical analysis are identified at a fairly aggregated level. Identifying additional shocks, like price and wage mark-up shocks, could potentially provide further information. This is left for future research.

[11] See also, on a similar issue, the discussion on the effects of government spending shocks and aggregate labor market fluctuations in Galí, López-Salido and Vallés (2004) and Bilbiie and Straub (2004).

A Appendix: Implementation of the Sign Restrictions

In this appendix, we explain how to implement the sign restrictions in our SVAR. For a detailed explanation, we refer to Peersman (2004). Consider equation (21) in section 3. Since the shocks are mutually orthogonal, $E(\varepsilon_t \varepsilon_t^{'}) = I$, the variance-covariance matrix of equation (21) is equal to: $\Omega = BB'$. For any possible orthogonal decomposition B, we can find an infinite number of admissible decompositions of Ω, $\Omega = BQQ'B'$, where Q is any orthonormal matrix, that is $QQ' = I$. Possible candidates for B are the Choleski factor of Ω or the eigenvalue-eigenvector decomposition, $\Omega = PDP' = BB'$, where P is a matrix of eigenvectors, D is a diagonal matrix with eigenvalues on the main diagonal and $B = PD^{\frac{1}{2}}$. Following Canova and De Nicoló (2002) and Peersman (2003), we start from the latter in our analysis. More specifically, $P = \prod_{m,n} Q_{m,n}(\theta)$ with $Q_{m,n}(\theta)$ being rotation matrices of the form:

$$Q_{m,n}(\theta) = \begin{bmatrix} 1 & \cdots & 0 & \cdots & 0 & \cdots & 0 \\ \cdots & \ddots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & \cos(\theta) & ... & -\sin(\theta) & \cdots & 0 \\ \vdots & \vdots & \vdots & 1 & \vdots & \vdots & \vdots \\ 0 & \cdots & \sin(\theta) & \cdots & \cos(\theta) & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \ddots & \cdots \\ 0 & \cdots & 0 & \cdots & 0 & \cdots & 1 \end{bmatrix} \quad (22)$$

Since we have five variables in our model, there are ten bivariate rotations of different elements of the VAR: $\theta = \theta_1, \cdots, \theta_{10}$, and rows m and n are rotated by the angle θ_i in equation (22). All possible rotations can be produced by varying the ten parameters θ_i in the range $[0, \pi]$. For the contemporaneous impact matrix determined by each point in the grid, B_j , we generate the corresponding impulse responses:

$$R_{j,t+k} = A(L)^{-1} B_j \varepsilon_t \quad (23)$$

A sign restriction on the impulse response of variable p at lag k to a shock in q at time t is of the form:

$$R_{j,t+k}^{pq} \gtrless 0 \quad (24)$$

Following Uhlig (1999) and Peersman (2004), we use a Bayesian approach for estimation and inference. Our prior and posterior belong to the Normal-Wishart family used in the RATS manual for drawing error bands. Because there are an infinite number of admissible decompositions for each draw from the posterior when using sign restrictions, we use the following procedure. To draw the "candidate truths" from the posterior, we take a joint drawing from the posterior for the usual unrestricted Normal-Wishart posterior for the VAR parameters as well as a uniform distribution for the rotation matrices. We then construct impulse response functions. If all the imposed conditions of the impulse responses of the four different shocks are satisfied, we keep the draw. Decompositions that match only the criteria of three or less shocks are rejected. This means that these drawings receive zero prior weight. Based on the drawings kept, we calculate statistics and report the median responses, together with 84th and 16th percentiles error bands.

References

[1] Basu, S., J. G. Fernald and M. Kimball, 1999, "Are Technology Improvements Contractionary?", mimeo.

[2] Bilbiie, F. and R. Straub, 2004, "Fiscal Policy, Business Cycles and Labor Market Fluctuations", Magyar Nemzeti Bank Working Paper 2004/6.

[3] Christiano, L. J., Eichenbaum, M. and R. Vigfusson, 2003, " What happens after a Technology Shock?", mimeo, Northwestern University.

[4] De Jong, D., B. Fisher and C.H. Whiteman, 1996, "A Bayesian Approach to Calibration", Journal of Business Economics and Statistics, vol. 14(1), pp. 1-9.

[5] Dedola, L. and S. Neri, 2004, "Can the RBC hypothesis be rescued? A model based VAR-Analysis", mimeo.

[6] Del Negro, M. and F. Schorfheide, 2002, "Priors from General Equilibrium Models for VARs: Forecasting and Identification", mimeo.

[7] Fagan, G., J. Henry and R. Mestre, 2001, "An Area Wide Model (AWM) for the Euro Area", ECB Working Paper 42.

[8] Faust, J., 1998, "The Robustness of Identified VAR Conclusions about Money", Carnegie Rochester Series on Public Policy, Vol. 49, pp.207-244.

