To Be or Not to Be (in the EU):
The International Economic Effects of Brexit Uncertainty

Abstract

This paper evaluates the impact of Brexit-related uncertainty on the economies of the UK, EU, and the US. We propose a measure of Brexit uncertainty that has not been employed before in the literature. We first construct a binary variable by selecting Brexit-related events. We subsequently employ the Qual VAR model of Dueker (2005) to transform this variable to a continuous latent variable that captures uncertainty on important economic and financial variables. Next, this latent variable enters a structural Factor-Augmented Vector AutoRegression model combined with 452 macro and financial variables for the sample countries. Overall, our results indicate that the prolonged period of uncertainty, had a positive effect on the economies of major EU countries and negative effects for the UK economy. Additionally, UK is the most important net sender of uncertainty spillovers in the EU, while Germany and France are among the most important net receivers of uncertainty shocks.

JEL Classification: B22, E44, E65, G28
Keywords: Brexit, Uncertainty, spillovers, FAVAR, Qual VAR.

"Uncertainty is the only certainty there is…."[1]

John Allen Paulos
Mathematics Professor

1. Introduction

This paper evaluates the impact of a prolonged uncertainty generated by significant events on the economies of the countries involved. Our results indicate that when there is a significant policy shock it will be beneficial for the economy where the shock originates to design and implement measures to absorb the shock as quickly as possible. For instance, our results suggest that, for the period between the initiation of the public Brexit discussion and the electoral win of PM Johnson (2013-2019), the prolonged uncertainty about a potential Brexit had a positive effect on the economies of major EU countries like Germany and France and negative effects for the UK economy.

More specifically, we examine the uncertainty surrounding the UK exit from the EU (Brexit) on the UK, 12 European Union (EU), and the US economies for the period between 2013 and 2019. Brexit presents an ideal setting to investigate the impact of uncertainty on economic conditions; as Kierzenkowski et al. (2016) discuss, Brexit is considered as a significant negative shock that is expected to have an impact not only on UK economic conditions but also to other countries, especially other EU member states. They further point out that one of the potential short-term channels through which the shock can be transmitted, is increased economic uncertainty that will affect confidence and potential capital outflows, among others. For example, as can be seen in Figure 1, the impact of uncertainty may be inferred by the increased levels of

[1] See Paulos (2003).

economic policy uncertainty not only for the UK but also for other European countries. Figure 1 presents the evolution of the Economic Policy Uncertainty (EPU) index (Baker et al., 2016)[2] between 2000 and 2019: a visual inspection of the Figure clearly indicates that the uncertainty surrounding Brexit is higher even when compared with either the Lehman default (2008) and the global financial crisis or the EU financial crisis (2010 – 2012). Figure 2 presents country specific EPU indices for selected EU economies.

The contribution of the paper to the relevant literature is threefold. Firstly, we propose a measure of Brexit uncertainty that has not been employed before in the literature. Secondly, we focus on how uncertainty has affected EU economies so far, rather than making an attempt to predict the future impact of Brexit on the UK, EU, and US economies, an issue that has been addressed adequately by many other recent studies. Thirdly, in order to study the effect of the Brexit uncertainty variable on the sample economies, our latent variable enters a structural Factor-Augmented Vector AutoRegression (FAVAR) model (Bernanke et al., 2005) combined with 452 macro and financial variables for the sample countries; this way we are able to investigate the three main uncertainty transmission channels identified in the literature.

More specifically, we propose a measure of Brexit uncertainty that has not been employed before in the literature. Previous studies on uncertainty use mainly either an event study methodology that is based on specific dates of policy implementation and/or reform, or quantify uncertainty by building measures/indexes that are based on the frequency of appearance of specific keywords in the press or in official minutes.[3]

[2] For more details see: www.PolicyUncertainty.com.
[3] For example, Brogaard and Detzel (2015) use data from a main news source aggregator and words such as regulation, tax, among others, while Hansen et al. (2017) use FOMC minutes.

For instance, a very well-known news-based index, and widely used in the literature, is the Economic Policy Uncertainty Index (EPU) of Baker, Bloom and Davis (2016). Other studies use indicators to measure broader uncertainty, such as the volatility index of the Chicago Board Options Exchange (VIX) (Bloom, 2009; Caggiano, Castelnuovo, and Groshenny, 2014; Ferrara and Guérin, 2018), surveys based on agents' expectations (Popescu and Smets 2010; Bachmann, Elstner, and Sims, 2013), credit spreads (Fendoğlu, 2014) and estimated time-varying productivity (Bloom et al., 2013).

As regards to measures of Brexit uncertainty, there are several approaches. For example, Hassan et al. (2020) propose a general text-based method using natural language processing to estimate the impact of Brexit related uncertainty, while Graziano et al. (2018) identify monthly variation in exports; Graziano et al. (2020) use a prediction market-based variable. Bloom et al. (2018) use the Decision Maker Panel in August 2016, a representative business survey which collects information on many different aspects of uncertainty, while Steinberg (2017) investigates the impact of higher trade costs following Brexit implementing a dynamic model. Oehler et al. (2017) and Ramiah et al. (2017) use event studies, Belke et al. (2018) use policy uncertainty (the EPU Index), Schiereck et al. (2016) examine equity and CDS investor reaction to the referendum announcement day.

In this paper, we adopt a different approach. Since we are dealing with a prolonged uncertainty period with many significant related events, we first construct a binary variable by listing and selecting Brexit-related events according to their coverage in the front page of Financial Times (for a similar approach see also, Fratzscher et al. 2013, 2014; among others). Subsequently, we transform this variable to a continuous latent variable that captures Brexit-related uncertainty on important UK economic and financial variables. In order to do this, we employ the Qual VAR model of Dueker (2005) which produces a continuous latent variable that captures the propensity to Brexit uncertainty from a set of macroeconomic and financial variables and the binary variable based on the Brexit related events. We also construct this variable for every sample country (France, the Netherlands, Germany, Belgium, Austria, Sweden, Finland, Greece, Spain, Italy, Portugal, and Ireland) using local economic and financial variables. This latent variable is then included in a FAVAR model to enable us to identify the effects of Brexit related events on several financial and macroeconomic variables in EU and the UK. Thus, our approach captures the impact of uncertainty on many macro and financial variables.

We include the US as well in the analysis, since the US is not only the largest economy globally, but it is also one of the UK's most important economic partners and have strong economic ties; for instance, the UK is the 5th top destination of the US exports and the 7th top US partner, (see Campello et al., 2020). In addition, Brexit could potentially affect US interests in Europe. For example, Brexit could potentially affect the geopolitical position of the UK and reshape EU geopolitics (see for further discussion, among others, Oliver and Williams, 2016; Möller and Oliver, 2014).

Note that the Treasury[4] assesses, before the Referendum, the short-run uncertainty and instability that will result from a Brexit vote and finds that a Brexit vote will shock the UK economy and might affect unemployment and GDP, among others. The report

[4] HM Treasury analysis: the immediate economic impact of leaving the EU. Presented to Parliament by the Chancellor of the Exchequer by Command of Her Majesty, May 2016. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/524967/hm_treasury_analysis_the_immediate_economic_impact_of_leaving_the_eu_web.pdf.

points out that an important reason for the short-term impact is the uncertainty effect that may lead households and businesses to delay spending and investment decisions, among others. Here, we are more interested to examine the contemporaneous effect of Brexit uncertainty and how market participants and economic agents in the UK, the EU, and the US responded to this prolonged uncertainty period, since our sample covers events from the initial speech of PM Cameron's promising in/out referendum on EU (2013) up to the UK election (2019) and the election of PM Johnson.

