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An SVAR-based empirical analysis for EU countries

by

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1. Introduction

In the wake of recent political developments around the globe, uncertainty has come to play an important role in explaining and forecasting the development of macroeconomic variables. Be it the rise of populistic and nationalistic parties in a variety of European states, the Brexit referendum in the United Kingdom, or the election of Donald Trump in the United States, recent developments have potentially sweeping implications for the performance of the global economy that are not easy to predict. We therefore analyze the past impact of uncertainty in general, and of policy uncertainty in particular, in a set of countries that have been and still are directly exposed to and affected by substantial economic and political uncertainty.

Recent studies have expended a great deal of effort in assessing the connection between uncertainty and economic performance, testing for causality as well as reverse causality. Groundbreaking work on the subject was done by Baker et al. (2015), who established the uncertainty index used in this paper and also created an empirical and theoretical framework for further research. Over the years, they extended their methods based on a variety of robustness checks such as analyzing the effects of political bias in newspapers and comparing the policy index to stock markets. These checks support the structure of their uncertainty indices overall.

Other studies analyzing the impact of fiscal, monetary, and political policy on uncertainty and vice versa include a study by Alexopoulos and Cohen (2015), who analyze the tie between business cycles, financial markets, and, as a proxy of uncertainty, the news reported by the *New York Times*. Further research on the influence of news media on stock prices has been conducted by Boudoukh et al. (2013). Jo and Sekkel (2015) used survey forecasts by the ECB to simulate economic uncertainty.

An impact of *policy uncertainty* on macroeconomic variables has been identified empirically in a variety of papers. Studies by Arnold and Vrugt (2008), Bernal, et al. (2014), and Liu and Zhang (2015) corroborate a positive effect of policy uncertainty on stock market volatility. Rising uncertainty also leads to a fall in investment and productivity, as shown by Gulen and Ion (2016), Kang et al. (2014) and Rodrik (1991). Tax adjustments (Hasset and Metcalf, 1999), regional conflict (Chau et al. 2014), and fiscal reforms in response to recessions (Higgs, 1997, Pástor and Veronesi, 2013), which might all stem from a period of uncertainty, dampen investment. All in all, these studies point to one-way causation between changes in uncertainty and the variation of macroeconomic variables.

Our own research has focused on the effect of uncertainty on exports, with a special focus on long-term hysteresis effects (Belke and Kronen, 2016). Uncertainty is implemented in our empirical models in a way that allows the uncertainty variable to have a non-linear impact on the macroeconomic variables. We call this model the "option value of waiting with investment-type decisions" model. In models of this kind, uncertainty affects the parameters of the model and, thus, the relation between the input and the output variables. In fact, uncertainty is multiplied by the original regression coefficients of the independent variables. This strand of research thus follows a *non-linear* approach of the hysteresis type to test for the impact of uncertainty.

Our empirical results once again underscore the importance of uncertainty for investments in trade. Aspects such as financing uncertainty are strongly (and not only in the Greek case) driven by euro-area policy uncertainty, which has in turn affected a variety of other euro-area member states (Pástor and Varonesi, 2013, Belke and Kronen, 2016). Furthermore, a higher degree of uncertainty may raise the cost of capital, especially since a large part of policy uncertainty is of a macroeconomic character and difficult to differentiate from other aspects (Baker et al. 2012). Additionally, higher policy and financial uncertainty may result in managers taking a more cautious approach to risk, which tends to delay decisions on investments such as installing distribution networks in foreign markets or hiring an export-oriented labour force (Panousi and Papanikolaou, 2011). Growing uncertainties of these kinds, paired with the credit constraints that have confronted exporting firms in European countries since the start of the European banking and debt crisis, have made it much more difficult, in many cases, for companies to enter foreign markets (Belke and Kronen, 2016).

The rise in uncertainty is, therefore, by no means new. In the wake of the financial crisis, labour costs have decreased (not least due to "Troika" activities in the euro-area program countries), but at the same time, some of the costs and uncertainties of doing business have increased. For established exporters in some countries, a lack of funds is probably the most important barrier, but there are many others. Corruption, bureaucratic hurdles, and an overall perception of a deteriorating economic and political environment ("institutional uncertainty") are creating increasingly high barriers to factor mobility (Arkolakis et al. 2014, pp. 21ff.). The generally slower reactions in the case of investment-type decisions can be explained by the fact that increasing institutional uncertainty plays a dominant role over decreasing fixed and variable costs (Belke et al. 2005). This may apply more to countries that have been severely affected by the recent crisis, but it reveals the general relevance of uncertainty in these times.

Taking this as our starting point, we examine the significance, sign, magnitude, and functional form of the impact of uncertainty on a set of macroeconomic variables, and identify how these different impacts are dependent on one another. In contrast to the hysteresis-type research on the impact of uncertainty, we follow current VAR (vector autoregressive)-type spillover studies and implement uncertainty as an additional variable in a VAR. We thus test for a direct impact of uncertainty on macroeconomic variables instead of assessing an indirect impact on the coefficients of the macroeconomic equations. Like other recent studies, we also abstract from aggregation issues to the macroeconomic level.

According to Caballero (1991), the sign of the relationship between uncertainty and investment-type macroeconomic variables is by no means clear a priori. It may be *negative* (as assumed in numerous previous studies), *positive* (in cases of general investment, which enables investors to react to a variety of future political conditions), or even *neither negative nor positive* if uncertainty drives a wedge between entry to and exit from investments. In the latter case, the central tenet is that uncertainty hampers structural change (Belke et al. 2005). We want to test whether there is a clear relationship between uncertainty and investment by testing whether the impulse-response functions of our model show a significant effect of uncertainty on investment. Since the current uncertain environment may result in more cautious behavior in investment decisions, we do not expect results supporting a definitive negative or positive effect.

To match the political uncertainty scenarios mentioned above, we focus our empirical analysis on the United Kingdom and the euro-area. In our previous research, we analyzed and tested these uncertainty effects on the general performance of exports. In this paper, we intend to expand on these findings by assessing the effects of uncertainty using a broader set of macroeconomic variables.