[9] Faust, J. and E.M. Leeper, 1997, "When do long-run identifying restrictions give reliable results?", Journal of Business and Economic Statistics, Vol. 15, No. 3, pp. 345-353.

[10] Fleischman, C., 1999, "The Causes of Business Cycles and the Cyclicality of Real Wages", Board of Governors of the Federal Reserve System.

[11] Francis, N., M. Owyang and A. Theodorou, 2003, "The use of long-run restrictions for the identification of technology shocks", Federal Reserve Bank of St Louis Review, Vol. 85, No. 6, pp. 53-66.

[12] Francis, N. and V. Ramey, 2002, "Is the Technology-Driven Business Cycle Hypothesis Dead? Shocks and Aggregate Fluctuations Revisited", NBER Working Paper, 8726.

[13] Galí, J., 1992, "How Well Does the IS-LM Model Fit Postwar US Data?", Quarterly Journal of Economics, pp. 709-738.

[14] Galí, J., 1999, "Technology, Employment and the Business Cycle: Do Technology Shocks explain Aggregate Fluctuations?", American Economic Review, Vol. 89, No 1. , pp. 249-271.

[15] Galí, J., 2004, "On the Role of Technology Shocks as a Source of Business Cycles: Some New Evidence", Journal of European Economic Association Papers and Proceedings, forthcoming.

[16] Galí, J., M. Gertler and D. López-Salido, 2001, "European Inflation Dynamics", European Economic Review, 45(7), 1121-1150.

[17] Galí, J., D. López-Salido and J. Vallés, 2004, "Understanding the Effects of Government Spending on Consumption", ECB Working Paper No. 339, European Central Bank, April.

[18] Ingram, B. and C.H.Whiteman, 1994, "Supplanting the 'Minnesota' Prior: Forecasting Macroeconomic Time Series using Real Business Cycle Model Priors," Journal of Monetary Economics, vol. 34(3), pp.497-510.

[19] Ireland, P., 2002, "Technology Shocks in the New Keynesian Model", mimeo, Boston College.

[20] Kydland, F.E. and E.C. Prescott, 1982, "Time to Build and Aggregate Fluctuations", Econometrica, Vol. 45, pp. 329-359.

[21] Peersman, G., 2004, "What Caused the Early Millennium Slowdown? Evidence Based on Vector Autoregressions", Journal of Applied Econometrics, forthcoming.

[22] Peersman, G. and F. Smets, 2001, "The Monetary Transmission Mechanism in the Euro Area." ECB Working Paper 91.

[23] Rabanal, P. and J. Rubio-Ramirez, 2003,"Comparing New Keynesian Models for the Euro Area. A Bayesian Approach", mimeo.

[24] Rotemberg, J., 1982, "Sticky Prices in the United States", *Journal of Political Economy,* Vol. 90, No 6 1187-1211.

[25] Shea, J., 1998, " What Do Technology Shocks Do?", NBER Working Paper No. 6632.

[26] Smets, F. and R. Wouters, 2003 "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area", September 2003 1 (5), pp. 1123-1175.

[27] Sims, C., J.H. Stock and M. Watson, 1990, "Inference in Linear Time Series Models with Some Unit Roots", *Econometrica* 58

[28] Uhlig, H., 1999, "What are the Effects of Monetary Policy: Results from Agnostic Identification Approach", Tilburg University Working Paper No. 9928.

[29] Uhlig, H., 2004, "Do technology shocks lead to a fall in total hours worked?", Journal of European Economic Association Papers and Proceedings, forthcoming.