Finally, in order to study the effect of the Brexit uncertainty variable on the sample economies, our latent variable enters a structural Factor-Augmented Vector AutoRegression (FAVAR) model (Bernanke et al., 2005) combined with 452 macro and financial variables for the sample countries (such as gross domestic product, consumption, gross fixed capital formation, unemployment, imports and exports, money supply, consumer price indexes, short and long term interest rates, economic sentiment indicators, credit default swaps, bonds, etc.). This way we can investigate the three main uncertainty transmission channels identified in the literature, i.e., investment, consumption, and financial markets (see for a discussion Prüser and Schlösser, 2019; among others). In addition, in order to test for potential spillover effects of Brexit uncertainty on other country-specific uncertainties in EU but also on the G7 economies we use the country-specific Economic Policy Uncertainty indices constructed by Baker et al. (2016) and employ the Spillover matrix introduced by Diebold and Yilmaz (2009, 2012).

[INSERT FIGURE 1 HERE]

[INSERT FIGURE 2 HERE]

Our findings indicate that, between 2013 and 2019, about 8.6% of the variance in UK GDP is explained by Brexit uncertainty. The respective percentages are 8.9% for Finland, 7.4% for Italy, 7% for Austria and 6.3% for Spain while for Greece, and Portugal has a moderate effect (5.7% for Greece, 5.1% for Portugal). The percentage of Gross Fixed Capital Formation (GFCF) variance explained by the variance of Brexit uncertainty is lower compared to GDP, with two notable exceptions: for France about 16.0% of the variance in GFCF is explained by the uncertainty variable, and for Italy 8.5%. The Brexit uncertainty explains 5% and 5.3% of the consumption variance for Spain and Italy respectively, while the variance proportions explained for Trade Balance, Economic Sentiment, Stock returns and CDS spreads are relatively lower for all the sample countries. In the case of the US economy, the results indicate a limited impact of Brexit uncertainty.

Impulse Response Functions (IRFs) from the FAVAR model indicate that an increase in Brexit related uncertainty seems to have had similar and positive results for the biggest EU economies while for the UK, the response is negative for all variables. More specifically, Brexit uncertainty increases real output activity in almost all sample countries with a more pronounced effect in Finland, Austria, Italy and Spain (which have the largest variance proportions explained by the Brexit uncertainty), while for the UK an increase in Brexit uncertainty causes a decrease in GDP. The response of the gross investment to an increase in uncertainty is positive and quite important for France and Italy, while the response of consumption for Spain and Italy is positive.

Our results are consistent with findings in both academic and professional[5] literature. Note also that we do not find significant effects on trade balance for the period under investigation, a result consistent with the argument of Kierzenkowski et al. (2016) who point out that trade will be affected after the formal exit of the UK from the EU. The rest of the paper is organized as follows. Section 2 discusses briefly previous studies, section 3 presents the data and the methodology, section 4 the results. Section 5 concludes the paper.

2. A Brief review of the relevant literature

The discussion on the impact of Brexit for the UK and the EU member states is ongoing, and probably it will take many years before one is able to quantify adequately the potential positive or negative economic effects, which still may differ depending on the issue discussed or the economic sector analyzed. For instance, Felbermayr et al. (2017) point out that although deviations from the standard of economic integration will result to economic losses and macroeconomic costs for all stakeholders, some sectors, such as the financial sectors in some EU members or the agri-food sector in the UK, may benefit. The most important economic issues involved, however, can be identified and have to do with international trade and potential trade restrictions with the EU market[6], the potential impact on the UK financial sector (which contributes significantly to the

[5] For example, in their Financial Times article "Brexit uncertainty drives investment boost for other EU countries" Valentina Romei and Gavin Jackson (JUNE 10, 2019) indicate that for the three years following the referendum, uncertainty about Brexit resulted in boosting capital investment in the EU by 43% up to 2019, while in the UK there has been a 30% decrease in investment (based on FDI Markets data). For more details see Financial Times, available at: https://www.ft.com/content/93c681ca-7c9c-11e9-81d2-f785092ab560.

[6] As Ramiah et al (2017), among others, point out, at the time of the Brexit referendum, approximately half of the goods exports from the UK are directed to the EU. For a more detailed recent discussion on the economic consequences and the interrelations of goods and services sectors between the UK and the EU see also Sampson (2017) and Felbermayr et al. (2017).

UK economy), the impact on real investment due to the prolonged negotiations on the final details of the Brexit deal, and changes in regulation (for further discussion see Ramiah et al., 2017; Sampson, 2017; Felbermayr et al., 2017).

Recent studies use a variety of models and methods to study the impact of Brexit on trade, income and investment; a widely used approach is simulations based on general equilibrium trade models (Sampson, 2017). For example, Steinberg (2019) employs the two scenarios of Dhingra et al. (2016) and a dynamic general equilibrium model and finds that only a small amount of the welfare costs for households in the UK is related to uncertainty; furthermore, the model predicts, among others, a minor impact on macroeconomic fundamentals. Hosoe (2018) employs a general equilibrium model and argues that tariff/nontariff barriers will lead to a reduction of bilateral trade between the UK and the EU. Reenen (2016) examines a multi-country and multi-sector general equilibrium model and finds that a welfare loss for the UK will not be offset by the proposed benefits, such as better trade deals with international partners. Breinlich et al. (2017) also document welfare losses due to inflation following the Brexit-induced drop in the value of the pound.

Oberhofer and Pfaffermayr (2021) use a panel data structural gravity approach and various scenarios to examine a longer-term effect on UK and EU trade and, among other, find that both UK exports and imports to and from the EU will decline, and that for the UK, international trade may not fully offset the reduced trade with the EU. Dhingra et al (2016) concentrate on income and trade and analyze the impact of Brexit on UK GDP in an optimistic and a pessimistic scenario. They find that the effect may be negative in both cases and their results also suggest that the reduction in trade will negatively affect other EU members. Graziano et al. (2018) also evaluate the effect on UK and EU trade flows of shocks to Brexit probability up to the 2016 referendum and find that as the Brexit probability increases, bilateral exports decrease, especially for products with higher risk of protection in case of a final disagreement in trade negotiations. In addition, Bruno et al. (2016) estimate that Brexit will reduce foreign direct investment towards the UK by approximately 22%, while Born et al. (2019) estimate that the output loss for the UK between 1.7% and 2.5% of GDP.

Other studies focus on the impact on financial markets. Ramiah et al. (2017) use an event study methodology to examine the effect of Brexit-related events on stock prices for different UK economic sectors. They find negative abnormal returns for sectors like travel, leisure and banking, and mixed results for other sectors. Oehler et al. (2017) also employ an event study and find that the Brexit referendum resulted in negative next-day abnormal stock returns, especially for listed firms that had a larger proportion of their sales in the UK rather than abroad. This result is consistent with the findings of Hill et al. (2019) who evaluate UK firm exposure to Brexit uncertainty and find evidence consistent with the notion that firms that are internationally diversified suffer a moderate effect and that high-growth firms are more sensitive to Brexit. Belke et al. (2018) study the impact of the uncertainty around Brexit on several financial markets. They use policy uncertainty (EPU) to proxy Brexit uncertainty in order to estimate interactions between uncertainty and financial market volatility, and the impact on equity returns, CDS spreads, interest rates and currencies. They find that uncertainty causes instability in financial markets. Schiereck et al. (2016) also examine equity and CDS investor reaction to the referendum and find that the negative financial market reaction was more significant even than the reaction to the Lehman Brothers default, a result more pronounced for EU bank stocks.

