Economic Policy Uncertainty and the Euro Crisis*

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Abstract

Abstract. The european sovereign debt crisis coincides with a shortfall in investment that is particularly pronounced in the Eurozone. At the same time, uncertainty about economic policy remains elevated ever since the Great Recession. An estimated DSGE model of the euro area is used to analyze the role of uncertainty in explaining movements in investment. The impulse response of investment to second-moment policy shocks suggest rather small effects of uncertainty. Furthermore, the effects of policy uncertainty are estimated in an SVAR setting. While the results suggests negative effects on investment in the short run, these are rather small as well.

Keywords. Uncertainty, DSGE, SVAR

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1 Introduction

High policy uncertainty is often mentioned as a major cause for the prolonged slump of the Great Recession. For the United States, Bloom and Floetotto (2009) and Baker et al. (2012) claim that policy uncertainty contributes both to the downturn and the disappointing recovery. For the Euro area, a report of the European Commission (Balta et al. (2013)) and Buti and Mohl (2014) regard the reduction in uncertainty as a precondition for a robust recovery. A conclusion that has not been remained unchallenged (Hatzius et al. (2012), Krugman (2012)).

In general, uncertainty as a driving force for business cycles has called a lot of attention in economic theory recently. The seminal contribution by Bloom (2009) has motivated a lot of research on uncertainty implications for business cycle variations. As Born and Pfeifer (2014) point out, there are different ways to introduce uncertainty into real business cycle models. On the one hand, general equilibrium models such as Bloom et al. (2012) or Bachmann et al. (2013) use real option effects which emerge when investment costs are (partly) irreversible. On the other hand, New-Keynesian models like Basu and Bundick (2012) or Gourio (2012) introduce uncertainty effects by assuming risk-averse households that respond to higher risk by precautious saving adjustments.

To show the effect of uncertainty shocks we first set up a DSGE model with fluctuations in volatility ('second-moment shocks'). Different to e.g. Basu and Bundick (2012) we focus on uncertainty effects in the Eurozone. To do this, we use the DSGE model of Smets and Wouters (2003b) developed for the Euro area as a starting point. We augment the model by introducing second-moment shocks following Caldara et al. (2012) to show the effects of uncertainty shocks. The model is calibrated with the estimated values of Smets and Wouters (2003b). We compare the effect of volatility shocks to policy, namely monetary policy, to other types of volatility shocks.

Next, we use a structural vector autoregression (SVAR) to show the effect of the mentioned policy uncertainty in the Euro area by using the policy uncertainty index of Baker et al.

(2013) for Eurozone countries. We conduct both, a SVAR for the currency area ('EU4') as a whole and for the single countries covered by the policy uncertainty index of Baker et al., that is Germany, Spain, Italy and France, to highlight and discuss different implications. Also, we run regressions for the US and Great Britain to point out differences. Furthermore, we try to account for possible asymmetric effects of uncertainty.

Our preliminary results both of the DSGE and the SVAR model hint to a lesser role of uncertainty in the Euro area. The impulse response functions of our augmented DSGE model show the same pattern of uncertainty shocks like e.g. in Basu and Bundick (2012). Nevertheless, compared to the effects of first-moment shocks the effects of a uncertainty shock to monetary policy as well as to investment are rather small. In addition, our first results of the SVAR show that uncertainty effects in Europe are not as conclusive as for the US shown by Baker et al. (2012). Although shocks to uncertainty have the same implications for the Eurozone as a whole, they are not conclusive for the single countries with the exception of Germany.

In general, based on these first results our goal is to concentrate on Euro specific factors explaining the different outcomes for the single countries. Therefore, our next step is to switch to an open-economy DSGE model that fits the currency area better. In addition, we will try to examine the role of zero lower bound (ZLB) in greater detail and incorporate it into our model. As has been shown, the ZLB potentially changes the implications of uncertainty shocks (Basu and Bundick (2012), Johannsen (2014), Leduc and Liu (2015)).

Our paper aims to contribute to the growing literature on effects of uncertainty shocks and the role of policy uncertainty in particular. The real option approach of Bloom (2009) has been used in general equilibrium models such as Bloom et al. (2012) and Bachmann and Bayer (2013) showing that uncertainty could cause business cycle fluctuations. Real option features had also been combined with risk-averse agents in New-Keynesian style models. Leduc and Liu (2015) highlight the negative implications of uncertainty on the labor market with sticky prices. Born and Pfeifer (2014) use real options and precautious savings as one potential source for business cycle effects of uncertainty shocks. Fajgelbaum et al. (2015) show the effect of uncertainty in a Bayesian social learning model, in which active investment generates an information externality. New-Keynsian DSGE models such as Basu and Bundick (2012) combine risk-averse households with sticky prices and monopolistic competition. Gourio (2012) and Johannsen (2014) use 'disaster' shocks creating distortions in the risk-averse household's saving decisions. Basu and Bundick (2012) show for the US and Bachmann and Bayer (2013) for Germany that uncertainty has an impact on aggregate investment and output but is not the main driving force of depressed investment and the disappointing recovery. Also, different to Bloom et al. (2012), Bachmann and Bayer (2013) show that the effects of uncertainty shocks are of lesser importance.

The goal of this paper is to further investigate the issue of policy uncertainty shocks in the Euro area. Thereby, we like to contribute to both the ongoing debate of the quantitative impact of uncertainty to the business cycle in general and to the role of policy uncertainty in the Eurozone in particular. By addressing policy uncertainty in the Eurozone we investigate the economic consequences of the observable unpredictability of European crisis management e.g. the recent debate about Greece leaving the Euro.

Our paper is organized as follows: Chapter 2 briefly summarizes the macroeconomic situation of the Eurozone. The third chapter gives a literature review on different approaches how to introduce uncertainty shocks in DSGE models. In addition, we highlight the models' problems to replicate the pattern of recessions. Chapter 4 presents the extended DSGE model for the Euro zone. Chapter 5 shows our empirical results of the SVAR. Chapter 6 discusses the results and chapter 7 concludes.

2 Output, investment and uncertainty in the ongoing Euro crisis

The financial crisis had a long-lasting negative effect on economic activity. Even after more then six years of crisis most economies haven't been returning to their long run growth path. Reinhart and Rogoff (2011) as well as Schularick and Taylor (2012) explain this deviation by referring to sluggish recoveries after financial recessions following a strong leverage in the credit market.[1] Based on these results Hatzius et al. summarize the effect of financial recessions as: “(...) recessions following large debt booms - similar to the one that the US experienced prior to 2007 - typically involve a cumulative drop in real GDP per capita in year 1 and 2, followed by a recovery that only returns GDP to the starting point in year 5 or later.” (Hatzius et al., 2012, p.3). The slow recovery of the recent ’Great Recession’ fits into this picture.

Financial crises like the Great Recession do also have a long-lasting negative effect on investment. The IMF (WEO, 2014) shows that this type of crisis typically causes a decline in the investment-to-GDP ratio with a peak of 3.5 per cent after three years. In the recent Great Recession the profitability of investment has declined dramatically since 2009 leading to a sharp decline of the real interest rate. Private consumption declined by an average of 25 per cent compared to the trend before the crisis (WEO (2014)).[2].