Figure 1 - Theoretical impulse response functions

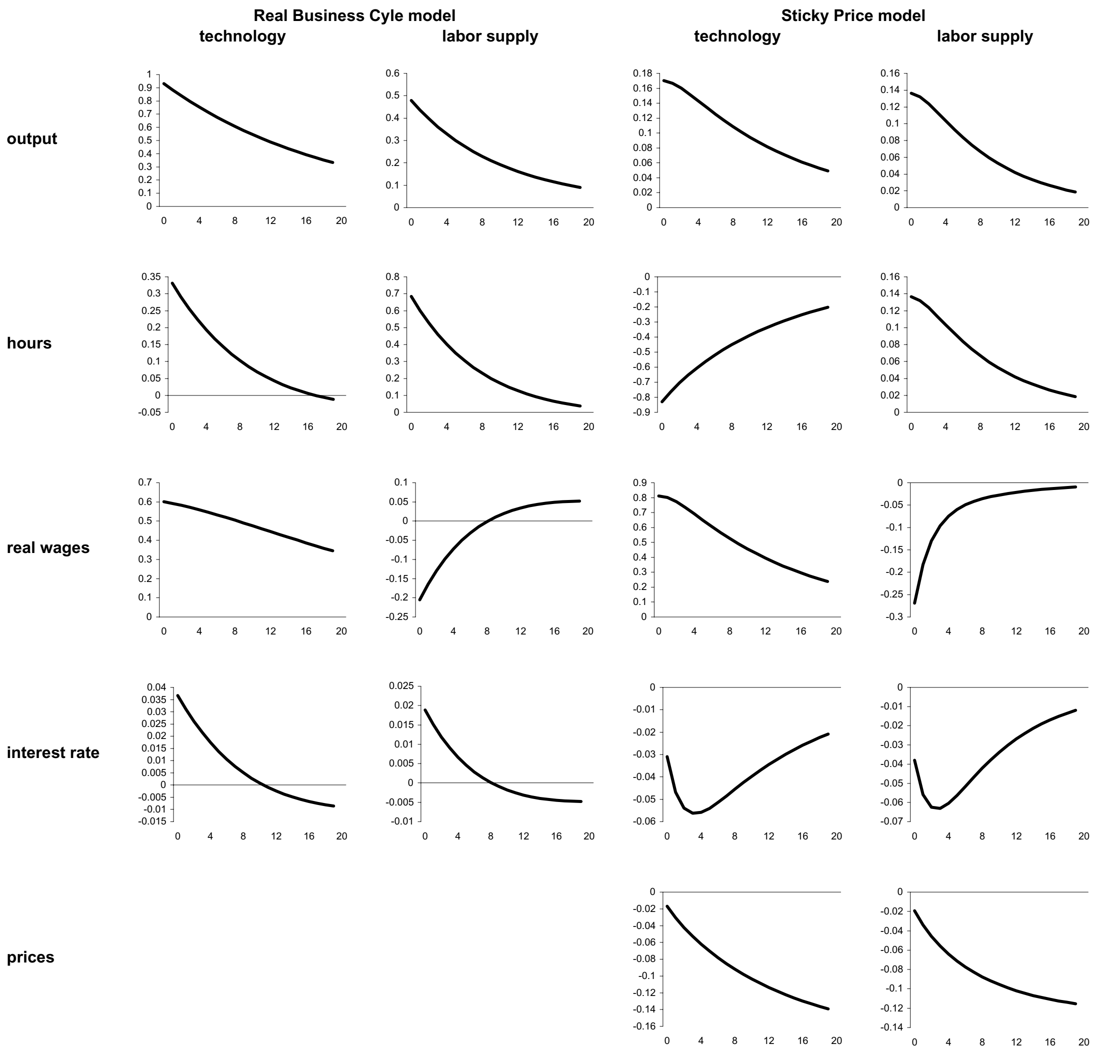


Figure 2 - Responses on impact in the Sticky Price model after a technology shock