For this purpose, we use the *Policy Uncertainty Index* developed and published by Baker et al. (www.policyuncertainty.com) to estimate the impact of policy uncertainty on real economic variables. The index was created by evaluating news articles published by major media outlets in the respective countries. Incidents like the collapse of Lehman Brothers, the burst of the dotcom bubble, and the 9/11 attacks result in peaks in policy uncertainty and an index that is suitable to act as a proxy of uncertainty on a national level. We apply a Structural Vector Autoregressive (SVAR) model to gauge the impact of political uncertainty on a set of different variables such as interest rates, production (GDP), investment, and consumption for all of the countries under investigation.

The remainder of the paper is structured as follows. In Section 2, we describe the econometric estimation setup of the SVAR approach, which we apply in the subsequent analysis. Section 3 presents the dataset used in our estimation. Section 4 gives an overview of our estimations of the coefficients of uncertainty (the "α-coefficients") and structural impulse-response functions as the main results of our analysis. Section 5 concludes.

2. The empirical model

In this paper, we use a structural Vector Autoregressive Model (SVAR) to estimate the connection between the macroeconomic variables mentioned above. The procedure employed in this paper was originally proposed by Bernanke (1986) and Sims (1986). It adds a parametric character to the model of factorization and serves as an alternative to the standard Vector Autoregressive (VAR) approach to interpreting the correlation of variables.

2.1 Model specification and likelihood

The SVAR model in our case follows a basic VAR equation, which can be written as:

$$Y_t = c + \Phi_1 Y_{t-1} + \cdots + \Phi_p Y_{t-p} + \varepsilon_t \tag{1}$$

where Y_t describes an (n x 1) vector containing the values of the n variables at time t and Φ_t corresponds to the coefficients to be estimated and ε_t ~ i.i.d. $N(0, \Omega)$. The model is estimated using maximum likelihood estimation and serves as the basis for the SVAR estimation.

Our structural model can be expressed by

$$A(\theta)\varepsilon_t = B(\theta)\rho_t \quad \text{with} \quad E\rho_t\rho'_t = I \tag{2}$$

where θ represents the structural ordering of the matrices in the SVAR. These models are referred to as A, B, and A-B models, depending on whether or not matrices A and B are absent. The model can also be described as:

$$\Sigma = G(\theta)$$

with (3)

$$G(\theta) = A(\theta)^{-1}B(\theta)B(\theta)'A(\theta)^{t-1}$$

The covariance matrix Σ of the SVAR model has $m(m+1)/2$ free parameters, which means that a properly constructed SVAR model has to have as many or fewer free parameters in θ. If the number of distinct elements in Σ and θ is the same, the model is just identified by the order

condition. If there are fewer elements in θ, the model is over-identified, which means that the estimation setup has testable implications.

If, however, there is no interaction between θ and the model's lag coefficients, it follows that the lag coefficients can be found by maximizing the likelihood by OLS equation by equation. This applies even if the model is over-identified.[1]

2.2 Identification

The identification of a SVAR is not straightforward. With the exception of the usual counting rule, which determines whether the estimated model is identified as a whole, there is no "order condition" such as a Choleski Ordering that can be applied to the model. The only hint for identification comes from the restriction that the process ρ_t is orthonormal. However, it is still possible that global identification will fail, which would be unlikely in normal simultaneous models. Due to a covariance matrix that does not have a full rank, the model may be locally non-identified.

We use a less technical rule to assess whether the model is identified.[2] In an A model (as is the case in our application) identified with no restrictions, the SVAR is identified only if exactly one row has j zeros for each j from 0 to $m-1$ (so from 0 to 5). Furthermore, only if exactly one row has j non-zero elements for each j from 1 to m.

Our matrix therefore has the form:

$$\begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} & \alpha_{16} \\ \alpha_{21} & \alpha_{22} & 0 & \alpha_{24} & \alpha_{25} & \alpha_{26} \\ \alpha_{31} & 0 & \alpha_{33} & \alpha_{34} & 0 & \alpha_{36} \\ \alpha_{41} & 0 & 0 & \alpha_{44} & 0 & \alpha_{46} \\ \alpha_{51} & 0 & 0 & 0 & 0 & \alpha_{56} \\ 0 & 0 & 0 & 0 & 0 & \alpha_{66} \end{bmatrix} \begin{bmatrix} u_Y \\ u_I \\ u_C \\ u_G \\ u_i \\ u_u \end{bmatrix} = \begin{bmatrix} v_Y \\ v_I \\ v_C \\ v_G \\ v_i \\ v_u \end{bmatrix} \tag{4}$$

With the first row showing six non-zero elements, we can follow this rule and conclude that this matrix will properly identify an A model (since the model has 6-5-4-3-2-1 non-zero elements in its rows) and can be used to estimate our structural model specification.[3]

This is exactly the modelling framework that we decided to use in our application. In the following section, we apply the SVAR approach to estimate the different shocks on the variables

[1] A detailed description of the maximum likelihood approach is available on request.
[2] For a more detailed description of the identification progress, see Stock (2016).
[3] The identification procedure used here is described in more detail in Uhlig (2005).

observed in the system. After describing our initial model and the results for the α-coefficients of the system, we concentrate on the estimated impulse-response functions, highlighting the short- and long-term effects of initial shocks on the observed variables. We estimate the model for all countries contained in our sample comprising the Euro area and the United Kingdom and then comment on our results. Our dataset is explained in the subsequent section.

2.3 Derivation of hypotheses

We are interested in the transmission channels of uncertainty effects on the economy and the sign of these effects on macroeconomic variables (Belke and Goecke, 2005). Especially when looking at the effect of *uncertainty on investment* or investment-type decisions, we follow the reasoning of Dornbusch (1987), Dixit (1989), Bentolila and Bertola (1990), and Pindyck (1991). In this strand of literature, option price effects are determined in a quite sophisticated way. By abstracting from risk aversion and therefore postulating a risk-neutral environment, investment (and disinvestment) decisions are caused by uncertainty (i.e., volatility) in revenue and *sunk hiring and firing costs*. In these models, investment is therefore specified as irreversible. The degree of irreversibility depends on the asymmetry of adjustment costs (Caballero, 1991) and on the magnitude of the so-called scrapping values (Darby et al., 1998). As already mentioned in the introduction, theory therefore suggests a *different sign* of the impact of uncertainty on investment, depending on whether the type of investment is general or specific.