There are also a number of studies that focus on the uncertainty effects of Brexit. For example, Graziano et al. (2018, see above) argue that an increase in uncertainty will reduce export investments due to the increased value of the waiting option and empirically evaluate export elasticity to the uncertainty surrounding Brexit. Smales (2017) argues that there exists well-defined relationship between financial market uncertainty and political uncertainty and finds that financial market implied volatility in the UK and Germany increases with increasing uncertainty about the polling result. In addition, Biljanovska et al. (2017) examine economic policy uncertainty spill-over effects on other countries' economic activity and find that economic policy uncertainty decreases real output growth and private consumption and investment, while Meinen and Röhe (2017) focus on the four largest euro-area countries and find pronounced negative investment responses to uncertainty shocks.

3. Data and Methodology

3.1 Brexit Uncertainty Measure: Building the Binary Variable

As discussed in the introduction, our Brexit Uncertainty Measure is a continuous latent variable that captures Brexit-related uncertainty. To build this latent variable we initially construct a binary variable as follows: for the period between January 2013 to September 2019, we first identify significant Brexit-related events leading to the UK's exit from the EU, based on the timeline suggested by Walker (2020). Then, from these events, we select the events that were covered in the front page of Financial Times (US edition) on the following day (a similar selection procedure is followed in Fratzscher et al. 2013, 2014; among others). Next, from the events that appeared in the front page we keep and include in our dummy variable only events that appear as *Headline Article*s in the Financial Times (FT) front page. This is done to alleviate the concern that events were not important enough to affect markets or were simply “no news” (not unexpected). Appendix A presents the chronology of Brexit-related events that we employ in this paper, as well as the events selected for our binary variable (17 event dates, see last column). The Appendix also presents the changes in the VIX index, the changes of the FTSE100 volatility, and the change in the effective exchange rate change (Sterling/$), for the respective dates.

3.2 Brexit Uncertainty Measure: A Qual VAR approach

In order to construct the Brexit uncertainty variable, we use the Qual VAR model introduced by Dueker (2005). The Qual VAR features as a single-equation dynamic ordered probit model (Eichengreen et al. 1985; Dueker, 1999) and by using Markov Chain Monte Carlo (MCMC) techniques allows the derivation of the latent variable; thus we are able to transform the binary variable discussed above and generate a continuous latent variable which can be then included as an endogenous factor in the VAR system with the only variable needed to generate multi-step forecasts being the dependent’s historical path (see also, Galariotis et al. 2018, Krokida et al. 2020, Meinusch and Tillmann, 2016; Assenmacher-Wesche and Dueker, 2010; Tillmann, 2015; Bordo et al. 2008; Amstad et al. 2008).

More specifically, denote as y^* the latent variable (autoregressive process of order ρ) depending on constant δ, a set of explanatory variables X_{t-P} (lagged), and its own lagged values, as illustrated in equation (1) below. In (1) φ and β are vectors of coefficients and e_t is the random error term from a standard normal distribution;

$$y_t^* = \delta + \sum_{l=1}^{\rho} \varphi_l y_{t-l}^* \sum_{l=1}^{\rho} \beta_l X_{t-l} + e_t, \qquad e_t \sim N(0,1). \tag{1}$$

In (1), *t* is the time index, y_t is a binary variable takes the value of one when a Brexit related event occurs in period *t* and the value of zero otherwise. The variable y_t appears as follows:

$$y_t = \begin{cases} 0 & if\ y_t^* \leq 0 \\ 1 & if\ y_t^* \geq 0 \end{cases} \tag{2}$$

The dynamics of *k* regressors are expressed by the 2nd component of the model (VAR (ρ) process):

$$Y_t = \mu + \sum_{l=1}^{\rho} \Phi^l\, Y_{t-l} + \nu_t, \qquad \nu_t \sim N(0, \Sigma) \tag{3}$$

In (3) $Y_t = (X_t, y_t^*)'$ is a k ×1 vector, while $k - 1$ time series of observations (we use macroeconomic and financial data) constitute X_t. y_t^* complements a vector of the latent variable, μ is a k ×1 vector of constants, ν_t is the k ×1 error vector, while Σ is the covariance matrix of errors. The VAR coefficients are:

$$\Phi^l = \begin{bmatrix} \Phi_{XX}^{(l)} & \Phi_{Xy^*}^{(l)} \\ \Phi_{y^*X}^{(l)} & \Phi_{y^*y^*}^{(l)} \end{bmatrix} \tag{4}$$

In the estimation of the system MCMC techniques and Gibbs Sampling are used (see Dueker, 2005; Assenmacher-Wesche and Dueker, 2010). In order to estimate the mean and variance of the latent variable we employ Kalman Smoothing, an iterative algorithm that generates the draws, while OLS coefficients estimates and initial values (given the binary data of the Brexit events) are employed to generate the latent variable, y_t^* [7].

Finally, we estimate the VAR model, by including the sampled time series of the latent variable and the OLS estimates of Φ and Σ (denoted, respectively, as $\hat{\Phi}$ and $\hat{\Sigma}$). This information together with the assumed Jeffrey's prior define the OLS covariance, i.e., a draw with (*T*-*k*) d.f., with *T* the number of observations. Σ is the result of the inverted Wishart distribution:

$$\Sigma \sim IW\left\{\left(\left(T\hat{\Sigma}\right)^{-1}, T - k\right\}\right. \tag{5}$$

In (5), k is the number of variables $((T\hat{\Sigma})^{-1})$, while the variance of (y_t^*) is unity. This way we equally adjust the suitable element in Σ and in the relevant columns we normalize the other elements. The OLS mean estimates are then added to a multivariate Normal distribution draw where the covariance matrix is the Kronecker product. Given Σ, the draws for Φ are obtained from:

[7] The y_t^* is drawn from the truncated Normal distribution for each period, based on the 1st and 2nd moment.

$$\Phi \sim N\left\{\widehat{\Phi}, \Sigma \otimes (Y'Y)^{-1}\right\} \quad (6)$$

We use 10,000 iterations for the Gibbs sampling, and remove the first 5,000 iterations to allow for posterior distribution (Dueker, 2005). We reject coefficient draws that do not satisfy stationarity and resample from the resulting sample in order to obtain (y_t^*) and the VAR coefficients. The binary index in the Qual VAR system is entered as $y_t\{0, 1\}$ and together with the rest of the variables in the X_t vector is employed for the derivation of the latent tendency of Brexit-related uncertainty (y^*). The model is estimated in first differences and for the ordering of variables we follow the order introduced by Baker et al. (2016) listing first the uncertainty, followed by the stocks and the macroeconomic variables. In order to overcome the issue of lag length criteria not being defined for binary data, we use three lags in the Qual VAR framework assuming three lags are sufficient enough for our sample period, since our analysis includes detrended growth rates and logarithmic differences (Krokida et al. 2020, Galariotis et al. 2018; Meinusch and Tillmann, 2016; Tillmann, 2016; Chen et al. 2017).[8]

For the empirical estimation we use monthly observations for variables that capture business cycle conditions, stock market conditions, and economic expectations (see also, Baker et al. 2016; Hardouvelis et al., 2018) in the UK. More specifically, we use industrial production excluding Construction (*IP*), stock market returns (*Sr*), unemployment rate (*Ur*), the Economic Sentiment Indicator (*ESI*), and sterling

[8] This also allows for well- behaved residuals and also helps in limiting the issue of instability and dimensionality for MCMC estimation (Krokida et al. 2020; Chen et al. 2017).

volatility (*SV*), which according to the Bank of England captures the political and business cycle uncertainty.[9] Since we are using a Cholesky decomposition, the ordering of the variables is important. The ordering we adopt is according to Baker et al. (2016) and Hardouvelis et al. (2018) and appears as follows: y^*, sterling volatility, stock returns, unemployment rate, industrial production and economic sentiment. As a robustness test we also use alternative orderings and the results remain qualitatively similar. All data cover the period between January 2013 and September 2019 and are obtained from Thomson Reuters Eikon and Bloomberg. The resulting continuous latent variable (y^*) is presented in Figure 3 and captures the Brexit uncertainty generated from UK macro and financial variables and the dummy variable; the Brexit related events are reflected with the shaded areas. In addition, Figure 4 presents the resulting continuous latent variable (y^*) when country-specific (instead of UK) macro and financial variables are employed for each one of the EU countries in our sample to construct the Brexit uncertainty generated from the dummy variable (see below for a discussion).