The consequences of the financial crisis on both output and investment are especially pronounced in the Eurozone. Due to the lack of growth recovery output gaps in most countries of the Euro area remain high European Commission (2015). As a consequence the persistently low growth has led to a process of constant downgrading the Eurozone’s economic potential (Summers (2014)). Also, the recent debate about a new era of *secular stagnation* (Teulings and Baldwin (2014)) seems to be of special importance in the Eurozone.[3] In Europe the crisis has ended up in a vicious cycle of high debt, austerity, low aggregate

[1] In the case of a normal recession an economy recovers after a year and finds its way back to a normal growth process after a few years. Financial recessions have a similar pattern with a somehow deeper slump in the first years. Nevertheless, the picture of recovering in the mid-term changes dramatically when a credit bust is added. Schularick and Taylor show that the time to close the output gap becomes persistently long (Schularick and Taylor (2012)).

[2] Although public consumption had come down after the initial stimulus the decline in total investment is largely driven by private investment (WEO (2014))

[3] As Paul de Grauwe points out: ”Nowhere in the developed world is the *secular stagnation* more visible than in the Eurozone” (Grauwe (2015)).

demand and a permanent depressed economy.

Figure 1: Investment

(Source: OECD and authors' own calculations)

With respect to investment Barkbu et al. (2015) show that in the Eurozone also the decline in the investment-to-GDP ratio with 4.25 per cent is more severe not only compared to other industrialized countries in the recent crisis but also to their benchmark case of standard financial crises. In general, as figure 1 shows the picture of Europe's investment ratios show a drop both in 2009 (collapse of Lehman Brother's) and 2011 (Euro debt crisis) with no recovery in recent years.

Uncertainty in the Eurozone, in particular policy uncertainty, has repeatedly been mentioned as a cause for weak investment especially in the second phase of the crisis since 2010. Concerning the policy uncertainty index of Baker et al. (2013) the two shocks mentioned above are visible too. Figure 2 shows that following the collapse of Lehman Brother's

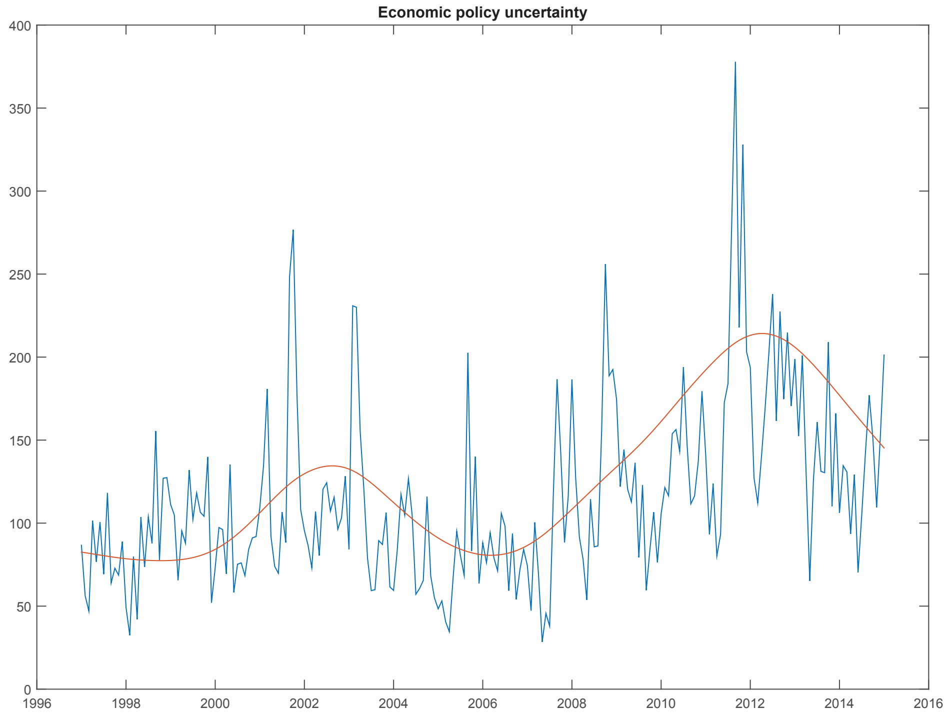

Figure 2: Uncertainty
(Source: www.policyuncertainty.com)

in 2009 and the peak of the Euro debt crisis in 2011 the index increased substantially. Moreover, uncertainty remains on an elevated level ever since in Europe. The coincidence of heightened uncertainty and depressed investment raises the question about the impact of uncertainty shocks as a driving force for weak economic performance in general and low investment in particular. As the European Investment Bank (EIB) highlights there is a significant negative correlation between high uncertainty and investment (EIB (2013)). Also, the IMF points out that uncertainty was associated with a large decline in fixed investment **?**. Applying an accelerator model, Barkbu et al. (2015) show that uncertainty is potentially a major cause for additional weakness of investment in stressed Euro member countries (Spain, Italy, Greece and Ireland) and for the Euro area as a whole.[4] Using the

[4]Barkbu et al. (2015) first estimate the residual of investment explained by shifts in output and the

same method, the OECD states that during the period of 2011-14 there is a higher then usual investment residual potentially caused by higher uncertainty (OECD (2015)).

3 Uncertainty effects in business cycle models - a short literature review

As a more recent part of economic research we present a summary of how uncertainty can be connected to real business cycle effects in this chapter. To model real effects of volatility additional features have to be added to a standard business cycle model. In the recent literature, mainly two approaches have been applied. First, irreversible costs are introduced to generate real option values which induce a "wait-and-see" attitude in economic activities. Second, risk aversion and precautious saving trigger changes in households' labor supply to 'insure' against potential negative future outcomes. Both features are used in a variety of models. We discuss these models and show how there predictions match the actual economic pattern in the ongoing crisis.

The first approach of real options has been developed by Bloom (2009) in a partial equilibrium model to show the consequences of exogenous shocks to volatility to aggregate investment by introducing (partly) irreversible costs and uncertainty on different levels.[5] His approach has been adopted in more sophisticated general equilibrium models such as Bloom et al. (2012) or Bachmann and Bayer (2013). In addition, the approach inspired empirical research to look at uncertainty as a potential cause of recessions and booms (e.g. Baker et al. (2013), Stock and Watson (2012), Balta et al. (2013)).

capital stock as well as capital costs. They show that adding uncertainty reduces the residual substantially.

[5]The is often regarded as the starting point of the recent uncertainty-RBC-research ((Elstner, 2011, p.2). For further discussion of 'real option' effects see Bernanke (1983) or Dixit and Pindyck (1994)).

Fajgelbaum et al. (2015) combine the mechanism of real options with Bayesian social learning of agents. By investing, a firm reveals information about its future expectations, shaping the Bayesian rule of all other firms. Both, the degree of uncertainty (the precision of the firm's beliefs about future fundamentals) as well as the mean of the distribution (the 'optimism' of the agents), depend on the amount of active investment. The information externalities cause volatility to fall and the mean to rise with active investment. The model of Fajgelbaum et al. (2015) shows how an economy can be trapped in an equilibrium with low investment and high uncertainty.

The second approach, introducing risk-averse households and precautious saving, is a common feature of DSGE models. Gourio (2012) and Johannsen (2014) use the precautious saving motive to show the effect of bad news such as catastrophic tale events or 'disasters'. Here, Gourio (2012) models shocks to uncertainty as a rise in the probability of disaster risk which triggers consumers to adjust their risk expectations. Whereas Gourio (2012) concentrates on the effect of shocks to productivity Johannsen (2014) highlights the effect of fiscal policy uncertainty. Basu and Bundick (2012) combine the effect of precautious saving with monopolistic competition and sticky prices in a New-Keynesian DSGE model. Here, higher labor supply following a positive shock to uncertainty rises the markups of firms which causes aggregate output, investment and employment to decline. Leduc and Liu (2015) show similar implications by adding sticky prices and labor market frictions in a DSGE model without capital.