For *general investment*, a positive sign of uncertainty (i.e., the sign of the estimated coefficient alpha) may be expected if it pays off to be able to adapt to different political and economic conditions in the future. Bloom (2013) distinguishes between two different positive effects of uncertainty on economic growth, following the ideas of Caballero (1991). The first one relates to the prospect of an expansion of the "upside of future outcomes," which is fostered by higher uncertainty. The second one refers to the reaction of firms to shocks. A positive shock results in expansion, while a negative shock might manifest itself in a contraction, resulting in turn in a potential rise in average output through a mean-preserving spread (Oi, 1961, Hartmann, 1972, and Abel, 1983).

Looking at *specific investment*, the sign of the effect of uncertainty (i.e., the sign of the estimated coefficient alpha) is expected to be negative to cut off the negative part of the distribution of the empirical realization of the variable vulnerable to uncertainty (Leduc and Zheng, 2016). This real option effect results in firms being more cautious when hiring and firing employees, and in consumers being more cautious when buying durable goods. Both effects thus also tend

to lower growth insofar as economic growth is dependent on investment, private consumption, and the degree of employment (Caggiano et al. 2017).

A third possibility that we leave unaddressed in this paper has been explored in a number of papers by Nicholas Bloom and coauthors (see, e.g., Baker et al. 2012): a potential *effect of uncertainty on the relation among different variables*, for instance, between private consumption and income. To give one example, a "band of inaction," which emerges due to sunk costs, may be widened by option value effects of uncertainty (Belke and Goecke, 2005). Since these mechanisms may apply to other "investment" cases in which the aggregation of microeconomic real option effects under uncertainty are relevant, they may even be of a more general interest for the variables under investigation here: production, private consumption, and investment (Belke and Goecke, 2005). As a result, the sign of the impact of uncertainty on the real economy is ambiguous in this third option. But it appears legitimate to state regarding this third option that higher uncertainty implies less structural change in the economy because it prevents investment and de-investment. For instance, Aastveit et al. (2013) estimate that investment reacts two to five times less when uncertainty is in its upper instead of its lower decile.

It should be added that models *with risk aversion* typically lead to negative effects of uncertainty. For instance, in this case, *risk-premium* effects emerge, which act to raise the cost of finance (Bloom, 2013) and thus may have a dampening impact on asset prices as well. Accordingly, Chen and Tong (2016) find that economic policy uncertainty predicts negative future stock market returns at various horizons. In the same vein, Jiang and Tong (2016) show that monetary policy uncertainty (MPU) induces a risk premium in the US Treasury bond market. They arrive at the robust result that MPU forecasts significant and positive future monthly Treasury bond excess returns. Finally, increasing risk premia induced by additional uncertainty can also be expected to have negative impacts on investment, consumption, and hence also on output due to a dampening of asset prices resulting from the wealth effect. Among other outcomes, *precautionary savings* effects may occur that act to reduce consumption spending (Bloom, 2013).

To summarize, the literature finds that uncertainty hampers growth (Ramey and Ramey, 1995, Engle and Rangel, 2008, Baker and Bloom, 2013) and credit (Bordo et al. 2016), thus reducing investment and output (Aastveit et al. 2013, Bloom, 2009, Bloom et al. 2013) as well as consumption (Romer, 1990).[4] However, empirical evidence showing that uncertainty stimulates

[4] A solid and comprehensive survey in this context is IMF (2016), p. 41.

R&D spending driven by growth options effects and thus has a positive effect on longer-run output growth is comparatively scarce.

We therefore examine *two dimensions* of our estimation results in greater detail. First, we are interested in the *signs of the alphas* in equation (4). Since the interpretation of single coefficients is of little use (Uhlig, 2005), we focus, second, on the estimated *impulse-response functions* derived from our SVAR to identify the dynamic reactions of the macroeconomic variables to the shocks to our different specifications of uncertainty. Since economic theory is not unambiguous regarding the effect of uncertainty, we have no prior regarding the sign (positive or negative) of the effect of an uncertainty shock on the variables examined in this paper. Instead, we expect to find a pattern of signs of the uncertainty effect with results differing with respect to both the average state of the economy in the respective country and the character of investment underlying the respective macroeconomic variable, general or specific.

3. Data and variables

Before we can estimate the SVAR, the standard VAR serves as the basis for the final specification of our empirical model, which uses the earlier residuals and covariance matrices to establish the α-coefficients in the structural approach and the resulting effects for the impulse-response functions.

We analyze a variety of euro area member countries, the euro area as a whole, and the United Kingdom. In cases of insufficient data, we ignore smaller countries included in the dataset for the entire Euro area.

The variables we analyze in this paper are the following: production (Y), consumption (C), investment (I), short-term interest rates (i), and uncertainty (u). The dataset has a quarterly frequency and extends from 1995 to the second quarter of 2016. GDP is expressed in market prices. All macroeconomic variables are taken from the Eurostat database of GDP and its main components and are expressed in millions of euros. To measure uncertainty, we employ a variety of variables:

- the policy uncertainty index developed by Baker, Bloom and Davis (www.policyuncertainty.com) based on news articles from the respective countries,
- the volatility of the Euro Stoxx 50[5] measured as the standard deviation over time, and

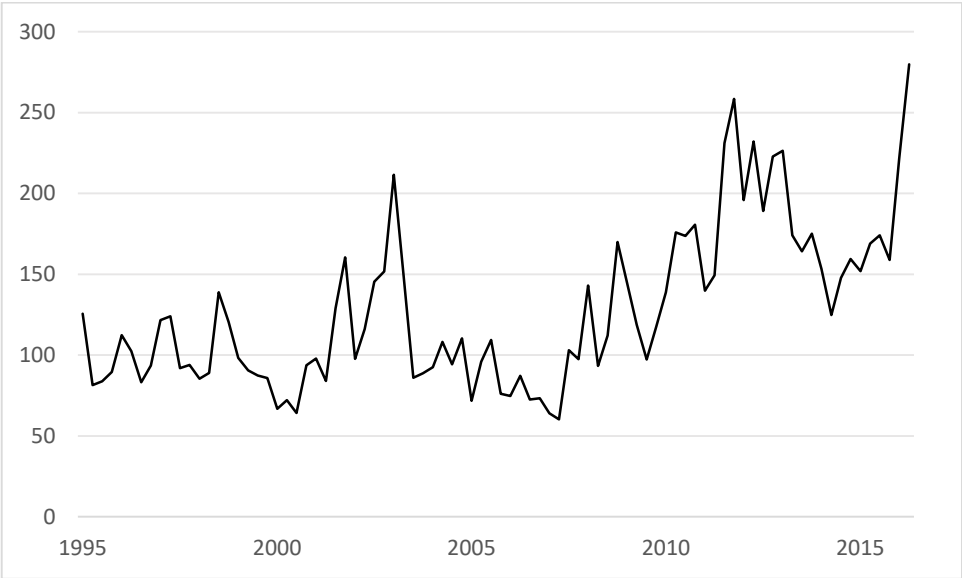
[5] Due to data non-availability, this time series starts in 1999.