[INSERT FIGURE 3 HERE]

[INSERT FIGURE 4 HERE]

3.3 The Effect of Brexit uncertainty on UK and EU: A FAVAR Approach

Since uncertainty affects many economic activities and different economic sectors the proper empirical approach to study the effect of Brexit uncertainty should combine as many informative economic activity variables as possible for our sample countries, i.e.,

[9] See Bank of England, Monetary Policy Report, November 2019. https://www.bankofengland.co.uk/-/media/boe/files/monetary-policy-report/2019/november/monetary-policy-report-november-2019.pdf.

the aim here is to combine a very large dataset of macroeconomic and financial monthly variables from many different countries and then investigate for the main transmission channels of uncertainty in UK and EU economies. One such approach is the use of the structural Factor-Augmented Vector AutoRegression (FAVAR) model, which is quite advantageous as it combines the standard VAR analysis with factor analysis, while by including a large number of informative macroeconomic and financial series allows us to deal with the potential omitted variable issue, often encountered in standard VAR modeling. The model is introduced by Bernanke, Boivin and Eliasz (2005) and a large body of empirical literature has investigated large-scale VAR systems, such as FAVAR and Global VAR models (Bernanke et al., 2005; Mumtaz and Surico, 2009; Mumtaz, 2010; Liu et al., 2014; Chang and Kwak, 2017; Lutz, 2015; Gabriel and Lutz, 2015; Boivin and Giannoni, 2008; Belke and Osowski, 2018; among others).

More specifically, the FAVAR procedure employed in this paper allows us to create a large model using a total of 452[10] EU country specific macroeconomic and financial variables such as industrial production, unemployment, consumer price indices, exchange rates, GDP, consumption, gross fixed capital formation, short and long-term interest rates, money supply, main stock price indexes, economic and consumer confidence/sentiment indicators, trade balance, bond spreads, Credit Default Swap spreads[11] among others. We also include several global variables such as oil prices, S&P 500 Composite Index, VIX-CBOE volatility index, ECB Commodity price index

[10] We limit our time series to 452 since to have a balanced panel we had to match all country specific variables included in the sample.
[11] The Greek CDS spread is not included due to unavailable observations during the sample period.

and euro-area variables such as the EUROSTOXX 50, EU to UK exchange rate, the Euribor, the EU industrial production, etc.[12]

The FAVAR model is estimated with a two-step principal component[13] analysis (see, Bernanke et al. 2005; Boivin et al., 2009) including the latent continuous variable capturing the UK Brexit uncertainty derived from the Qual VAR model estimated above (Krokida et al. 2020, Galariotis et al. 2018). Cubic spline interpolation was used in order to disaggregate quarterly series to monthly (see, among others, Bernanke et al. 1997; Lescaroux and Mignon, 2009). All variables are transformed to induce stationarity except for rates. All variables used to estimate the factors are standardized in order to alleviate the deal with the factor extraction issue arising when dealing with different time series scales. Appendix B presents the variables employed in the FAVAR modelling.

To illustrate, $N \times 1$ is a vector of macroeconomic variables X_t, and we assume that economic and capital market conditions are affected by a $K \times 1$ vector of unobserved factors (F_t). We next suppose that an observed factor R_t exists such that:

$$C_t = \begin{bmatrix} F_t \\ R_t \end{bmatrix} \tag{12}$$

[12] Global shocks might affect the EU economy. For example, previous studies include global variables in their EU FAVAR specifications (see, Galariotis et al., 2018; Krokida et al., 2020) such as oil prices, the S&P 500 Composite Index, VIX-CBOE volatility index, ECB Commodity price index. Also, Soares (2013) includes foreign variables, and Blaes (2009) encompasses a number of foreign and global variables.

[13] The FAVAR model with two principal components was chosen instead of the Bayesian FAVAR model. Both models are introduced by Bernanke, Boivin and Eliasz (2005), who indicate that the results of the former model in their study seem more reasonable.

Using Principal Components Analysis (PCA) the observation equation is estimated:

$$X_t = \Lambda^f F_t + \Lambda^r R_t + e_t \tag{13}$$

In (13) Λ^f, is the $N \times K$ matrix of factor loadings, Λ^r is the $N \times 1$ vector of factor loadings, and e_t is the $N \times 1$ vector of (zero mean) error terms. Then, we evaluate the standard VAR with the C_t as:

$$C_t = \Phi(L) C_{t-1} + u_t \tag{14}$$

In (14) $\Phi(L)$ is the finite order matrix of lag polynomials.

In the results section, we present Forecast Error Variance Decompositions (FEVDs) and Impulse Response Functions (IRFs) from the model. We use Cholesky ordering, with Brexit uncertainty last in the ordering $[F_t, y^*]$ since we assume that uncertainty shocks impact the unobserved factors, F_t, with a lag (Popp and Zhang, 2016). Nevertheless, we do not impose this assumption to all the variables in our setting. For that reason, we split our variables in X_t to slow-moving and fast moving (Bernanke et al., 2005). Fast moving variables are assumed to respond contemporaneously to uncertainty shocks while slow variables do not. In order to recover orthogonal shocks, we use the common in the literature ordering of Baker et al. (2016) listing the uncertainty first.[14] Thus, we consider all variables as fast moving by responding contemporaneously to Brexit uncertainty, except the global variables, since, according

[14] Other studies that also consider the uncertainty first in the ordering are those of Born et al. (2019), Prüser and Schlösser (2018), Popescu and Smets (2010), Hardouvelis (2018), among others.

to Favero and Giavazzi (2008), shocks hitting the Euro-area induce no contemporaneous effects on the US variables. Consequently, the US and global variables are ordered first in our vector and thus are considered as slow-moving to Brexit uncertainty shocks. In the FAVAR estimation we use three lags and employ three factors according to Bernanke et al. (2005). Note that Bai and Ng (2002) propose a criterion for the number of factors selection; nevertheless, we follow Bernanke et al. (2005) who suggest exploiting the sensitivity of the results to alternative factor numbers.[15]

4. Results

4.1 Variance Decomposition Analysis

Table 1 presents the Variance Decomposition Analysis results from the FAVAR model and is organized as follows: the first column presents the sample countries, the second and the third column present the variance decomposition (i.e. the fraction of variance of forecast error explained by a Brexit uncertainty shock) and the R^2 (the fraction of variance explained by the common factors) of the model for the Gross Domestic Product (*GDP*), the fourth and the fifth column present the variance decomposition and the R^2 for the Gross Fixed Capital Formation (*GFCF*), the sixth and the seventh column for Trade Balance (*TB*), the eighth and the ninth column for the Economic Sentiment Indicator (*ESI*), the tenth and eleventh for Consumption (*CONS*), the twelfth and thirteenth for Stock returns (*STOCK*) while the fourteenth and fifteenth columns for Credit Default Swaps spreads (*CDS*).