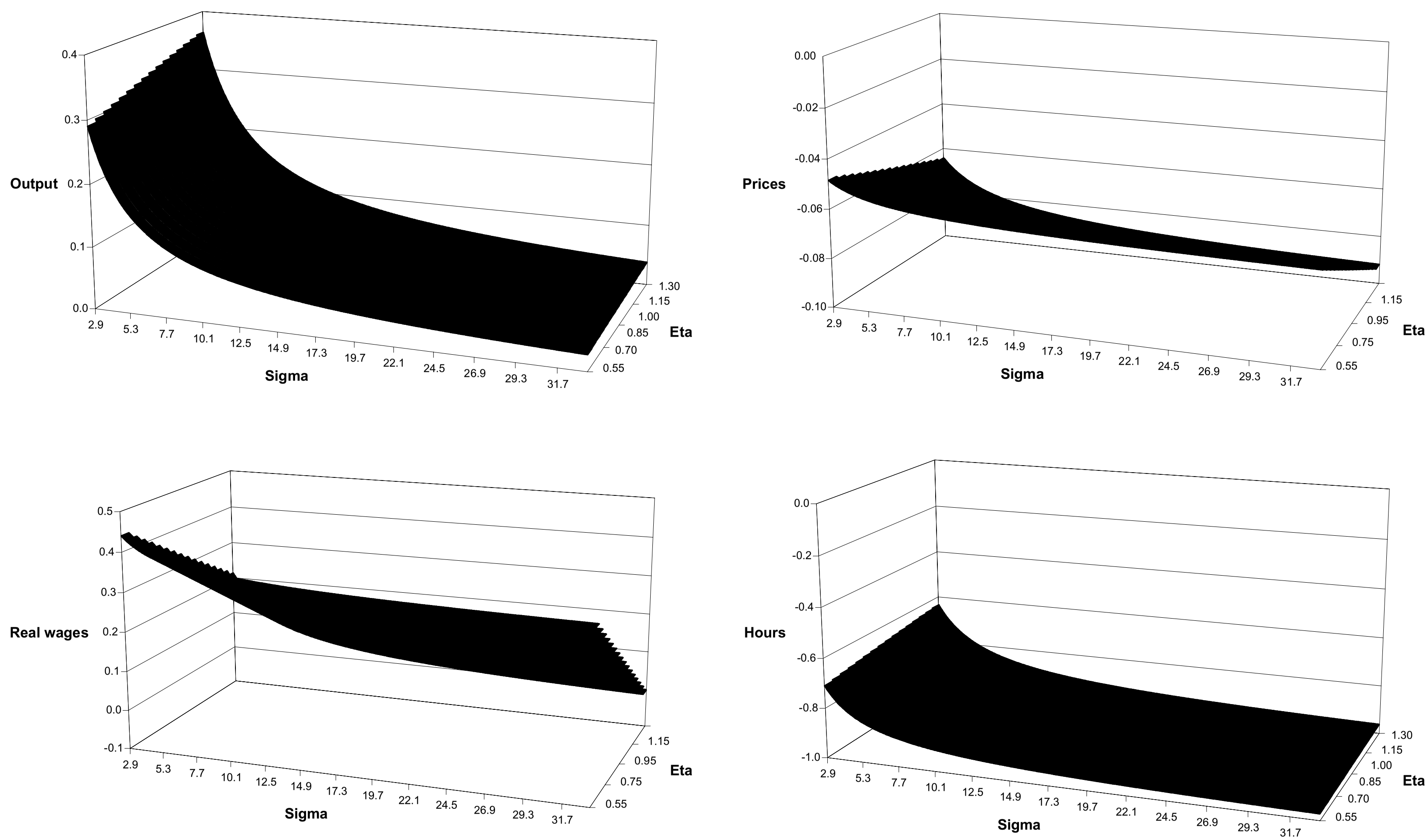
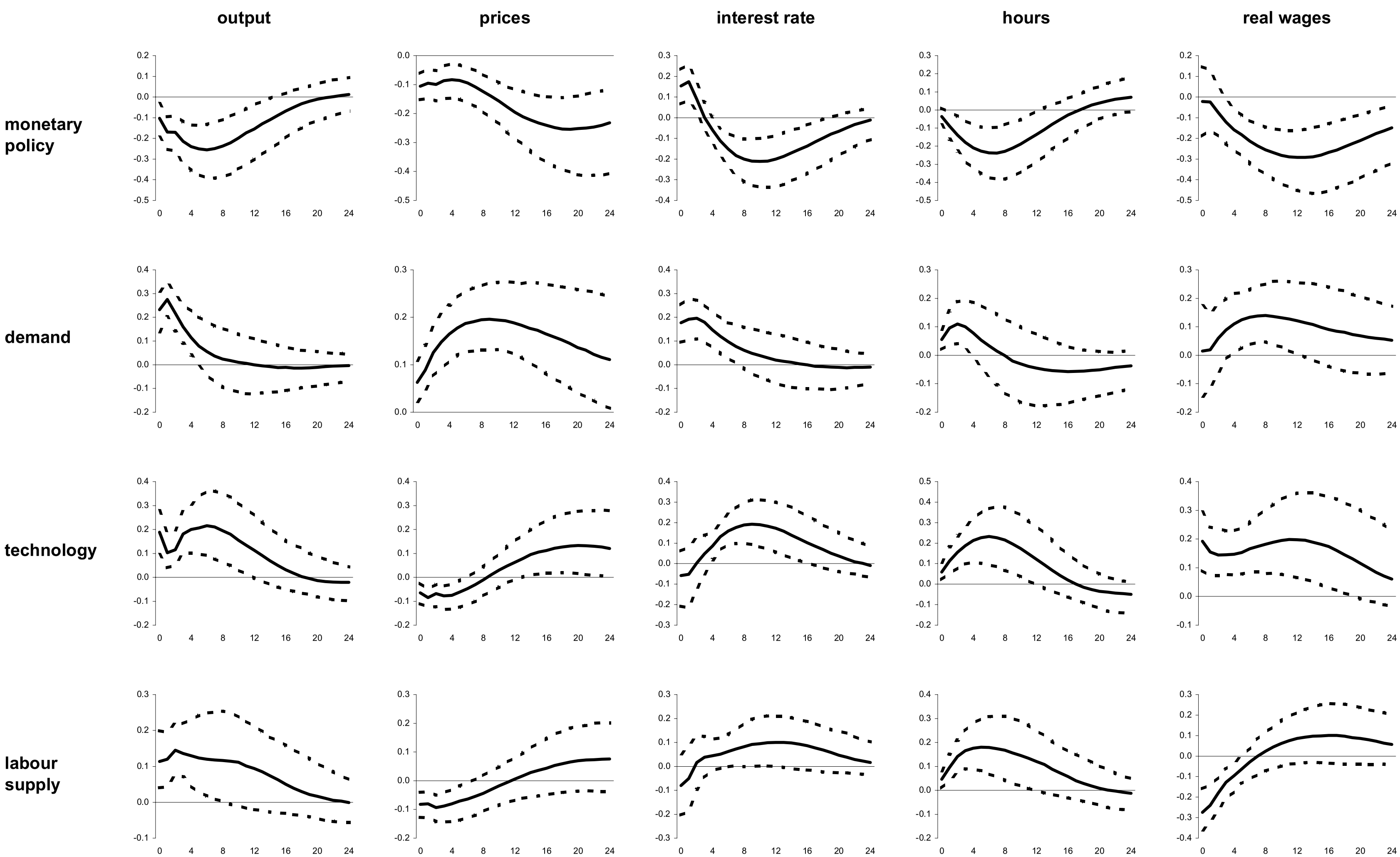