- the TED spread of the Federal Reserve of St. Louis, which can be used to measure faith in the banking sector.

All series have been seasonally adjusted using the Census X-11 procedure. To determine the lag length of our sample, we employed the Akaike information criterion (AIC), which suggests a lag length of two quarters.

We now take a closer look at the policy uncertainty index used in this paper. The index is constructed by drawing articles from two newspapers per European country. These are *Le Monde* and *Le Figaro* for France, *Corriere Della Sera* and *La Republica* for Italy, *El Mundo* and *El Pais* for Spain, *Handelsblatt* and *Frankfurter Allgemeine Zeitung* for Germany, and *The Times of London* and *Financial Times* for the United Kingdom. The papers were searched on a monthly basis for keywords such as "economic," "uncertainty," "deficit," "European Central Bank," and "regulation". The number of articles including the keywords was then divided by the total number of articles to address changes over time. Standardising the values results in a multi-paper index.[6] The series for the policy uncertainty index in Europe is depicted in Figure 1 for illustration purposes.

Figure 1 – The European policy uncertainty index



Source: www.policyuncertainty.com.

The strong impact of uncertainty can be derived from the rise in uncertainty following the financial crisis in the year 2008. The influence of global and European developments, such as the *imminent Greek default* and other events causing post-crisis uncertainties can be identified by

[6] See www.policyuncertainty.com.

the trend of the index. The peak at the end of our sample can be explained by both the *US elections* and the *Brexit* referendum in the United Kingdom.

4. Estimation results

In this section, we present the estimation results from our structural vector autoregressive model. We illustrate our results by (a) presenting detailed regression outputs for a selected number of countries, and (b) concluding with a systematic overview of the results for all countries under investigation. We estimate our empirical model employing three different variables capturing uncertainty: first, Baker's *policy uncertainty index*, second, the *volatility of the Euro Stoxx*, and third, the *TED spread* of the Federal Reserve of St. Louis. To represent prime examples of policy uncertainty, we chose Germany, as one of the most stable countries, Greece, the country that has received the most attention since the financial crisis, and the euro area, to give an overview of all of the countries under investigation.

4. 1 Policy uncertainty

Table 1 displays the results of our SVAR estimations for Greece. The coefficients represent the estimated alphas appearing in equation (4). A negative value suggests a negative relation between the two variables signified by the index of the alpha. The parameter A26, for example, suggests a negative influence of the sixth variable in our specification (i.e., uncertainty) on the second variable in our estimation set (in our case, investment).

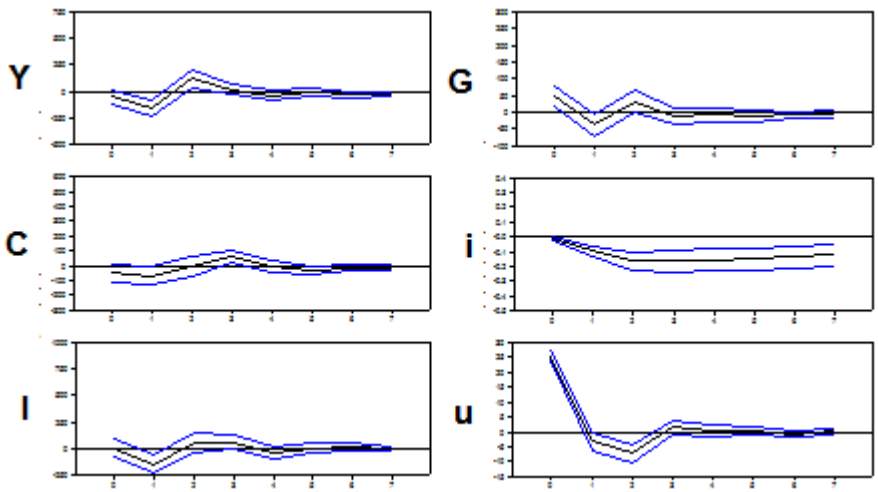
Note that not all coefficients turn out to be significant. To interpret the results and to derive some economic implications from the estimation, it is reasonable to look at the empirical form of *impulse-response functions* (IRF) of the estimated system, since interpreting the single coefficients of the system is of no use (Uhlig, 2005). This is because coefficients tend to be estimated imprecisely and to interact in ways that cannot be easily explained. Referring to the impulse-response functions we can show how the system reacts to *specific isolated shocks*, which in our case are uncertainty shocks. Figure 2 displays the estimated impulse-response function to a shock of uncertainty for the Greek case.

Table 1 – SVAR coefficients for Greece

Variable	Coeff.	Std. Error	T-Stat	Signif.
1. A11	0.00003	0.00002	1.72662	0.08424
2. A22	0.00005	0.00001	5.33707	0.00000
3. A33	-0.00013	0.00001	-12.08110	0.00000
4. A44	-0.00035	0.00003	-11.81235	0.00000
5. A55	3.53199	0.78285	4.51172	0.00001
6. A66	-0.03354	0.00260	-12.89894	0.00000
7. A12	0.00003	0.00002	1.69610	0.08987
8. A13	0.00002	0.00003	0.63589	0.52485
9. A15	-2.50654	1.21557	-2.06202	0.03921
10. A16	0.00499	0.00510	0.97855	0.32780
11. A21	-0.00002	0.00001	-2.09790	0.03591
12. A24	-0.00004	0.00004	-0.98618	0.32404
13. A26	-0.01160	0.00445	-2.60750	0.00912
14. A31	0.00006	0.00001	5.97756	0.00000
15. A35	0.50023	0.72280	0.69208	0.48889
16. A36	0.00557	0.00454	1.22662	0.21996
17. A41	0.00003	0.00001	5.54332	0.00000
18. A46	-0.00617	0.00392	-1.57476	0.11531
19. A51	0.00000	0.00002	0.15164	0.87947

Since both the market short-term interest rate, which is decided upon by the ECB Executive Board in Frankfurt, and the respective reaction of uncertainty to changes in the rate cannot be attributed solely to the respective euro area member country, we leave out uncertainty effects on the interest rate and on uncertainty itself and concentrate on the three variables production, consumption, and investment.