Both approaches are also used simultaneously. Born and Pfeifer (2014) introduce precautious saving as well as real option effects to quantify the impact of different uncertainty channels. Highlighting labor market implications, Leduc and Liu (2015) introduce irreversible costs next to search frictions in the labor market.

With respect to reproducing the pattern of business cycle fluctuations both approaches have problems of generating the comovement of key aggregate variables, namely a fall in consumption, investment, employment, output, inflation and the nominal interest rate. Because output is not effected by a pure uncertainty shock in the short-run, real option effects will lower investment which ultimately raises households' consumption (Bloom et al. (2012)). Precautious saving on the other hand will lower consumption but the induced higher labor supply will raise output and employment (Basu and Bundick (2012)). Such a pattern contradicts the strong comovement of investment, consumption, employment and output in the data. In addition, pure real option based models like Bloom et al. (2012) predict correctly that a rise in uncertainty lowers investment in the short-term. But because the underlying state of the economy namely growth is not effected, a 'pure' temporary volatility shock would cause an investment boom in the mid-term because of pent-up investment demand. Even if uncertainty stays high, like in the Great Recession, investment growth will recover after some time because higher real options have only a level effect. A pattern which is not observable in the Eurozone (see figure 1).

Johannsen (2014) avoids the negative comovement of investment and consumption by introducing government bonds as an additional option to save. Facing higher uncertainty, households switch to riskless bonds to avoid risky capital investment thereby reducing investment and consumption simultaneously. Riskless government bonds are also introduced by Gourio (2012). Nevertheless, his results show that a rise in disaster probability still produces an output and investment boom induced by precautious saving (Gourio, 2012, p.2754). Gourio solves the problem by assuming an additional depreciation shock to the capital stock. Nevertheless, concerning the Great Recession such a shock can hardly be justified. Basu and Bundick (2012) and Born and Pfeifer (2014) show that the problem of the missing comovement can be solved by adding New-Keynesian features. Under monopolistic competition the countercyclical movements of firms' markups cause the observable decline in output. Price stickiness serves as an additional amplifier.

In general, a shock to uncertainty cannot be explained easily without first-moment shocks (Bachmann and Bayer (2013)). In fact, second-moment shocks are widely modeled together with first-moment shocks (Fajgelbaum et al. (2015)). As shown, Gourio (2012) introduces a shock to the capital stock. Also Johannsen (2014) introduces a decline in the marginal efficiency of investment as a first-moment shock together with second-moment shocks (a rise in fiscal policy uncertainty) to generate the economic outcome that reflects the pattern of the Great Recession.

Analysing the quantitative impact of uncertainty shocks, Born and Pfeifer (2014) and Bachmann and Bayer (2013) point out, that the effects on aggregate investment and output are most likely too small to be considered as a main driving force of business cycles fluctuations. Born and Pfeifer point out that fluctuations of policy uncertainty are simply too low to generate the negative effect on output in the Great Recession. Furthermore, Bachmann and Bayer (2013) show that fluctuations in uncertainty measures are also not able to cause the degree of variations in aggregate variables.[6] To amplify the effects of uncertainty nominal rigidities are potentially important. Leduc and Liu (2015) show that both frictions and sticky prices are central as amplifiers to reduce aggregate demand and rising firms' markups.[7] As in Basu and Bundick (2012) an increase in uncertainty always has a negative implication on aggregate demand if nominal rigidities are added.

In the context of the uncertainty-business-cycle-link Johannsen, Basu, Bundick as well as Leduc, Liu emphasize the aggravating role of the zero lower bound (ZLB) for the negative impact of rising uncertainty. Concentrating on the effect at the ZLB, Johannsen (2014) shows that the outcome of future events become asymmetric. Positive risk realizations

[6] In their study risk shocks could only explain 15 per cent of aggregate fluctuations (Bachmann and Bayer (2013)).

[7] "Absent nominal rigidities, a technology uncertainty shock - for example - generates a response that is about one-tenth as large as that in the benchmark model. Similarly, absent significant search frictions, the effect (...) is about one half (...)." (Leduc and Liu, 2015, p.4)

will push the economy into moderate expansion, whereas negative ones will lead to catastrophic downturns. Households react to this downside risk with additional precautious savings which raise labor supply and reduce consumption further. Higher labor supply together with nominal rigidities like sticky prices raises firms' markups so output is further reduced (Basu and Bundick (2012), Born and Pfeifer (2014)). As Born and Pfeifer point out, the higher degree of the *uncertainty multiplier* can be rationalized the same way like higher fiscal multipliers at the ZLB shown e.g. in Christiano et al. (2011).

In summery, general equilibrium models working with uncertainty shocks have to overcome the problem of the missing comovement of aggregate variables. Real options cause a negative correlation of investment and consumption. Precautious saving generate a negative correlation of consumption and output. Without features such as information externalities or monopolistic competition the pattern of the crisis can not be generated by a shock to uncertainty alone. Adding those features doesn't necessarily turn uncertainty shocks into the major cause of business-cycle fluctuations. Nevertheless, uncertainty can still be an amplifier of first-moment shock inducing significant effects on its own (Basu and Bundick (2012)). The results of Johannsen, Basu and Bundick and Leduc and Liu show that like the fiscal multiplier also the uncertainty multiplier is potentially high when the economy is at the zero lower bound.

Concerning the special issue of policy uncertainty the question about the general effects of uncertainty are of course highly relevant. If uncertainty does play a minor role the 'trade-off between policy correctness and decisiveness' ((Bloom, 2009, p.674)) is rather small. As a consequence policy decisiveness e.g. stick to rules and treaties like the fiscal pact are of lesser importance compared to policy correctness e.g. addressing insufficient aggregate demand. Quantifying the effect of the ZLB is likely important for economic policy. If uncertainty effects are high only at the ZLB, avoiding such a situation should be a high priority.

4 The model

4.1 The linearized version

To analyze the issue of uncertainty in a DSGE model theoretically we take the medium scale model by Smets and Wouters (2003a) and enhance it with time varying volatility of investment following Caldara et al. (2012). Smets and Wouters (2003a) estimate a dynamic stochastic general equilibrium model of the Euro area using Bayesian techniques. We take these estimated parameters as given and plot impulse response functions to different first- and second-moment shocks.

We shortly describe the key features of the model.[8] On the demand side households maximize lifetime utility and thus determine consumption demand and labor supply. Consumption exhibits some external habit formation and thus the linearized consumption Euler equation depends on past and expected future consumption (the ˆ above a variable denotes its log deviation from steady state):[9]

$$\hat{C}_t = \frac{h}{1+h}\hat{C}_{t-1} + \frac{1}{1+h}\hat{C}_{t+1} - \frac{1-h}{(1+h)\sigma_c}(\hat{R}_t - E_t\hat{\pi}_{t+1}) + \frac{1-h}{(1+h)\sigma_c}\hat{\varepsilon}^b_t - E_t\hat{\varepsilon}^b_{t+1}$$

Here h is the coefficient of habit persistence in consumption and σ_c denotes the coefficient of relative risk aversion of households. $\hat{\varepsilon}^b$ represents a preference shock (shock to the discount rate).