Figure 3 - Impulse responses for VAR with levels (hours)



Note: median impulse responses with 84th and 16th percentiles error bands based on Monte Carlo integration, horizon is quarterly

Figure 4 - Impulse responses for VAR with first differences (hours)

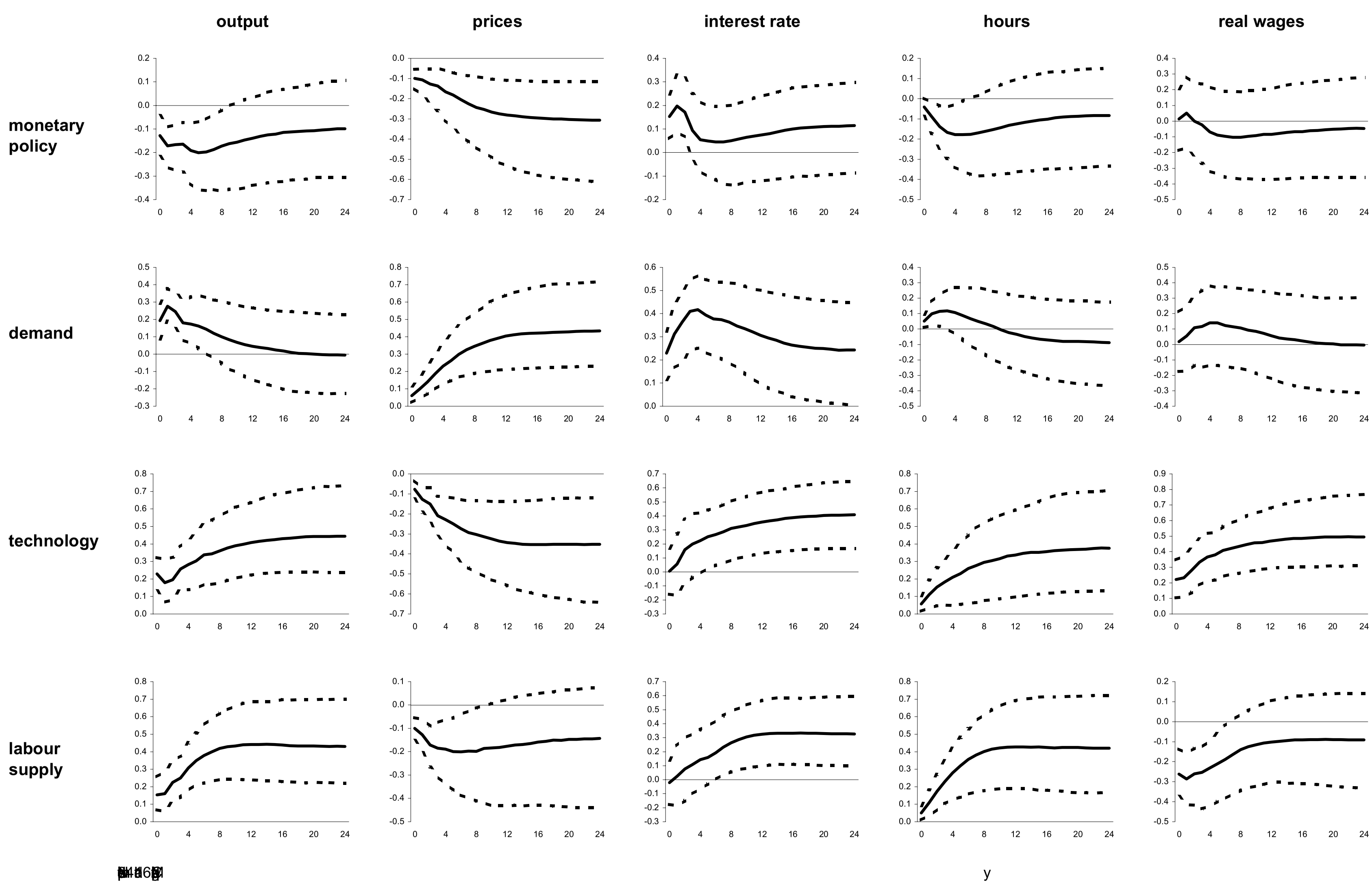
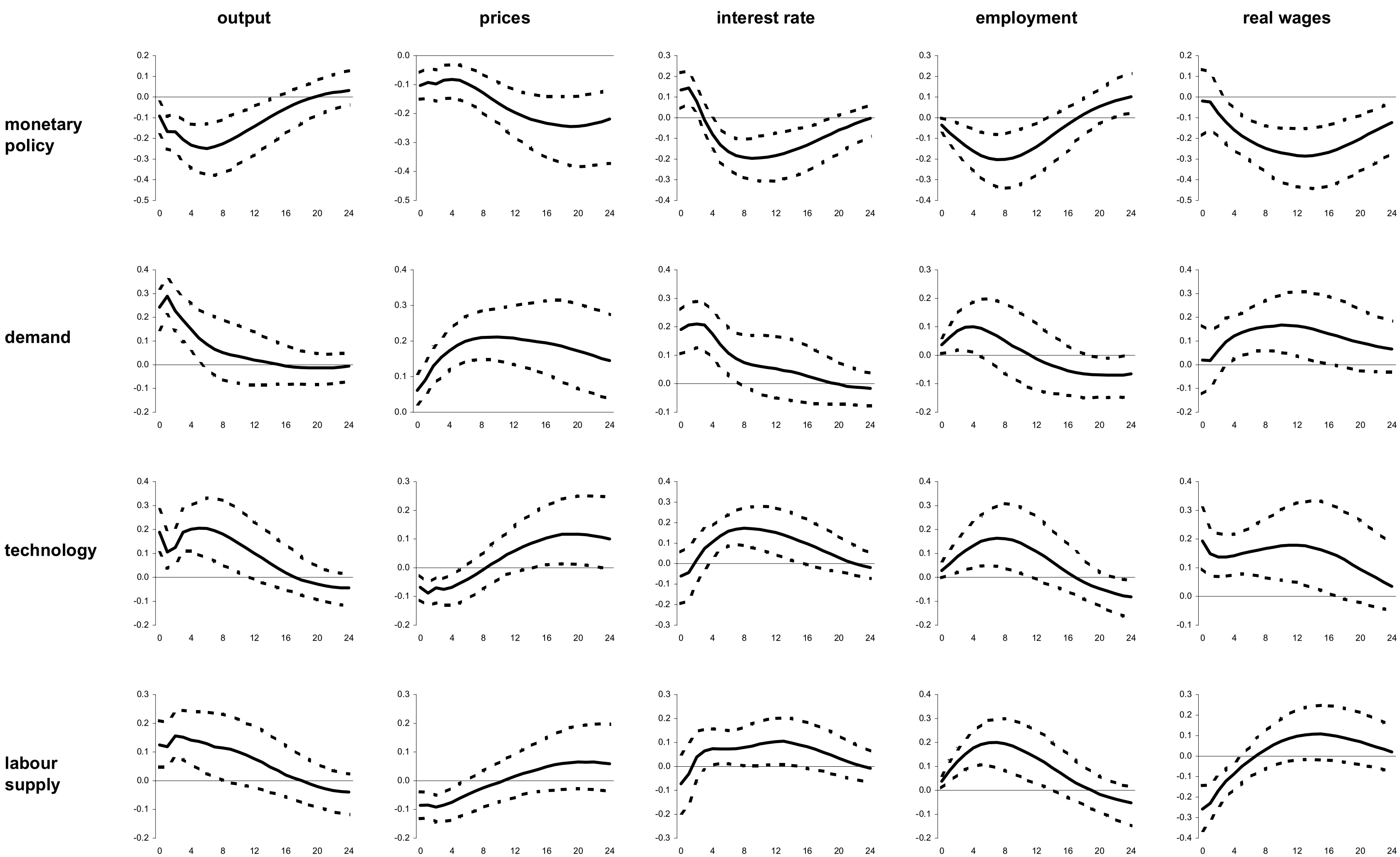
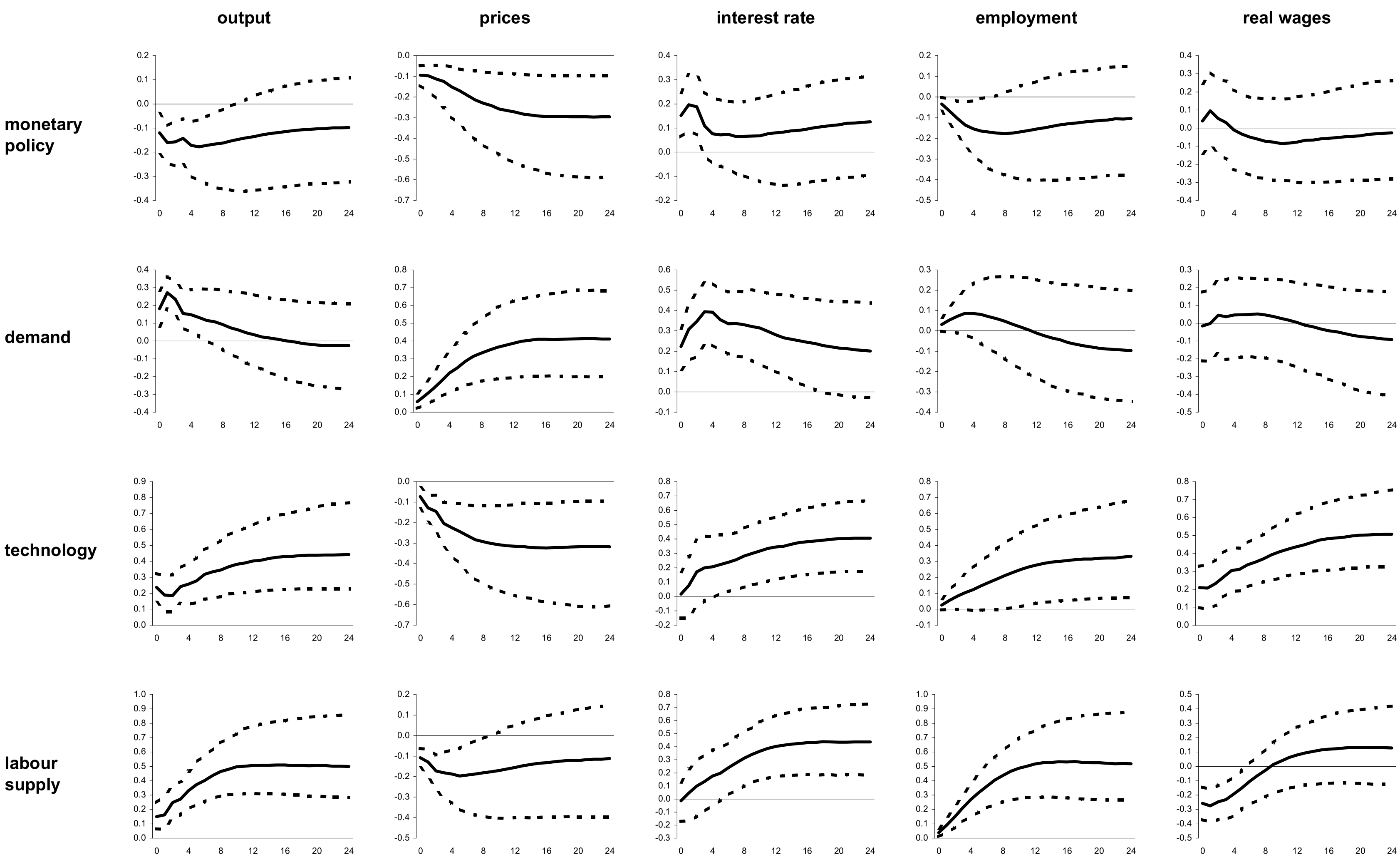