Figure 2 – Impulse-response functions for Greece (policy uncertainty)

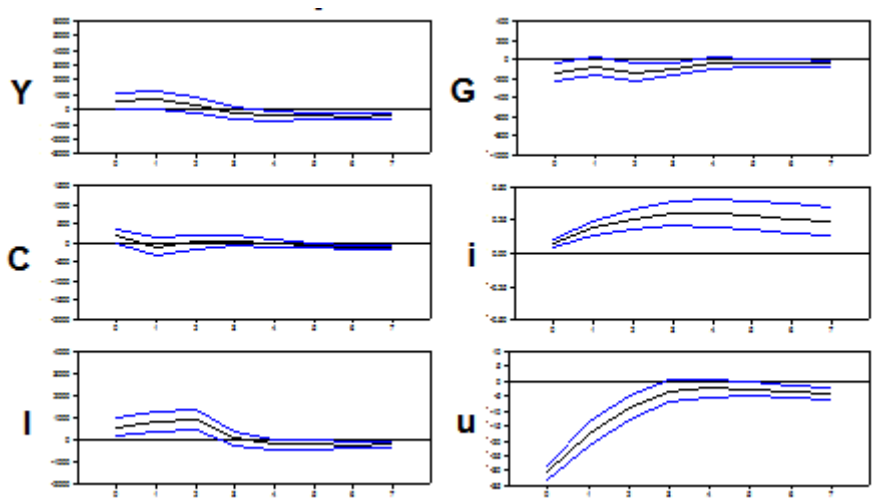


Source: Own calculations and graphs.

Figure 2 above shows the reaction of all six variables to a *one standard deviation shock* of the uncertainty variable expressed as policy uncertainty. We calculate the 5 percent error bands using Monte Carlo methods with a random walk Metropolis.[7] A visual inspection of Figure 2 confirms that there is a significant negative effect in the first quarter for production, consumption, and investment in Greece. However, all three variables begin to recover after half a year, resulting in positive effects for both production and consumption later on. This pattern may be driven by investment decisions that were initially postponed after a shock of uncertainty and only made several months later. It clearly shows, however, that a rise in policy uncertainty tends to *dampen economic growth* in Greece. The negative reaction of investment may also be a result of this.

Besides the results for Greece, we want to highlight and interpret the estimated IRFs for both Germany, a country that is considered to be one of the most stable economies in Europe, and the euro area, as the weighted average of the entire EMU member country sample.[8] Figures 3 and 4 show the IRFs for both Greece and the euro area.

Figure 3 – Impulse-response functions for Germany (policy uncertainty)



Source: Own calculations and graphs.

We estimate a barely significant positive effect of uncertainty on production that turns insignificant after one period and therefore one quarter. The effect of uncertainty on investment appears to be more sustained, and turns insignificant after three lags. The effect of uncertainty on consumption turns out to be insignificant. There are different potential explanations for these reactions, such as a shift in capital flows from countries with a less stable economy than Germany,

[7] For a detailed explanation of the procedure, see Sherlock et al. (2010).
[8] Tables displaying the estimated α-coefficients of Germany and the Euro area are available on request.

which might explain the rise in investment accompanying a rise in uncertainty.[9] This may also be interpreted as confirming our hypotheses in 2.3. A rise in uncertainty may raise *general investment* by fostering a rise in the expectation of future outcomes and also by a rise in average output.

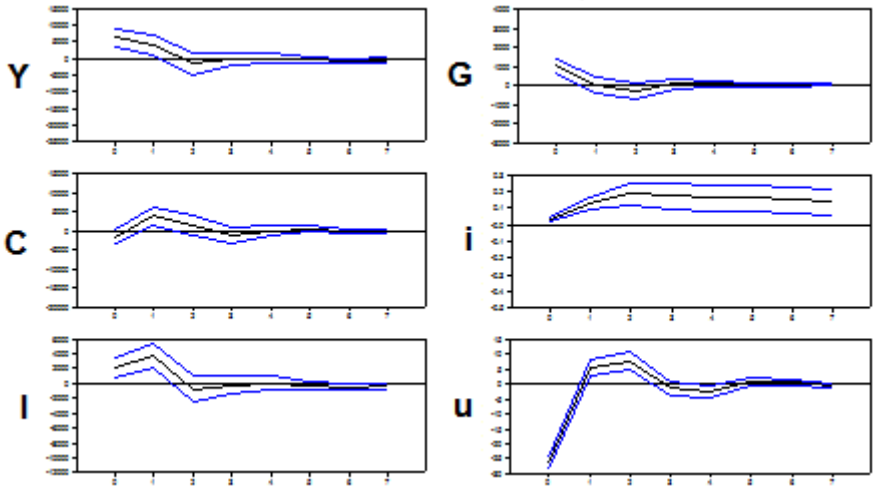
A visual inspection of Figure 2 confirms that there is a significant negative effect in the first quarter for production, consumption, and investment in Greece. However, all three variables start to recover after half a year, resulting in positive effects for both production and consumption later on. This pattern may be driven by investment decisions that were *initially postponed* after a shock of uncertainty and therefore only realized after a period of months. It clearly shows, however, that a rise in policy uncertainty tends to dampen economic growth in Greece. The negative reaction of investment may be a result of the aforementioned process of investing in foreign markets instead of the domestic market, which is assessed to be more difficult (Panousi and Papanikolaou, 2011).

The results for euro area as a whole are displayed in Figure 4, which shows consistently positive effects for *all three variables*. For all variables, the effect turns insignificant between the first and the second quarter. The detailed results in Table 2 should be interpreted with caution since the analysis on the country level does not support the overall positive results of the estimations for the euro area as a whole.[10]

Table 2 summarizes the results, giving an overview for the effects in all euro area member countries plus the United Kingdom, i.e., all countries under investigation here. Entries to this table exclusively denote cases in which the effects of uncertainty shocks turn out to be significant. Insignificance is denoted by a minus. Values in brackets represent the *number of lags* for which the uncertainty impact is *significant*.

[9] A deeper analysis of capital flows in this context may be an interesting avenue for further research.
[10] An additional test for the Euro area may be to aggregate the series for all countries under investigation. This would be to ensure that only those countries that are used in the estimation framework are considered in the subgroup “Euro area”.