[15] Note that our results are not sensitive to adopting five or more factors and using different lag length such as one or two (due to the limited time period of our sample we retain as max lag the three lags).

For example, as can be seen from the Table, about 8.6% (0.086) of the variance in UK *GDP* is explained by the Brexit uncertainty variable (R^2= 38.5%), about 8.9% for Finland (R^2= 37.3%), about 7.4% for Italy (R^2= 45%), about 7% for Austria (R^2= 28.1%), about 6.3% for Spain, (R^2= 46.9%), about 5.7% for Greece (R^2=17.7%), about 5.1% for Portugal (R^2= 22.7%). For Germany and France, the percentages are lower; about 2.3% for Germany, (R^2= 21.1%) and about 3.3% for France (R^2= 12.6%). As regards to the gross fixed capital formation (*GFCF*) variance, the percentage explained by the Brexit uncertainty variable is lower compared to *GDP*, with two notable exceptions: for France about 16.0% of the variance in *GFCF* is explained by the uncertainty variable (R^2= 34.5%), and for Italy 8.5% (R^2= 38.6%). The respective percentages for Trade Balance and the *ESI* are lower compared to the percentages obtained for *GDP*. Moreover, Brexit uncertainty explains 5% (R^2= 36.8%) of the consumption variance for Spain and 5.3% (R^2= 38.5%) of the consumption variance for Italy while the rest of the countries' proportions explained remain relatively lower. The variance proportions for Stock returns (*STOCK*) and Credit Default Swaps spread explained by the Brexit uncertainty are relatively low for all the countries of the sample. The R^2 coefficients indicate that the common factors explain a sizable fraction in most cases in *GDP*, *GFCF* and Stock returns variables, partly in consumption (in Spain and the Netherlands) - but less in *TB*, *ESI* and *CDS* -, thus revealing that important business cycle dynamics are captured by the FAVAR approach employed.

[INSERT TABLE 1 HERE]

4.2 Impulse Response Functions

Figures 5 to 11 present the Impulse Response Functions (IRFs), i.e. the response to a 1 standard deviation positive shock in the Brexit uncertainty variable (an increase in uncertainty), resulting from the FAVAR modelling for Gross Domestic Product (*GDP*), Gross Fixed Capital Formation (*GFCF*), Trade Balance (*TB*) and the Economic Sentiment Indicator (*ESI*), Consumption (*CONS*), CDS spreads (*CDS*) and Stock returns (*STOCK*), respectively, for all the sample countries. For example, as can be seen from Figure 5, the response of *GDP* to a positive shock in the Brexit uncertainty variable is positive for Spain, Portugal, Italy, Netherlands, Greece, France, Finland, Belgium, Austria; that is for all countries except the UK (for which it is negative and remains significant until the end of the horizon). In Sweden after 5 months the response to the uncertainty shock turns to negative, in Ireland there is a negative response during the first two months while in Germany there in a positive response during the first 8 months which then turns negative and remains significant until the end of the horizon depicted here. Overall, for Finland, Austria, Italy, and Spain (which have the largest percentages of variance explained), an increase in Brexit uncertainty causes an increase in *GDP*, while for the UK (8.6% in variance decomposition) an increase in Brexit uncertainty causes a decrease in *GDP*.

The response of the Gross Fixed Capital Formation to an increase in uncertainty (Figure 6) is positive for all countries, except for Spain, Ireland, and Sweden. Note that for France and Italy, where the proportion of variance explained after an uncertainty shock is important (variance decomposition equal to 16% and 8.5%, respectively, see Table 1) the response of gross investment is positive, indicating that an increase in Brexit uncertainty could cause an increase in gross investment. For France, the increase in gross investment remains significant for the whole horizon, while for Italy for almost 20 months. Almost all countries face a negative response of Trade Balance during the first 5 months (Figure 7), however, after the first 5 months for most of the countries (Ireland, France, Italy, Netherlands, and Finland) the response becomes positive, expect for the UK which remains negative for almost 20 months. The response of the Economic Sentiment Indicator (ESI) to an increase in uncertainty appears positive only for France and Finland (Figure 8). Nevertheless, as indicated by the variance decompositions, for both Trade Balance and Economic sentiment the proportion of the variance explained by Brexit uncertainty appears low for all the countries of the sample.

The response of consumption to an increase in Brexit uncertainty appears positive for all countries except for Sweden and the UK for which it turns negative during the first 5 months; nevertheless, for Spain and Italy (which have the largest proportion of variance explained; 5% and 5.3%, respectively), the response appears positive, indicating that an increase in Brexit uncertainty could cause an increase in consumption. For stock returns and CDS spreads the pattern appears similar for all countries; stock prices decrease in the first three months after the uncertainty shock and then turn positive, while CDS spreads increase (except for Austria) during the first 3-4 months and then turn to negative. Overall, the variance decompositions reveal only small fractions explained by the Brexit uncertainty for Stock returns and CDS spreads for all countries of our sample.

The interesting result that emerges from this analysis is that, between 2013 and 2019, an increase in Brexit related uncertainty seems to have had significant and negative effects for the UK economy while at the same time it had an overall significant and positive effect to most of the countries in the sample; suggesting Brexit uncertainty spillovers to the EU. The overall impact to most of the countries is recorded on domestic activity, while the strongest impact on gross investment is observed for France and Italy, suggesting that the major transmission channels of Brexit uncertainty are real output/domestic activity and investment; a moderate impact on consumption (in Spain and Italy) and a quite weak impact on financial variables – CDS spreads and Stock returns- is observed.

[INSERT FIGURE 5 HERE]

[INSERT FIGURE 6 HERE]

[INSERT FIGURE 7 HERE]

[INSERT FIGURE 8 HERE]

[INSERT FIGURE 9 HERE]

[INSERT FIGURE 10 HERE]

[INSERT FIGURE 11 HERE]

4.3 The effects on US economy

In this section, we repeat the analysis in order to study the uncertainty effects on the US economy. More specifically, for the US FAVAR model we include 112 macro and financial variables[16] and use (as in the EU specification) 3 factors and 3 lags. The

[16] The format used is according to Stock and Watson (2002). We use as measure of economic sentiment the Michigan Consumer Sentiment Indicator and as stock returns the returns of S&P500. We do not include in our sample the Baker and Wurgler (2006) and Baker and Wurgler (2007) Sentiment Index, Investors Intelligence, Net Exchange Between Stock and Bond Mutual Funds, Average Hourly Earnings of Production, and Nonsupervisory Employees: Manufacturing and US employees on nonagricultural payrolls, due to data limitations. We add to the sample in order to monitor the effect on, the Real Gross Domestic Product, Gross Fixed Capital Formation, Trade Balance, and the US 5yr CDS spread. Transformations of our FAVAR specifications are as in Bernanke et al. (2005), Stock and Watson (2005).