Moreover, household own firms, and decide how much capital to accumulate given some capital adjustment costs. Thus, investment is determined by the equation

$$\hat{I}_t = \frac{1}{1+\beta}\hat{I}_{t-1} + \frac{\beta}{1+\beta}\hat{I}_{t+1} + \frac{\varphi}{1+\beta}\hat{Q}_t - \frac{\beta}{(1+\beta)}\hat{\varepsilon}^I_t + \frac{1}{(1+\beta)}E_t\hat{\varepsilon}^I_{t+1} \tag{1}$$

where φ is the inverse of capital . $\hat{\varepsilon}^I$ is a positive shock to the adjustment cost function (a negative investment shock).

The corresponding Q equation is given by

[8] For the detailed exposition, the reader is referred to the original paper. Notation as in the paper.

[9] We only state the model in linearized form as these linearized equations can be implemented in Dynare.

$$\hat{Q}_t = -(\hat{R}_t - E_t\hat{\pi}_{t+1}) + \frac{1-\tau}{1-\tau+r^k}E_t\hat{Q}_{t+1} + \frac{r^k}{1-\tau+r^k}E_t\hat{r}^k_{t+1} + \eta^Q_t \tag{2}$$

Capital accumulation is given by

$$\hat{K}_t = (1-\tau)\hat{K}_{t-1} + \tau\hat{I}_{t-1} \tag{3}$$

On the supply side, prices are sticky in a Calvo (1983) fashion. Moreover, partial indexation leads to a more general type of new Keynsian Phillips curve:

$$\hat{\pi}_t = \frac{\beta}{(1+\beta)\gamma_p}E_t\hat{\pi}_{t+1} + \frac{\gamma_p}{(1+\beta)\gamma_p}\hat{pi}_{t-1} + \frac{1}{(1+\beta)\gamma_p}\frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p}\left[\alpha\hat{r}^k_t + (1-\alpha)\hat{w}_t - \hat{\varepsilon}^a_t + \eta^p_t\right] \tag{4}$$

Real wages are governed by

$$\begin{aligned}\hat{w}_t \quad = \quad & \frac{\beta}{(1+\beta)}E_t\hat{w}_{t+1} + \frac{1}{(1+\beta)}\hat{w}_{t-1} + \frac{\beta}{(1+\beta)}E_t\hat{\pi}_{t+1} - \frac{1+\beta\gamma_w}{(1+\beta)}\hat{\pi}_t + \frac{\gamma_w}{(1+\beta)}\hat{\pi}_{t-1} \\ & - \frac{1}{(1+\beta)}\frac{(1-\beta\xi_w)(1-\xi_w)}{\xi_p\left(1+\frac{(1+\lambda_w)\sigma_L}{\lambda_w}\right)}\left[\hat{w}_t - \sigma_L\hat{L}_t - \frac{\sigma_c}{1-h}(\hat{C}_t - h\hat{C}_{t-1}) - \hat{\varepsilon}^L_t + \eta^w_t\right]\end{aligned} \tag{5}$$

Labor demand is determined by

$$\hat{L}_t = -\hat{w}_t + (1+\psi)\hat{r}^k_t + \hat{K}_{t-1} \tag{6}$$

The equilibrium on the goods market is determined by

$$\begin{aligned}\hat{Y}_t = \quad & (l - \tau k_y - g_y)\hat{C}_t + \tau k_y\hat{I}_t + g_y\hat{\varepsilon}^G_t \\ = \quad & \phi\hat{\varepsilon}^a_t + \phi\alpha\hat{K}_{t-1} + \phi\alpha\psi\hat{r}^k_t + \phi(1-\alpha)\hat{L}_t\end{aligned} \tag{7}$$

The model is closed by a policy rule for the monetary authority in form of a Taylor rule for the nominal interest rate $\hat{R}_t$:

$$\begin{aligned}\hat{R}_t \quad = \quad & \rho\hat{R}_{t-1} + (1-\rho)\left[\bar{\pi}_t + r_\pi(\hat{\pi}_{t-1} - \bar{\pi}_t) + r_Y(\hat{Y}_t - \hat{Y}^p_t)\right] \\ & + r_{\Delta\pi}(\hat{\pi}_t - \hat{\pi}_{t-1}) + r_{\Delta Y}(\hat{Y}_t - \hat{Y}^p_t - (\hat{Y}_{t-1} - \hat{Y}^p_{t-1})) + \eta^R_t\end{aligned} \tag{8}$$

4.2 How to introduce stochastic volatility

FernÃ¡ndez-Villaverde and Rubio-RamÃrez (2010) discuss how to include uncertainty in a DSGE model. They propose three approaches, namely Markov regime switching model, GARCH processes, or stochastic volatility. We adopt the third approach because this approach is applied in several other articles on uncertainty and risk in business cyle models (?Basu and Bundick, 2015; Caldara et al., 2012).

We assume that the investment shock $\hat{\varepsilon}^I$ in (1) follows the following process:

$$\hat{\varepsilon}_t^I = \rho^I \hat{\varepsilon}_{t-1}^I + \sigma e^{\sigma_t^I} v_t^I \tag{9}$$

where v_t^I is standard normally distributed. Thus, investment shocks follow an AR(1)-process. Moreover, it is assumed that σ_t^I evolves over time as an AR(1) process which includes time varying volatility

$$\sigma_t^I = \rho_\sigma \sigma_{t-1}^I + \eta u_t \tag{10}$$

where u_t is standard normally distributed and uncorrelated with the innovation on investment. We assume that there is a permanent shock to volatility, i.e. in the simulation we set $\rho_\sigma = 1$.

Adding time-varying volatility to equation (9) has according to FernÃ¡ndez-Villaverde and Rubio-RamÃrez (2010) several advantages. The main advantage is the fact that $\log \sigma_t$ can take any value which make perturbation methods feasible for solving this problem.[10]

However, adding a term like that renders the linear model nonlinear which leads to some computational challenges. There are some ways to deal with these challenges. In this paper we use perturbation methods to solve the model. However, instead of log-linearizing the equilibrium conditions laid out in the previous sectors a third-order approximation has to be performed as volatility shock are second-moment shocks which do not appear in second-order approximation.

[10] Assuming Markov switsching regimes implies just a few numbers for $\log \sigma_t$.

4.3 Calibration and Impulse response functions

We assign the estimated values by Smets and Wouters (2003a) to the model's parameters. These numbers are summarized in table 1.

Impulse responses to first and second-moment investment shock are depicted in figure 3.