Figure 4 – Impulse-response functions for the euro area (policy uncertainty)



Source: Own calculations and graphs.

Table 2 - Effects of policy uncertainty on the real economy

	Production	**Consumption**	**Investment**
Belgium	-	-	-
Cyprus	negative (1,2)	-	-
Estonia	positive (1)	-	positive (2)
Finland	-	-	-
France	positive (1,2)	positive (1)	positive (1)
Germany	positive (1)	-	positive (3)
Greece	negative (1) positive (2)	negative (1) positive (2)	negative (1)
Ireland	positive (1)	positive (2)	-
Italy	-	-	negative (1)
Latvia	positive (1)	-	-
Lithuania	negative (1)	-	-
Netherlands	positive (2)	positive (2,3)	positive (2)
Portugal	negative (1,2)	negative (1,2)	negative (1,2)
Slovakia	negative (1)	negative (1)	-
Slovenia	negative (1)	-	negative (1)
Spain	negative (2)	negative	-
United Kingdom	-	positive (1)	positive (2)
Euro area	positive (2)	positive (2)	positive (2)

Note: Values in brackets represent the lag numbers for which the uncertainty impact is significant. "-" indicates the absence of significant effects of an uncertainty shock on the respective macroeconomic variable.

As postulated in section 2.3, a consistent impact of uncertainty in the sense that there is a *uniquely negative* sign of this impact *cannot be established* empirically. However, there are clusters of countries for which the sign turns out to be positive or negative.

The effect of uncertainty tends to be *positive* in countries that have been less affected by the European financial crisis of 2008. For countries like France, Germany, the Netherlands, and the United Kingdom, our estimations yield positive reactions to changes in uncertainty for most of the country-specific macroeconomic variables. In the French case, a positive effect for one period of consumption and investment emerges. As already mentioned, for Germany, the uncertainty effect on investment turns out to be positive. For both variables, the impact of an uncertainty shock lasts for two periods. The latter effect may mirror the "rule-based" (i.e., public debt brake oriented) expenditure policy of Germany's Ministry of Finance in times of higher uncertainty. The Dutch case shows positive effects of an uncertainty shock on all macroeconomic variables, whereas the United Kingdom exhibits an overall positive effect of an uncertainty shock exempting production, on which uncertainty has no significant effect at all. This might be interpreted as an inclination of entrepreneurs to take uncertainty as an opportunity to achieve high yields in general investments and to profit from fluctuations in consumer good prices. As a consequence, the uncertainty effect on both investment and consumption may turn out to be positive.

The effects for countries that have been *heavily affected* by the financial crisis, i.e., Greece, Ireland, Italy, Portugal, and Spain (GIIPS), seem to show the opposite sign. Here, a rise in uncertainty typically results in a *negative effect*, especially for investment and consumption. Italian investment reacts negatively to uncertainty shocks, whereas the Portuguese economy reacts negatively for two periods in all variables. In Spain, the uncertainty shock induces a negative effect on both production and consumption. The only country with inconclusive results in this group is Ireland, which is coincidentally the country that has been able to recover the fastest after the financial crisis.

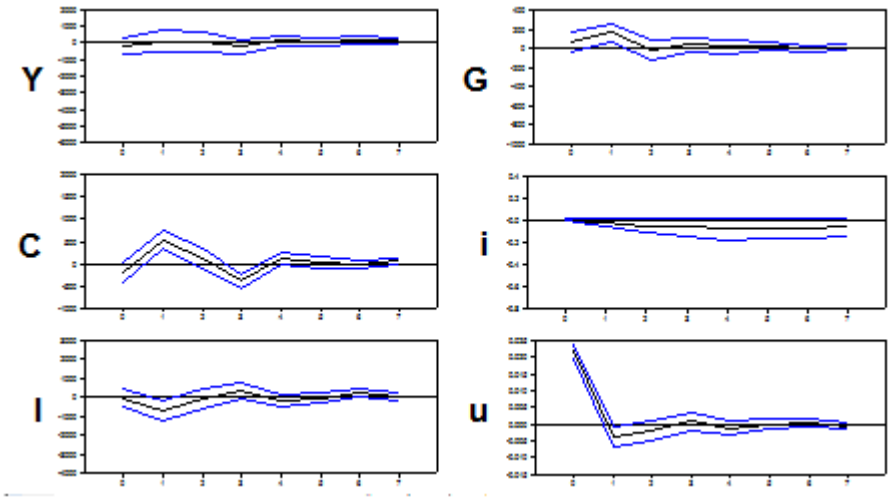
Looking at the euro area as a whole yields a *positive* sign of the uncertainty effect for all macroeconomic variables, which seems plausible when comparing the economic strength of the stable countries to that of the GIIPS and taking into account that the stable economies represent the majority of the euro area member countries.[11] In the following, we will employ alternative measures of uncertainty to check the robustness of our analysis.

[11] Detailed estimation results including the impulse-response functions are available on request.

4.2 Uncertainty effects employing the volatility of Euro Stoxx 50

The first alternative is the *Euro Stoxx 50* index. This is a European Blue Chip Index that contains the 50 leading European stocks such as Airbus, BMW, and Siemens. By observing the volatility of the Euro Stoxx for the time period under consideration, we can analyze the reaction of the dependent variables on uncertainty in the stock markets, thus adding another dimension to our analysis of policy uncertainty. Similar to the analysis in the preceding section, we present the results for two countries in our sample and then give a concluding overview for our estimations.

Figure 5 – Impulse-response functions for Germany (Euro Stoxx 50)



Source: Own calculations and graphs.