Cholesky ordering assumption we use here is according to Baker et al. (2016), but, since our aim is to find the effect of an external source of uncertainty, and according to Favero and Giavazzi (2008)[17] who argue that the US block is not effected contemporaneously by foreign shocks, we place the UK Brexit uncertainty variable last in the ordering. Nevertheless, since the ordering of variables used prohibits foreign shocks originating from the Euro-area uncertainty having a contemporaneous effect on the US block, and thus ex ante limits the exploitation of a potential transmission channel (Fontaine et al. 2017), we also run the model by listing the Brexit uncertainty first.[18] The results remain qualitatively the same and are presented in Table 2.

As can be seen from Table 2, the results of the forecast error variance decompositions indicate that there is no significant effect on the US economy, since in both specifications, the fraction of the variable variance explained by a Brexit uncertainty shock is low. In the first specification, when we assume that a foreign uncertainty shock cannot affect contemporaneously the US block, the fraction of consumption explained by the shock is 9.5% but with a low R^2 equal to 11.8%. The effect disappears when using the assumption that the foreign uncertainty can impact contemporaneously the US block. Figure 12 presents the Impulse Response Functions (IRFs) and, as can be seen from the Figure, almost all responses of the macro and financial variables are negative to a Brexit uncertainty shock, except for the S&P500 response which turns positive after one month. Note that, in order to save space, we only report the IRFs of the first ordering specification, however, the results from the IRFs of the second ordering specification are qualitatively similar and are available upon request. These

[17] Colombo (2013) suggests that the US uncertainty can affect contemporaneously the EU uncertainty, but not the other way around.
[18] See Caggiano, Castelnuovo, and Groshenny (2014), Bloom (2009).

results are not surprising, in the sense that direct trade links are rather small[19] and trade negotiations and decisions will take place after the actual departure of the UK from the EU and will depend on how close the former will remain on the latter.

[INSERT TABLE 2 HERE]

[INSERT FIGURE 12 HERE]

4.4 Robustness Tests

The results presented so far are obtained with the latent uncertainty variable constructed employing the binary variable and UK macroeconomic and financial variables, as discussed above. In order to test the robustness of the results, we also create an aggregate EU Brexit uncertainty variable by employing a separate Qual VAR model for each EU sample country and estimate country specific latent propensity for Brexit uncertainty. Together with the UK latent variable used previously in our estimation we employ Principal Component Analysis (PCA) and generate the first principal component of all sample country specific latent propensities (see Figure 4). Next, we re-estimate the FAVAR model as above but instead of using the UK y^* we now use the newly constructed EU y^* variable.[20]

The results are presented in Table 3, which is organized as in Table 1 above. As we can see from the Table, about 11.4% of the variance in UK *GDP* is explained by the Brexit

---

[19] For example, in 2019 the US trade in goods with the UK amounted to approximately $69 billion of exports and approximately $63 billion in imports (US Census Bureau available at: https://www.census.gov/foreign-trade/balance/c4120.html), while the US GDP stood at approximately $21 trillion (World Bank: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=US).

[20] The results obtained from the US FAVAR model remain qualitatively the same when using the EU based Brexit uncertainty variable (available upon request).

uncertainty variable (R^2= 36.9%), about 5.5% for Finland (R^2= 41.8%), about 5.9% for Italy (R^2= 46.5%), about 6.3% for Austria (R^2= 28.1%), about 4.9% for Spain, (R^2= 45.8%), about 6.6% for Greece (R^2=17.5%), about 4.1% for Portugal (R^2= 22.1%), while less and about 1.9% for Germany, (R^2= 22%) and about 2.8% for France (R^2= 12.9%), etc. As regards to the capital formation (*GFCF*) variance, the percentage explained by the variance in the Brexit uncertainty variable is lower compared to *GDP*, with the two notable exceptions appearing here as well: for France about 12.6% of the variance in *GFCF* is explained by the uncertainty variable (R^2= 36.0%), and for Italy 7.3% (R^2= 38.3%). The variance decomposition for consumption shows that there is a moderate effect of 4.3% (R^2=36.5%) and 4.1% (R^2=38.1%) in Spain and Italy, respectively. The respective percentages for *Trade Balance*, *ESI*, *Stock returns* and *CDS* spreads are lower compared to the percentages observed in the other variables. In other words, the results are qualitatively similar to the results presented in Table 1.

As a further robustness test, we re-built the Brexit uncertainty variable by including in the binary variable not only events that were covered as Headline Articles, but also events that appeared in the front page not as Headline articles but as title with main text (second top article with text denoted as Title/Text in Appendix A). This results to 23 events instead of the original 17. We re-estimate the Qual VAR models with the new binary variable and re-construct the Brexit uncertainty measure. After estimating the FAVAR models with the new uncertainty variables the results discussed above remain qualitatively the same (available upon request).

As a further test, we use the methodology of Diebold and Yilmaz (2009, 2012) in order to produce the "generalized" decomposition of the variance - which is not sensitive to ordering. In addition, we replace our Brexit-uncertainty variable with the Economic Policy Uncertainty Index (*EPU*)[21] and the Brexit-EPU index, i.e., a measure based on newspaper articles regarding policy uncertainty (see Baker et al., 2016) that scales the *EPU* index by the share of *EPU* articles that also contain the terms "Brexit", "EU" or "European Union" (*source*: www.PolicyUncertainty.com). Furthermore, we test for uncertainty spillovers not only for the EU but also for G7 economies (Canada, France, Germany, Italy, Japan, UK and US). The results are presented in Tables 4 (EU) and Table 5 (G7). In the Spillover Connectedness matrix, the "Contribution to others" row and "From Others" column show the aggregate impact of shocks sent to and received from, respectively. A lag order of one was selected according to the Schwartz and Hannan-Quinn information criteria.

The results from the EU countries spillover matrix (Table 4) indicate that during the period between January 2013 to September 2019, the UK was the most important net sender of uncertainty shocks (63.2 and 121.9 including its own shock) suggesting significant uncertainty spillover effects to the other EU countries; at the same time, Germany, France, and the UK were the most important net receivers of uncertainty shocks. From 2013 to 2019 the UK Economic Policy Uncertainty appears to be in its highest levels and well above all the other EU country specific *EPU*s (see Figure 2). The results from the G7 countries spillover matrix (Table 5) indicate that even among the biggest economies of the world, the UK still remains a very important sender of uncertainty shocks (67.1), with a contribution almost as high as Japan (68.6). Quite

[21] The *EPU* index is available only for 9 of the 13 EU countries we include in our analysis. All country-specific constructed *EPU* indices follow the newspaper-based method in "Measuring Economic Policy Uncertainty" of Baker et al (2016). The *EPU* index for Greece is constructed by Hardouvelis, Karalas, Karanastasis and Samartzis (2018), for Ireland by Zalla (2016), for the Netherlands by Kroese, Kok and Parlevliet (2015), for Spain by Ghirelli, Perez, and Urtasun (2019) and for Sweden by Armelius, Hull, and Köhler (2017). For more details see: www.PolicyUncertainty.com.

interesting is also the finding that the US is an important receiver of uncertainty spillover shocks (56.9) following Germany (62.6) and France (57.5).