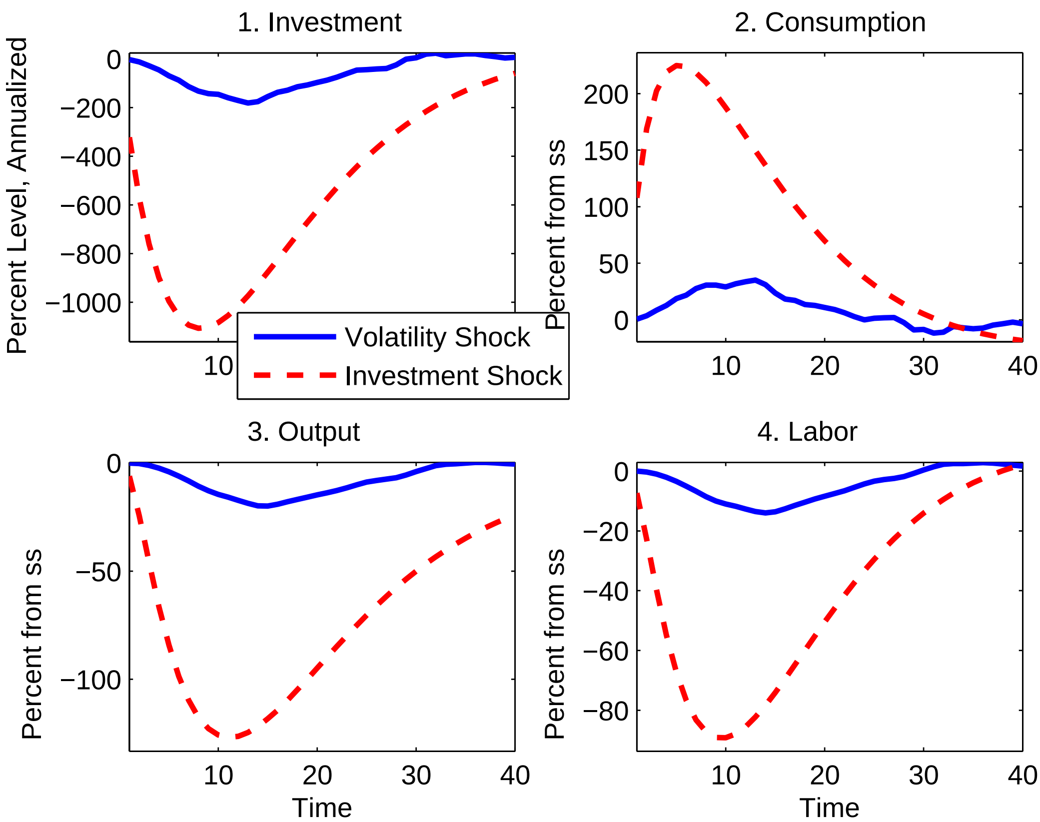

Figure 3: IRFs to first- and second-moment investment shocks

Impulse responses to first- and second-moment policy shocks are shown in 4.

First of all, the main conclusion which can be drawn immediately is the fact that the responses to volatility shocks are not that immense as probably assumed. However, this is in line with the findings by **?**.

Table 1: Calibration of the model

Parameter	Meaning	Value
h	habit formation	0.573
φ	inverse of inv. adj. costs	1/6.771
τ	depreciation rate of capital	0.025
β	discount factor	0.99
$\bar{r}$	steady state return on capital	$(1/\beta) - 1 + \tau$
γ_p	degree of partial price indexation	0.469
ξ_p	Calvo price stickiness	0.908
α	capital output ratio	0.3
γ_w	degree of wage indexation	0.763
ξ_w	Calvo wage stickiness	0.737
λ_w	mark up in wage setting	0.5
σ_L	inverse elasticity of labor supply	2.4
σ_c	coeff of rel risk aversion	1.353
ϕ	1+ share of fixed cost in production	1.408
ψ	inverse elasticity of cap util. cost	1/0.169
k_y	steady state capital-output ratio	2.2
r_π	coefficient in Taylor rule on inflation	1.684
r_y	coefficient in Taylor rule on output gap	0.099
$r_{\Delta\pi}$	coefficient in Taylor rule on inflation growth	0.14
$r_{\Delta y}$	coefficient in Taylor rule on output growth	0.159

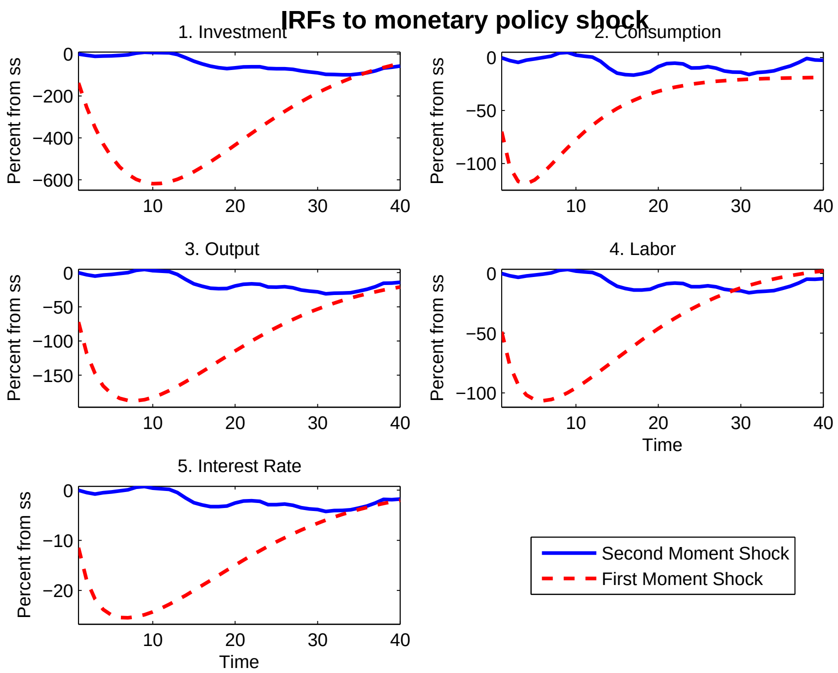

Figure 4: IRF to first- and second-moment policy shocks

4.4 What is missing?

The analysis above serves as a starting point and can be improved in several directions. First of all, the model by Smets and Wouters (2003a) is still a standard DSGE model which is used for policy analysis very often. However, simulating the European Monetary union as a single closed economy has several drawbacks from a theoretical and practical point of view. In general, the shock to monetary policy only serves as a first proxy for policy uncertainty implications. Adding government spending, which is not explicitly modeled by Smets and Wouters (2003a), does not serve the purpose of Euro-specific policy uncertainty neither. Policy uncertainty in the Euro area consists mainly about a break-up of the currency union. That kind of uncertainty refers to a shock to the real exchange rate within a two or more country model. So, in a next step we would like to explore the issue of uncertainty in a theoretical set up which models the circumstances more precisely, e.g., we will use an at least two-country model of the monetary union to account for country-specific investment uncertainty. Using such a model makes it feasible to explore different and more elaborated uncertainty shocks, for example, the effects of the shock that one or two countries might leave the monetary union. Second, parameters should be estimated with a new data set which includes the years of the ongoing crisis.[11] Third, more robustness checks have to be performed.

Last but not least monetary policy is presently constrained by the binding zero lower bound on the nominal interest rate. Thus, the central bank does not set the nominal rate according to the Taylor rule (8). Taking the zero lower bound into account adds another nonlinearity to the model which changes the results. Thus, in a next step we explore the interaction of time-varying volatility and the zero lower bound as in Basu and Bundick (2015).

[11] In the original paper, data cover the periods 1970:1 - 1994:4.