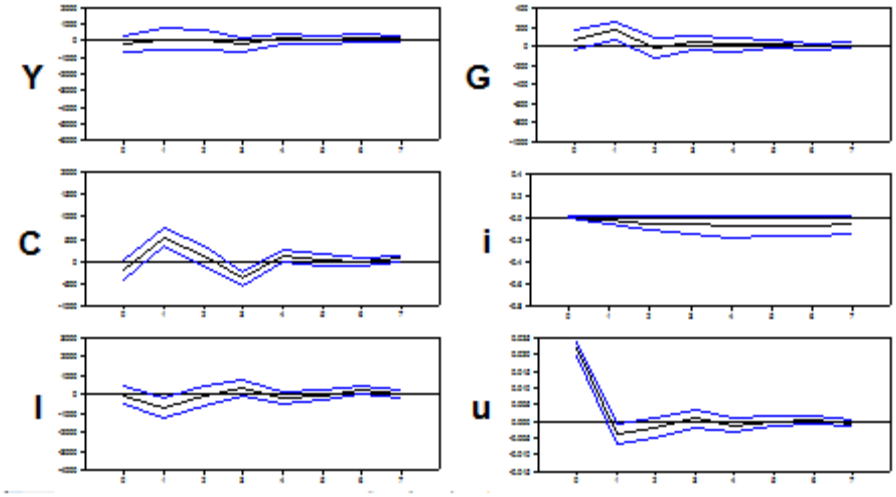
The effect of stock market uncertainty on production is insignificant. Consumption reacts positively at first but shows a subsequent negative effect in the third quarter. In contrast, investment shows a negative reaction at first, from which the economy seems to recover, leading to a short positive effect in the third quarter. This may follow from a rise in consumption because investment decisions seem to be too risky at first, while after some waiting and observation of the market, it results in a renewed rise in investment.

In the case of the euro area as a whole, there is no significant effect on production (GDP). The confidence intervals are around the abscissa for all lags. However, consumption and investment react negatively.

The results in Table 3, showing the volatility of the Stoxx 50 index on the real economy, are comparable to those in Table 2, with uncertainty proxied by political uncertainty. The interpretation of the results follows the same logic as in the previous section. However, the emerging pattern does *not seem to distinguish* between two distinct samples of countries. The overall

effect of stock market volatility on production, consumption, and investment seems to be more consistently negative than policy uncertainty.

Figure 6 – Impulse-response functions for the euro area (Euro Stoxx 50)



Source: Own calculations and graphs.

With the exception of Belgium and Cyprus, our estimations indicate a *consistently negative reaction* of the macroeconomic variables for the countries in our sample. The effect on production is negative for all countries except for Belgium, where it shows a positive effect after half a year, as well as Germany, Cyprus, Slovakia, and the euro area, where we find no significant effect.

Private consumption reacts in a more varied manner in the countries analyzed. We find a negative effect for France, Finland, Italy, Lithuania, the Netherlands, and Portugal, and long-lasting negative effects for Estonia and Spain. The macroeconomic variables in Belgium, Ireland, and Latvia react positively to a volatility shock of the Euro Stoxx 50. In both Germany and the euro area, an initial positive shock is followed by a negative one. The effect is insignificant for Cyprus, Greece, Slovakia, Slovenia, and the United Kingdom.

Investment does *not react consistently negatively* to changes in stock market volatility. Indeed, investment reacts negatively to increases in uncertainty in the cases of Estonia, France, Italy, Lithuania, the Netherlands, Portugal, Slovakia, Spain, and the euro area. We do, however, find positive effects following initial negative effects in Germany, Greece, and Latvia, while Belgium and Cyprus show a positive reaction across all lags. The estimation results for Finland and the United Kingdom turn out to be insignificant.

Table 3 - Effects of Stoxx 50 volatility on the real economy

	Production	**Consumption**	**Investment**
Belgium	positive (2)	positive (2)	negative (2)
Cyprus	-	-	positive (2)
Estonia	negative (2)	negative (3)	negative (1)
Finland	negative (1)	negative (3)	-
France	negative (1)	negative (1)	negative (1)
Germany	-	positive (1) negative (3)	negative (1) positive (3)
Greece	negative (1)	-	negative (1) positive (3)
Ireland	-	positive (1)	positive (1) negative (2)
Italy	negative (1)	negative (1)	negative (1)
Latvia	negative (1)	positive (1)	negative (1) positive (3)
Lithuania	negative (1)	negative (3)	-
Netherlands	negative (1)	negative (1)	negative (2)
Portugal	negative (1)	negative (1)	negative
Slovakia	-	-	negative (2)
Slovenia	negative (1)	-	negative (1)
Spain	negative (2)	negative (2)	negative (1)
United Kingdom	negative (1)	-	-
Euro area	-	negative (2)	negative (1)

Note: Values in brackets represent the lag numbers for which the uncertainty impact is significant. "-" indicates the absence of significant effects of an uncertainty shock on the respective macroeconomic variable.

4.3. Uncertainty effects employing the TED spread

The second approach to using policy uncertainty as a proxy of uncertainty is the TED spread. It illustrates the difference between the yields of the three-month LIBOR and US as well as British treasury bills. A larger difference between the two indicates the direction in which banks move their liquidity holdings. Since the LIBOR can be used to depict the risk of lending to commercial banks, while treasury bills are commonly seen as more risk-free, the TED spread indicates the perceived credit risk in the economy (Baele et al., 2015, and Lashgari, 2000). TED spread increases indicate that the anticipated risk of a default on interbank loans is increasing. This is mirrored either by a higher interest rate on the inter-banking market or by an acceptance of lower returns on treasury bills. The TED spread therefore represents a measure of trust in the banking sector. It may thus be used as a suitable proxy of financial uncertainty. The TED spread

has been used to model systematic risk in US banking (Baele et al., 2015) and to analyze the effect of financial uncertainty on stock market returns, oil prices, home prices, and exchange rates (Dania and Malhtora, 2016).

Our estimation results employing the TED spread as a proxy of uncertainty are summarized in Table 4.

Table 4 - Effects of the TED spread on the real economy

	Production	**Consumption**	**Investment**
Belgium	negative (3)	negative (1)	negative (2)
Cyprus	negative (1)	negative (2)	-
Estonia	negative	negative	negative
Finland	negative (3)		negative (2)
France	negative (3)	negative (2)	negative (3)
Germany	positive (3)	-	positive (3)
Greece	positive (1)	-	positive (2)
Ireland	-	negative (1)	-
Italy	positive (3)	positive (3)	positive (3)
Latvia	negative (3)	negative (2)	negative (3)
Lithuania	positive (3)	positive (3)	positive (3)
Netherlands	negative (3)	negative (4)	negative (3)
Portugal	negative (1)	negative (3)	negative (2)
Slovakia	negative (2)	negative (2)	negative (after3)
Slovenia		-	negative (2)
Spain	negative (3)	negative (4)	negative (3)
United Kingdom	positive (3)	positive (3)	positive (3)
Euro area	negative (3)	negative (1)	negative (3)

Note: Values in brackets represent the lag numbers for which the uncertainty impact is significant. "-" indicates the absence of significant effects of an uncertainty shock on the respective macroeconomic variable.