Figure 5 - Impulse responses for VAR with levels (employment)



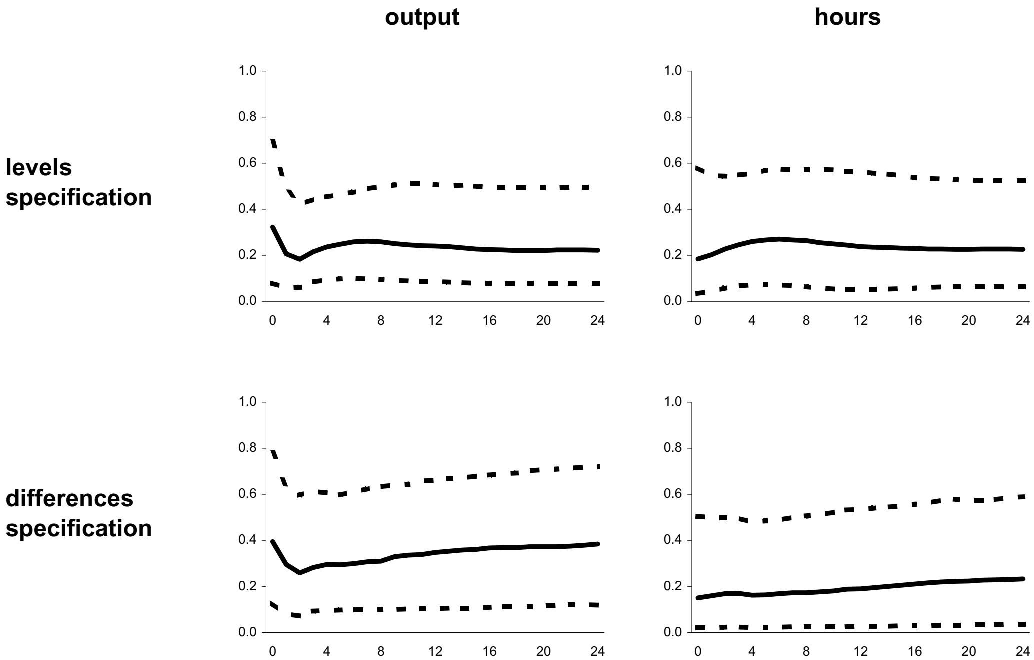
Note: median impulse responses with 84th and 16th percentiles error bands based on Monte Carlo integration, horizon is quarterly