5 Estimation of the Economic Effects of Uncertainty

5.1 Data

Our main uncertainty indicator is the news index provided by Baker et al. (2013) on their web page www.policyuncertainty.com. It fits best our purpose to cover economic policy uncertainty. Unfortunatly, they recently have stopped reporting economic forecaster disagreement. Therefore the news index is the only subindicator left from their economic policy uncertainty (EPU) indicator.[12] In order to reproduce the estimation results of Baker et al. (2013) for the euro area we had to aggregate the data of the four countries covered in their data set, namely Germany, France, Italy, and Spain.[13] Unfortunately for each country only two newspapers (as opposed to 10 newspapers for the US indicator) are covered. That could cause reliability problems when looking at country specific uncertainty instead of the aggregate indicator. The stock market indices are all supposed to be price indices as opposed to performance indices to keep it comparable to Baker et al. (2013) who use the S&P 500. Data is taken from the Bundesbank (DAX) and Yahoo! finance (CAC 40, FTSE MIB, IBEX 35). Other data sources are eurostat, the federal reserver economic data base (mainly for US data), OECD economic database (real gross fixed capital formation)

5.2 Inspection of time series

Baker et al. (2013) provide their news index for euro area countries not before 1997 (2001 in the case of Spain). The EPU index was discontinued after March 2014. A visual inspection of both indices in figure 5 show high similarities, not only because the news index makes up half of the EPU index. The EPU index seems to be smoother, correcting a little bit for the sometimes extreme bursts of the pure news index. These seem sometimes to exaggerate

[12] In future versions of this paper we will consider other indicators such as economic forecaster disagreement, business and consumer survey-based indices and financial market related indices (VIX).

[13] UK is covered as well, but as it does not make part of the euro area it will be included only for robustness tests.

the real uncertainty relating to economic policy. For example, the 9/11 peak of France's news index can hardly be justified. Thus, results should be treated with caution.

5.3 Methodology

In a first step we estimate the effects of uncertainty in the euro area using a structural vector autoregression (SVAR) on a monthly and on a quarterly basis. The reduced form VAR model is given by

$$y_t = A(L)y_{t-1} + u_t. \tag{11}$$

In addition to the lag polynomial $A(L)$ we add a constant and a linear trend variable. For the monthly SVAR we use exactly the same variables and ordering of Baker et al. (2013): Uncertainty (baseline: news index), stock market price index, interest rate, employment, and real industrial production. The benchmark estimation includes 6 lags. Because data for investment does not exist on a monthly frequency, we also need to estimate the effects of uncertainty in a quarterly SVAR. The variables included (so far) are uncertainty (news index), investement, and the interest rate. Here, we consider 4 lags as our benchmark. The starting date in both cases is 1997 for Germany, France and the euro area, 2001 for Spain and 1998 for Italy.[14] The recursive approach (Cholesky decomposition) is used to identify the exogenous movements in uncertainty. Uncertainty is ordered first, because it is assumed to be not affected contemporaneously by movements in real activity (Baker et al. (2013); Bloom (2009)). However, for the quarterly estimations this is a rather strong assumption. Therefore, as the next step we are considering a two stage estimation approach proposed by Kilian (2009) and already used by **?** to assess the effect of uncertainty on GDP in the United States.

Furthermore, we argue that uncertainty might have asymmetric effects. An increase in uncertainty is considered to have negative effects only. But a decrease in uncertainty might have ambigous effects. Decreasing uncertainty means that agents become more

[14]The uncertainty index for Spain only goes back to 2001 yet. Italy's FTSE MIB index starts only in 1998.

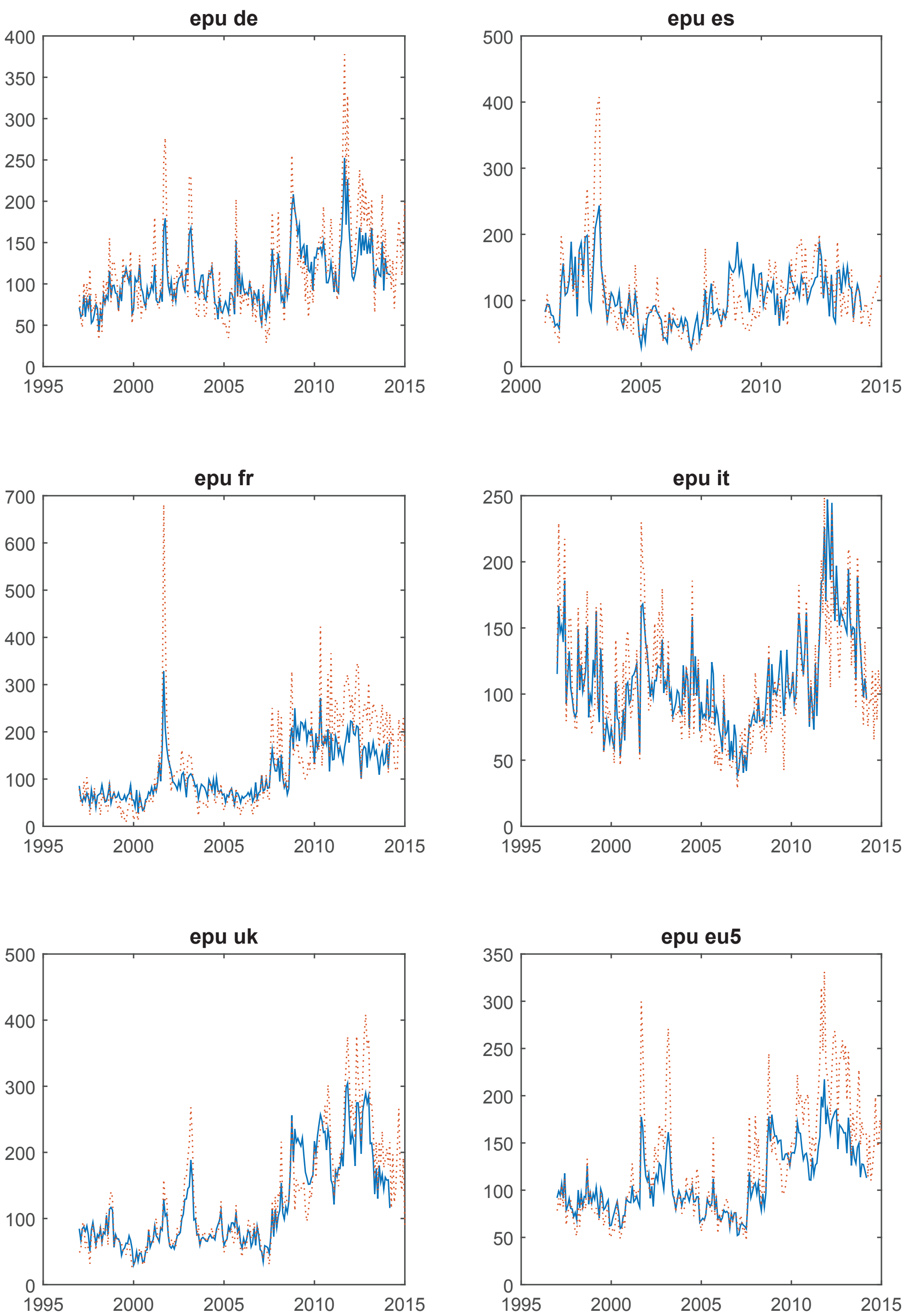

Figure 5: Economic Policy Uncertainty Index and the news index for the 4 available euro area economies, the UK and EU5

certain about economic policy or whatever they were uncertain about in the first place. However, the outcome might be considered positive, but also as negative. Consider an ongoing parliamentary debate about a corporate tax reform. If the debate ends (and uncertainty unwinds) with a substantial tax relief for the corporate sector, the decreasing uncertainty will surely lead to the overshooting in investment as observed in theoretical models (e.g. Bloom (2009)). However, if terms get worse for the corporate sector the decrease in uncertainty is unlikely to lead to an investment boom. Therefore, we differ between increases and decreases in uncertainty and combine the latter with an indicator for business confidence to find out whether the decrease in uncertainty has positive or negative implication for the corporate sector.