The results for the TED spread differ for some countries from those using Stoxx 50 volatility as a proxy of uncertainty. For *most countries*, however, the macroeconomic variables display a *negative reaction* to a positive shock of the TED spread. However, notable exceptions are Germany, the United Kingdom, Greece, Italy, and Lithuania. The estimated positive reaction to uncertainty in the case of the former two countries can again be interpreted as the empirical dominance of the shift of investment to a safe haven represented by these two economically strong economies.

Regarding the three alternative uncertainty variables employed in our estimation, we arrive at evidence of a different reaction of the real economy variables to the two specifications of uncertainty: *policy uncertainty* (represented by the European policy index) and *financial uncertainty* (proxied by the volatility of the Euro Stoxx and the TED spread). While policy uncertainty tends to have *different effects* depending on the basic economic performance of the country under investigation (i.e., a negative uncertainty impact in the GIIPS, whereas the real economy of the more stable countries such as Germany is characterized by a positive impact of uncertainty), stock market volatility has a *negative effect* in more cases throughout.

Especially when we apply the policy uncertainty index of Baker et al., we find confirmation of the hypothesis stated in section 2.3 that the impact of uncertainty on macroeconomic variables in less stable countries is *negative*. To be more concrete, the effects of uncertainty on the real economy come with a negative sign in Greece, Italy, Portugal, and Spain, whereas in Germany, France, the Netherlands, and the United Kingdom, real economic variables seem to be positively affected by an increase in uncertainty.

Employing both Euro Stoxx volatility and the TED spread (i.e., variables that both account for financial uncertainty) yields a more *uniform picture*. A shock to uncertainty usually results in negative effects on the real economy with a few exceptions, among them Germany, for which our estimations seem to perform well with all of the kinds of uncertainty investigated in this paper. This clearly backs our prior that the reaction of the real economy to a rise in uncertainty should be *dependent on the general economic performance* of the economy in question.

Our paper serves as a first effort to gauge the real economic effects of uncertainty in a wider country-based context. However, we leave several additional issues, such as the relevance of *non-linearities in the relationship between uncertainty and the real economy*, and the *transmission channel between uncertainty and macroeconomic variables*, to future research.

5. Conclusions and outlook

In this paper, we aimed to gain first insights into the dynamic effects of policy uncertainty and financial uncertainty on selected macroeconomic variables such as production, consumption and investment. We analyzed euro area member countries, the euro area as a single entity, and also the United Kingdom.

According to our findings, a rise in policy uncertainty leads to ambiguous effects of uncertainty (positive versus negative sign) on the macroeconomic variables production, consumption and investment across the economies under investigation here.

The impact of *policy* uncertainty on macroeconomic variables *in the GIIPS economies* turns out to be generally *negative*. A possible explanation, beyond the dominance of specific over general investment and an increase in the risk premium mentioned in section 2.3, especially of the negative effect on investment in the GIIPS, is the shift of capital flows to more secure investment opportunities in foreign markets, which is then observationally equivalent to a negative effect of uncertainty.

Note also that in the case of the GIIPS economies, political uncertainty often transforms into financial uncertainty (see, for instance, Belke and Kronen, 2016, for the Greek case). If refinancing becomes more difficult, consumption, investment, and output are negatively impacted as a direct consequence. Finally, those countries have been suffering from a lack of structural reforms for a long time. In other words, due to the high irreversibility of investment-type decisions, such as employment decisions, and to high entry and exit costs caused by low flexibility of wages and prices (across qualifications and sectors), these countries are prone to a negative sign of uncertainty on macroeconomic variables.

In contrast, for members of the EMU core such as Germany, a positive sign of the political uncertainty variable tends to dominate. This may indicate the higher importance of *general investment*. For instance, Germany may have realised that it pays off in general to be able to adapt to the different political and economic conditions that may arise in the future. For instance, it is well known that German firms may have pushed investment in general qualifications of the workforce in times of uncertainty, i.e., during the financial crisis after the collapse of Lehman Brothers (*"Facharbeiter"*).

The estimated effects of a rise in *financial* uncertainty display a less "dual" pattern. A shock of financial uncertainty tends to induce a negative reaction of production, i.e., GDP. Also for investment and consumption, we find evidence of a negative sign of uncertainty in several European countries. In some cases, initial negative effects are reversed after three quarters, a pattern that is compatible with higher (or lower) levels of investment after a thorough assessment of the risks in the market. The results for financial uncertainty do not show a pattern of different results for different country groups, and are more homogenous across country groups than the effects of policy uncertainty.

Our results should be interpreted as a first simple approach to an assessment of the rising importance of uncertainty on a macroeconomic level. Of course, our estimation results could be subjected to *further robustness checks*. Whereas in our case splitting the sample period and increasing the number of lags were not possible as robustness checks due to the limited range

of our data, one realistic option would be to apply an *alternative estimation procedure* to the SVAR used here. A suitable candidate would be threshold vector autoregression to estimate higher and lower thresholds that trigger an uncertainty impact on the macroeconomic variables contained in the empirical model (Belke and Goecke, 2005, Belke et al. 2005, Belke and Kronen, 2016). One could also employ panel estimation methods or a global vector autoregressive model (Belke and Osowski, 2017).

In future research, one could include *additional variables* in the analysis, such as exports and imports (which are important and even show opposite signs in the Greek and the German case) and capital flows initiated by the shocks of uncertainty. Note again that our results, a negative sign of uncertainty for the GIIPS and a positive sign for EMU core countries, are compatible with a shift of investment from the periphery to the core countries. What is more, one may add global variables to the specifications of the underling national VARs in order to model international uncertainty spillovers (Belke and Osowski, 2017).

Finally, our paper focused upon a positive or negative sign of the uncertainty impact on macroeconomic variables. We could extend this line of research by also taking the third alternative to modelling the relationship between uncertainty and macroeconomic variables into account. For this purpose, one would have to model hysteresis under uncertainty effects (i.e., the "option value of waiting under uncertainty") explicitly in a *non-linear* framework (Belke and Goecke, 2005, Belke and Kronen, 2016).

Taking this outlook into account, this paper not only points to a number of fruitful avenues for further research, but also bears important policy implications regarding the pros and cons of diminishing political and financial uncertainty and the need for policy cooperation in the euro area.

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