[INSERT TABLE 4 HERE]

[INSERT TABLE 5 HERE]

5. Conclusion

This paper evaluates the impact of the uncertainty surrounding Brexit on the UK, 12 European Union (EU), and the US economies for the period between 2013 and 2019. Our sample covers events such as the initial speech of PM Cameron's promising in/out referendum on EU (2013) up to the UK election (2019) and the election of PM Johnson. We propose a measure of Brexit uncertainty that has not been employed before in the literature. We combine standard event study methodology and Qual VAR modelling (Dueker, 2005) to build a continuous latent uncertainty variable that captures the propensity to Brexit uncertainty from a set of macroeconomic and financial variables. We also construct this variable not only for the UK but also for every sample country (France, the Netherlands, Germany, Belgium, Austria, Sweden, Finland, Greece, Spain, Italy, Portugal and Ireland) using local economic and financial variables. Unlike many previous studies, that focus on and attempt to predict the impact of Brexit on future economic conditions, we examine how the prolonged uncertainty about Brexit has affected economic conditions thus far. Overall our results indicate that the prolonged uncertainty about a potential Brexit had a positive effect on the economies of major EU countries like France, Spain and Italy and negative effects for the UK economy. Domestic activity and gross investment seem to be importantly affected while there is a weaker effect on financial variables and economic sentiment. No effect from the Brexit uncertainty was detected on the US economy. The main implication for policy makers and other agents in a country where a significant policy shock is generated is that it is beneficial for the economy to design and implement measures that absorb the shock as quickly as possible.

References

Amstad, M., Assenmacher-Wesche, K., Dueker, M., 2008. "Forecasting macroeconomic variables with a categorical latent variable based on the ISM index. Unpublished, Swiss National Bank.

Armelius, H., Hull, I., Köhler, H.S., 2017. "The Timing of Uncertainty Shocks in a Small Open Economy." *Economics Letters* 155, 31-34.

Assenmacher-Wesche, K., Dueker, M., 2010. "Forecasting macro variables with a qual var business cycle turning point index." *Applied Economics* 42, 2909–2920.

Bai, J., Ng, S., 2002. "Determining the number of factors in approximate factor models." *Econometrica* 70, 191-221.

Baker, S.R., Bloom, N. and Davis, S.J., 2016. "Measuring economic policy uncertainty." *The Quarterly Journal of Economics* 131, 1593-1636.

Baker, M., Wurgler, J., 2006. "Investor sentiment and the cross-section of stock returns." *Journal of Finance* 61, 1645–168.

Baker, M., Wurgler, J., 2007. "Investor sentiment in the stock market. Journal of Economic Perspectives, 21(2), 129–151.

Belke, A., Dubova, I., Osowski, T., 2018. "Policy uncertainty and international financial markets: the case of Brexit. " *Applied Economics* 50, 3752-3770.

Belke, A., Osowski, T., 2018. "International Effects of Euro Area versus U.S. Policy Uncertainty: A FAVAR Approach." *Economic Inquiry* 57, 453-481.

Bernanke, B. S., Boivin, J., Eliasz, P., 2005. "Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach." *The Quarterly Journal of Economics* 120, 387-422.

Bernanke, B., Gertler, M., Watson, M., 1997. "Systematic monetary policy and the effects of oil price shocks." *Brookings Papers on Economic Activity*, no. 1, 91-157.

Biljanovska, N., Grigoli, F., Hengge, M., 2017. "Fear Thy Neighbor: Spillovers from Economic Policy Uncertainty." *International Monetary Fund, Working Paper* No.17/240.

Blaes, B. 2009. Money and monetary policy transmission in the euro area: evidence from FAVAR and VAR approaches, Discussion Paper No. 18 (Series 1), July, Deutsche Bundesbank.

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

Bloom, N., Floetotto, M., Jaimovich, N., Saporta-Eksen, I., Terry, S. J. (2013). "Really Uncertain Business Cycles." CEP Discussion Paper No. 1195

Bloom, N., Bunn, P., Chen, S., Mizen, P., Smietanka, P., Thwaites, G., Young, G. (2018). "Brexit and uncertainty: insights from the Decision Maker Panel." *Fiscal Studies* 39, 555-580.

Boivin, J., Giannoni, M. P., Mojon, B., 2008. "How has the Euro changed the monetary transmission?" *National Bureau of Economic Research, NBER*, No. w14190.

Boivin, J., Giannoni, M. P., Mihov, I., 2009. "Sticky prices and monetary policy: Evidence from disaggregated US data." *The American Economic Review* 99, 350-384.

Bordo, M. D., Dueker, M. J., Wheelock, D. C., 2008. "Inflation, monetary policy and stock market conditions." *National Bureau of Economic Research, NBER*, No. w14019.

Born, B., Muller, G. J., Schularick, M., Sedlacek, P., 2019. "The Costs of Economic Nationalism: Evidence from the Brexit Experiment." *The Economic Journal* 129, 2722–2744.

Breinlich, H., Leromain, E., Novy, D., Sampson, T., 2017. "The Consequences of the Brexit Vote for UK Inflation and Living Standards: First Evidence." Centre for Economic Performance (CEP) Brexit Analysis No. 11 "

Brogaard, J., Detzel, A.L., 2015. "The Asset Pricing Implications of Government Economic Policy Uncertainty." *Management Science* 61, iv-vi, 1-247.

Bruno, R.L., Campos, N.F., Estrin, S., Tian, M.,2016. "Foreign Direct Investment and the Relationship Between the United Kingdom and the European Union." Centre for Economic Performance (CEP) Discussion Paper No 1453.

Caggiano, G., Castelnuovo, E., Groshenny, N., 2014. "Uncertainty shocks and unemployment dynamics in U.S. recessions." *Journal of Monetary Economics* 67,78–92.

Campello, M., Cortes, G., d'Almeida, F., Kankanhalli, G., 2020. Global effects of the Brexit referendum: evidence from US corporations. NBER Working Paper.

Chen, H., Chow, K.K., Tillmann, P., 2017. "The effectiveness of monetary policy in China: Evidence from qual VAR." *China Economic Review* 43, 216-231.

Colombo, V., 2013. "Economic policy uncertainty in the US: Does it matter for the Euro Area?" *Economics Letters* 121, 39-42.

Dhingra, S., Ottaviano, G.I.P., Sampson, T., Reenen, S., 2016. "The consequences of Brexit for UK trade and living standards." Centre for Economic Performance (CEP) Brexit Analysis No. 2, London School of Economics, available at: eprints.lse.ac.uk.

Diebold, F., Yilmaz, K., 2009. "Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets." *Economic Journal* 119, 158-171.

Diebold, F., Yilmaz, K., 2012. “Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers.” *International Journal of Forecasting* 28, 57–66.

Dueker, M., 1999. “Conditional heteroscedasticity in qualitative response models of time series: A Gibbs-sampling approach to the bank prime rate.” *Journal of Business & Economic Statistics* 17, 466-472.

Dueker, M., 2005. “Dynamic forecasts of qualitative variables: a Qual VAR model of US recessions.” *Journal of Business & Economic Statistics* 23, 96-104.

Eichengreen, B., Watson, M. W., Grossman, R. S., 1985. “Bank rate policy under the interwar gold standard: a dynamic probit model.” *The Economic Journal* 95(379), 725-745.

Favero, C. A., Giavazzi F., 2008. “Should the Euro Area Be Run as a Closed Economy?” *American Economic Review* 98, 138-145.

Felbermayr, G., Fuest, C., Gröschl, J.K., Stöhlker, D., 2017. “Economic effects of brexit on the European economy.” EconPol Policy Reports 4, ifo Institute - Leibniz Institute for Economic Research at the University of Munich, available at: ideas.repec.org.

Ferrara, L., Guérin, P. 2018. “What Are the Macroeconomic Effects of High-Frequency Uncertainty Shocks?” *Journal of Applied Econometrics* 33, 662-679.

Fontaine, I., Didier, L., Razafindravaosolonirina, J., 2017. “Foreign policy uncertainty shocks and US macroeconomic activity: evidence from China.” *Economics Letters* 155, 121–125.