5.4 Estimation results (preliminary)

Figure 6 shows impulse responses of industrial production to surprise increases in economic policy uncertainty for our euro area aggregate (EA4), Germany (DE), Spain(ES), France (FR), Italy (IT), and for comparisons the United States (US). The impulse respons functions of of the monthly SVAR estimation for the 4 biggest euro area economies look similar to those for the United States estimated by Baker et al. (2013). Especially in France and Spain, and to some extend also for the euro area aggregate, increases in uncertainty are followed by potracted downturns in industrial production recovering only after about 30 months. Germany and Italy follow a distinct pattern, more alike to the theoretical response of investment to a real options shock. A sudden drop in industrial production is followed by a quick recovery and an overshooting process as soon as uncertainty returns to normal levels. Though, the effects are tiny in the case of Italy. Interestingly, an immediate and significant decrease in share prices is a common reaction in all the countries covered. The impulse response of employment are mixed, but overall an increase in uncertainty seems to have a negative effect. Unfortunately, first estimations for crisis vs. pre-crisis show rather puzzling and inconclusive effects.

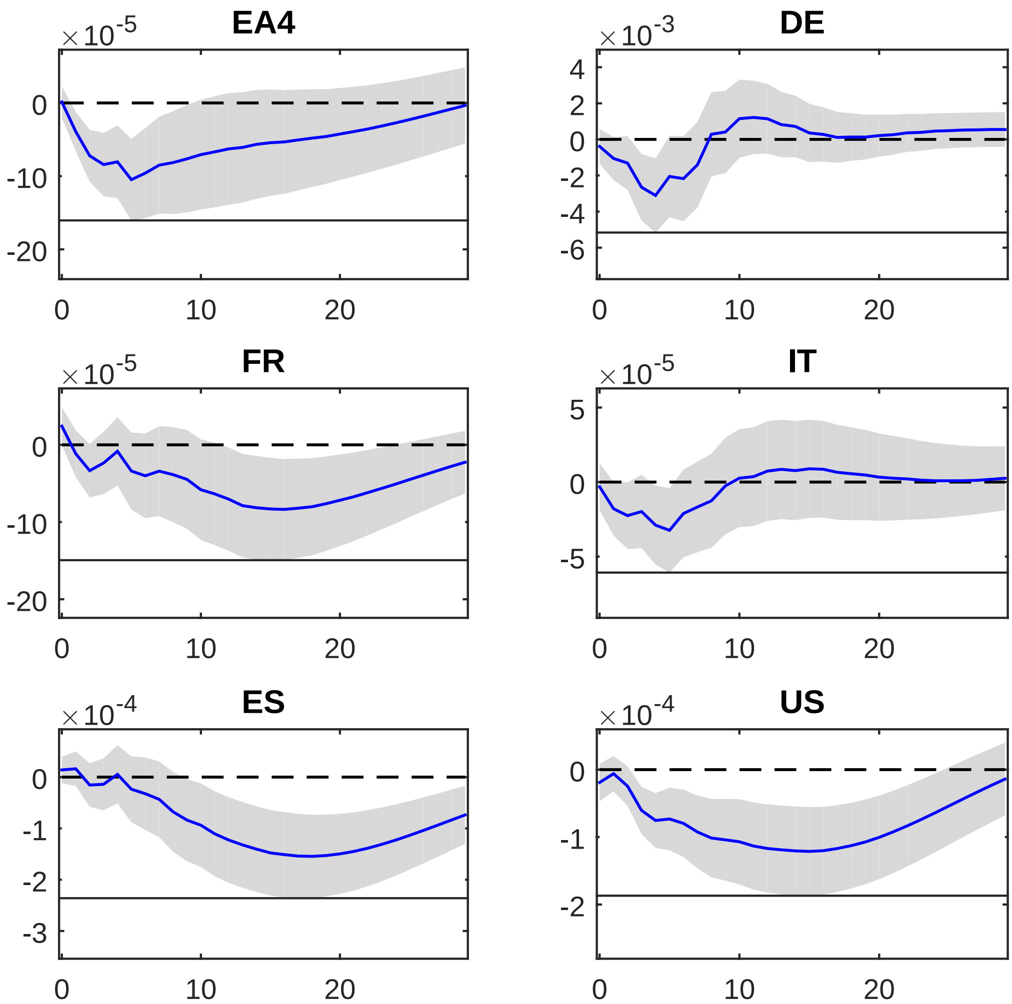

Figure 6: IRFs of Industrial Production to an Uncertainty Shock

The quarterly SVAR estimations indicate negative effects on investment following uncertainty shocks for the euro area (EA4) and as well for every of the four countries covered. On average, the downturns in investment last slightly less than a year. The recovery is in general followed by an overshooting proces before turning back to equilibrium. However, cross-country results vary widely. For Germany, the downturn is short and it is followed by a strong overshooting process. For Spain, the effects are much less significant, the downturn as well as the overshooting. Dividing the time series in crisis and pre-crisis is not advisable given the already short sample. But an approach with a dummy variable for crisis periods will be the next step.

Preliminary results also indicate that the effects of uncertainty are indeed asymmetric.

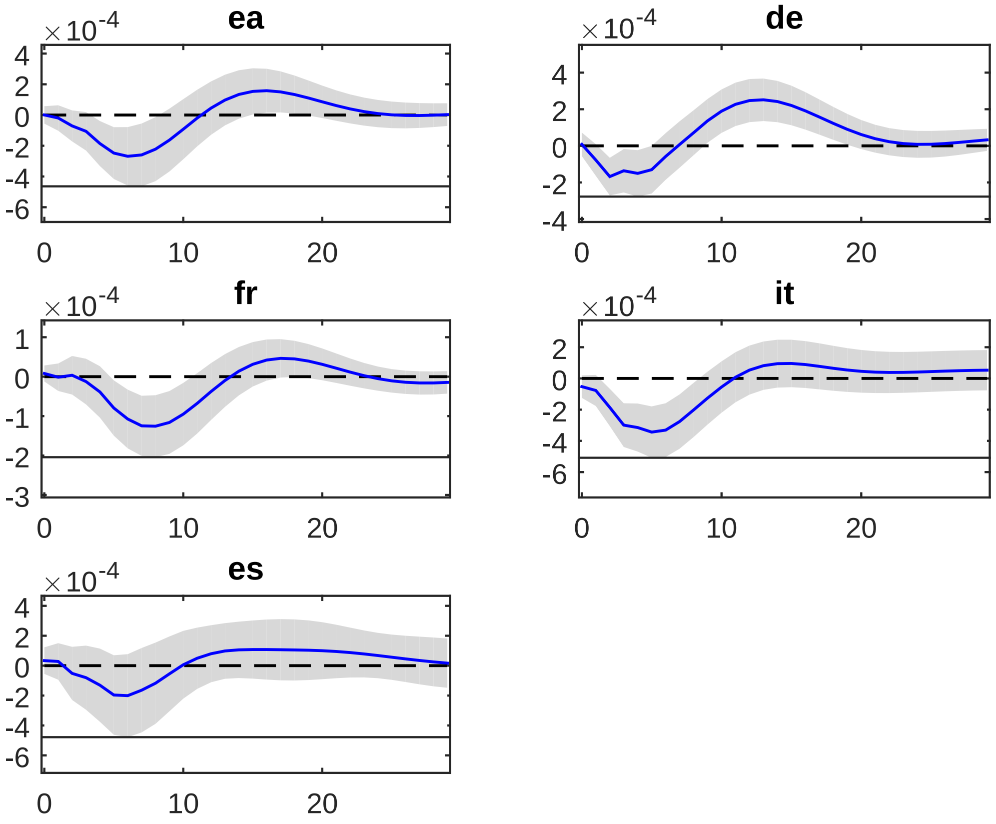

Figure 7: IRFs of Gross Fixed Capital Formation to an Uncertainty Shock

6 Conclusion

In general, our first SVAR results show a much clearer picture in the case of the US compared to the Eurozone. By breaking down the SVAR estimation to single countries, the relationship differs widely. We suspect these differences in the impulse response functions being caused by Euro specific factors that depress investment, output and employment reaction more strongly compared to the US. To highlight these effects the often used framework of Smets and Wouters (2003b) and Smets and Wouters (2007) are most likely not adequate to cover all the important macroeconomic connections in the context of the Eurozone recession. As a consequence our next step is to turn to an open-economy DSGE model that better captures the interaction of different countries in a monetary union. In general, one important feature missing in our model is the zero lower bound (ZLB) which not only leads to higher fiscal multiplier but most likely also aggravates the negative impact of uncertainty.