Figure 6 - Impulse responses for VAR with first differences (employment)



Note: median impulse responses with 84th and 16th percentiles error bands based on Monte Carlo integration, horizon is quarterly

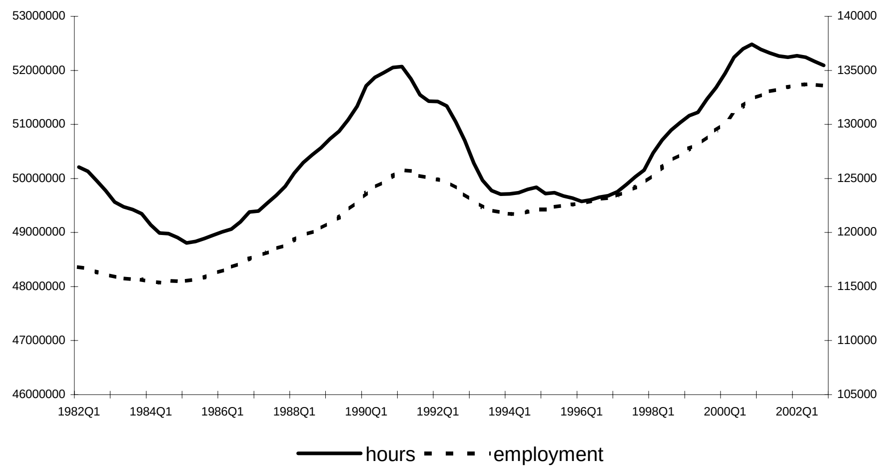
Figure 7 - Contribution of technology shocks to forecast variance



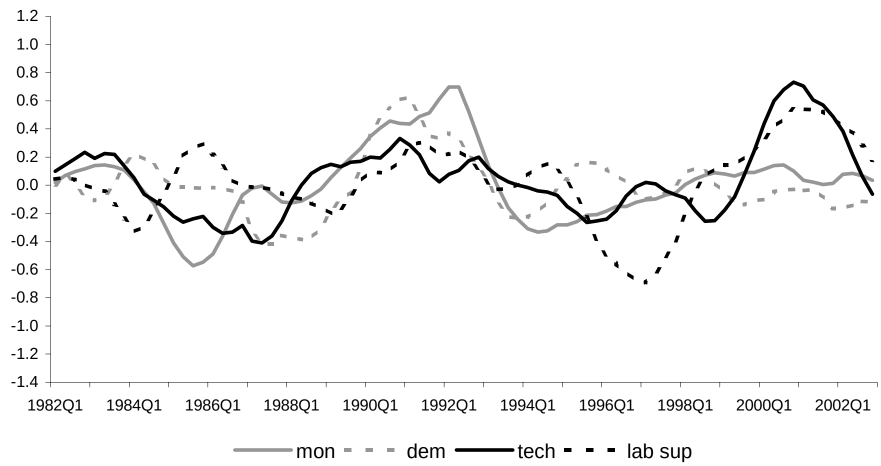
Note: median values with 84th and 16th percentiles error bands based on Monte Carlo integration, horizon is quarterly

Figure 8 - Historical contribution of shocks to hours worked in the Euro area

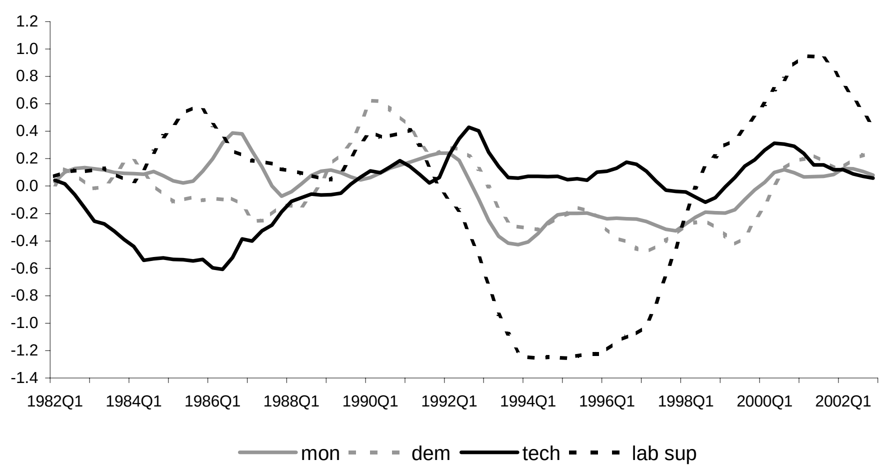
Actual



levels specification



differences specification



Note: actual employment is thousands of persons (right axis); hours is total hours worked per quarter (left axis)
contributions of shocks are measured as percentage point deviations from baseline

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