The final objective of our research is to clarify (and quantify) the role of uncertainty in the ongoing crisis in the Eurozone. To shed light on this issue is of major importance when it comes to evaluate macroeconomic policy. As mentioned, with strong uncertainty effects the potential trade-off between policy correctness and decisiveness (Bloom (2009)) favors decisiveness. If uncertainty is central to fluctuations in the business cycle of the Eurozone the ongoing debate on economic policy e.g. about Greece leaving the Euro is at the heart of depressed investment, not so much the result. It also means that e.g. rules for fiscal policies and debt ceilings could induce important positive impulses through their effect of reducing economic policy uncertainty. In general, an important role for uncertainty would also strengthen the often stressed business confidence story. On the other hand, if uncertainty is negligible economic policy in the Euro area should focus strongly on first-moment policies like e.g. fiscal stimulus.

References

Bachmann, R. and C. Bayer (2013). 'wait-and-see' business cycles? *Journal of Monetary Economics 60*(6), 704–719.

Bachmann, R., S. Elstner, and E. R. Sims (2013). Uncertainty and economic activity: Evidence from business survey data. *American Economic Journal: Macroeconomics 5*(2), 217–249.

Baker, S. R., N. Bloom, and S. J. Davis (2013). Measuring economic policy uncertainty. *SSRN Electronic Journal* (Working Paper No. 83).

Baker, S. R., N. Bloom, S. J. Davis, and J. van Reenen (2012). Economic recovery and policy uncertainty in the us.

Balta, N., E. Ruscher, and I. Valdés Fernández (2013). Assessing the impact of uncertainty on consumption and investment.

Barkbu, B., S. P. Berkmen, P. Lukyantsau, S. Saksonovs, and H. Schoelermann (2015). Investment in the euro area: Why has it been weak? *IMF Working Paper* (15/32).

Basu, S. and B. Bundick (2012). Uncertainty shocks in a model of effective demand.

Basu, S. and B. Bundick (2015, January). Endogenous volatility at the zero lower bound: implications for stabilization policy. Research Working Paper RWP 15-1, Federal Reserve Bank of Kansas City.

Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. *The Quarterly Journal of Economics 98*(1), 85–106.

Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica 77*(3), 623–685.

Bloom, N. and M. Floetotto (2009). Good news at last? the recession will be over sooner than you think — vox, cepr's policy portal.

Bloom, N., M. Floetotto, N. Jaimovich, I. Saporta-Eksten, and S. J. Terry (2012). Really uncertain business cycles.

Born, B. and J. Pfeifer (2014). Policy risk and the business cycle. *Journal of Monetary Economics 68*, 68–85.

Buti, M. and P. Mohl (2014). Raising investment in the eurozone — vox, cepr's policy portal.

Caldara, D., J. Fernandez-Villaverde, J. Rubio-Ramirez, and W. Yao (2012, April). Computing DSGE Models with Recursive Preferences and Stochastic Volatility. *Review of Economic Dynamics 15*(2), 188–206.

Caldara, D., J. Fernández-Villaverde, J. F. Rubio-Ramírez, and W. Yao (2012). Computing dsge models with recursive preferences and stochastic volatility. *Review of Economic Dynamics 15*(2), 188–206.

Christiano, L., M. Eichenbaum, and S. Rebelo (2011). When is the government spending multiplier large? *The Journal of Political Economy 119*(1), 78–121.

Dixit, A. K. and R. S. Pindyck (1994). *Investment under uncertainty.* Princeton, N.J.: Princeton University Press.

EIB (2013). Investment and investment finance in europe.

Elstner, S. (2011). *Uncertainty, Heterogeneous Expectation Errors and Economic Activity Evidence From Business Survey Data.*

European Commission (2015). *European economic forecast: Winter 2015*, Volume 1/2015 of *European economy.* Luxembourg: Publications Office.

Fajgelbaum, P., E. Schaal, and M. Taschereau-Dumouchel (2015). Uncertainty traps.

FernÃ¡ndez-Villaverde, J. and J. Rubio-RamÃrez (2010, December). Macroeconomics and Volatility: Data, Models, and Estimation. NBER Working Papers 16618, National Bureau of Economic Research, Inc.

Gourio, F. (2012). Disaster risk and business cycles. *The American Economic Review 102*(6), 2734–2766.

Grauwe, P. d. (2015). Secular stagnation in the eurozone — vox, cepr's policy portal.

Hatzius, J., A. Phillips, J. Stehn, and S. Wu (2012). Policy uncertainty: Is now the time? *Goldman Sachs Economic Research 12/42*.

Johannsen, B. K. (2014). When are the eï¬$ectsoffiscalpolicyuncertaintylarge?FinanceandEconomics$

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review 99*(3), 1053–1069.

Krugman, P. (2012). The uncertainty scam.

Leduc, S. and Z. Liu (2015). Uncertainty shocks are aggregate demand shocks: Federal reserve bank of san francisco working paper. *Federal Reserve Bank of San Francisco Working Paper 2012-10*.

OECD (2015). *OECD Economic Outlook, Volume 2015 Issue 1*, Volume 2015. OECD Publishing.

Reinhart, C. M. and K. S. Rogoff (2011). *This time is different: Eight centuries of financial folly* (13. print., 1. pbk. print ed.). Princeton, NJ: Princeton Univ. Press.

Schularick, M. and A. M. Taylor (2012). Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870–2008. *American Economic Review 102*(2), 1029–1061.

Smets, F. and R. Wouters (2003a, 09). An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area. *Journal of the European Economic Association 1*(5), 1123–1175.

Smets, F. and R. Wouters (2003b). An estimated dynamic stochastic general equilibirum model of the euro area. *Journal of the European Economic Association 1*(5), 1123–1175.

Smets, F. and R. Wouters (2007). Shocks and frictions in us business cycles: A bayesian dsge approach. *SSRN Electronic Journal*.

Stock, J. H. and M. W. Watson (2012). Disentangling the channels of the 2007-09 recession. *Brookings Papers on Economic Activity* (44 Spring), 81–135.

Summers, L. H. (2014). Reflections on the new 'secular stagnation hypothesis'.

Teulings, C. and R. Baldwin (Eds.) (2014). *Secular stagnation: Facts, causes and cures.* A VoxEU.org eBook. London: CEPR.

WEO (2014). *Recovery strengthens, remains uneven*, Volume 2014, Apr of *World economic and financial surveys.* Washington, DC: Internat. Monetary Fund.