Fratzscher, M., Lo Duca, M., Straub, R., 2013. “On the international spillovers of US quantitative easing.” *ECB Working Paper* No. 1557.

Fratzscher, M., Duca, M. L., Straub, R., 2014. “ECB Unconventional Monetary Policy Actions: Market Impact, international Spillovers and Transmission Channels.” Paper presented at the 15th Jacques Polak Annual Research Conference Hosted by the International Monetary Fund, Washington, DC─November 13–14, 2014.

Gabriel, S. A., Lutz, C., 2015. “The impact of unconventional monetary policy on real estate markets.” Available at SSRN 2493873, papers.ssrn.com.

Galariotis, E., Makrichoriti, P., Spyrou, S. 2018. “The Impact of Conventional and Unconventional Monetary Policy on Expectations and Sentiment.” *Journal of Banking and Finance* 86, 1-20.

Ghirelli, C., Perez, J.J., Urtasun, A., 2019. “A New Economic Policy Uncertainty Index for Spain.” *Bank of Spain, Working Paper* No. 1906.

Graziano, A., Handley, K., Limão, N., 2018. “Brexit Uncertainty and Trade Disintegration. *National Bureau of Economic Research*, *NBER*, No No. 25334.

Graziano, A., K. Handley, Lim˜ao, N., (2020). “Brexit uncertainty: Trade externalities beyond Europe.” *AEA Papers and Proceedings* 110, 552–56.

Hansen, S., McMahon, M., Prat, A. (2017). “Transparency and deliberation within the FOMC: A computational linguistics approach.” *The Quarterly Journal of Economics* 133, 801–870.

Hassan, T.A., Hollander, S., van Lent, L., Tahoun, A. (2020). “The Global Impact of Brexit Uncertainty.” *National Bureau of Economic Research, NBER*, No. w26609.

Hardouvelis, G. A., Karalas, G. I., Karanastasis, D. I., Samartzis, P. K., 2018. “Economic Policy Uncertainty, Political Uncertainty and the Greek Economic Crisis. Available at SSRN: https://ssrn.com/abstract=3155172.

Hill, P., Korczak, A. Korczak, P., 2019. “Political uncertainty exposure of individual companies: The case of the Brexit referendum.” *Journal of Banking & Finance* 100, 58-76.

Hosoe, N., 2018. “Impact of border barriers, returning migrants, and trade diversion in Brexit: Firm exit and loss of variety.” *Economic Modelling* 69, 193-204.

Kierzenkowski, R., Pain, N., Rusticelli., E., Zwart, S., 2016. “The Economic Consequences of Brexit: A Taxing Decision.” *OECD Economic Policy Papers*, No. 16, OECD Publishing, Paris.

Kroese, L., Kok, S, Parlevliet., J., 2015. Beleidsonzekerheid in Nederland. Economisch Statistische Berichten, No. 4715, 464-467.

Krokida, S.I., Makrychoriti, P., Spyrou, S., 2020. “Monetary policy and herd behavior: International evidence.” *Journal of Economic Behavior & Organization* 170, 386-417.

Lescaroux, F., and Mignon, V. 2009. “Measuring the effects of oil prices on China’s economy: a Factor-Augmented Vector Autoregressive Approach.” *Pacific Economic Review* 14, 410-425.

Lutz, C., 2015. “The Impact of Conventional and Unconventional Monetary Policy on Investor Sentiment.” *Journal of Banking & Finance* 61, 89-105.

Meinen, P., Röhe, O., 2017. “On measuring uncertainty and its impact on investment: cross-country evidence from the Euro area.” *European Economic Review* 92, 161–179.

Meinusch, A., Tillmann, P., 2016. “The macroeconomic impact of unconventional monetary policy shocks.” *Journal of Macroeconomics* 47, 58-67.

Möller, A., Oliver, T. (Eds.). (2014). The United Kingdom and the European Union: What would a “Brexit” mean for the EU and other States around the World? (DGAP-Analyse, 16). Berlin: Forschungsinstitut der Deutschen Gesellschaft für Auswärtige Politik e.V. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-55608-3.

Oberhofer, H., Pfaffermayr, M. (2021). “Estimating the trade and welfare effects of Brexit: A panel data structural gravity model.” *Canadian Journal of Economics* 54, 338-375.

Oehler, A., Horn, M., Wendt, S., 2017. “Brexit: Short-term stock price effects and the impact of firm-level internationalization.” *Finance Research Letters* 22, 175-181.

Oliver, T., and M.J. Williams. 2016. Special Relationships in Flux: Brexit and the Future of the US-EU and US-UK Relationships. *International Affairs* 92 (3): 547–567.

Paulos J. A., 2003. “A Mathematician Plays the Stock Market.” Basic Books.

Popescu, A., Smets, F. R., 2010. “Uncertainty, risk taking, and the business cycle in Germany.” *CESifo Economic Studies* 56, 596–626.

Popp, A., Fang, Z., 2016. “The macroeconomic effects of uncertainty shocks: The role of the financial channel.” *Journal of Economic Dynamics and Control* 69, 319-349.

Prüser, J., Schlösser, A., 2019. “The effects of economic policy uncertainty on European economies: evidence from a TVP-FAVAR.” *Empirical Economics* 58 2889–2910.

Ramiah, V., Pham H.N.A., Moosa, I., 2017. “The sectoral effects of Brexit on the British economy: early evidence from the reaction of the stock market.” *Applied Economics* 49, 2508-2514.

Reenen, J.V., 2016. “Brexit’s Long-Run Effects on the U.K. Economy.” *Brookings Papers on Economic Activity* (FALL), 367-383.

Sampson, T., 2017. “Brexit: The Economics of International Disintegration.” *Journal of Economic Perspectives* 31, 163–184.

Schiereck, D., Kiesel, F., Kolaric, S. 2016. “Brexit: (Not) another Lehman moment for banks?” *Finance Research Letters* 19, 291-297.

Smales, L.A., 2017. ““Brexit”: A Case Study in the Relationship Between Political and Financial Market Uncertainty.” *International Review of Finance* 17, 451-459.

Soares, R. (2013). Assessing monetary policy in the euro area: a factor-augmented VAR approach. *Applied Economics* 45(19), 2724-2744.

Steinberg, J.B., 2019. “Brexit and the macroeconomic impact of trade policy uncertainty.” *Journal of International Economics* 117, 175-195.

Stock, J. H., Watson, M. W., 2002. “Macroeconomic forecasting using diffusion indexes.” *Journal of Business & Economic Statistics* 20(2), 147–162.

Stock J.H. Watson, M.W., 2002. “Forecasting Using Principal Components from a Large Number of Predictors.” Journal of the American Statistical Association 97, 1167-1179.

Stock, J. H., Watson, M. W., 2005. “An empirical comparison of methods for forecasting using many predictors”. Manuscript, Princeton University, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.421.3470&rep=rep1&type=pdf.

Tillmann, P. 2015. “Estimating the effects of macroprudential policy shocks: A Qual VAR approach.” Economics *Letters* 135, 1-4.

Tillmann, P., 2016. “Unconventional monetary policy and the spillovers to emerging markets.” *Journal of International Money and Finance* 66, 136-156.

Walker, N., 2020. “Brexit timeline: events leading to the UK’s exit from the European Union. House of Commons Library.” *Briefing Paper* No. 7960, 24 January 2020.

Zalla, R., 2017. “Economic Policy Uncertainty in Ireland.” *Atlantic Economic Journal* 45, 269–271.

APPENDIX A

Brexit: Important Events

Date	Event	Financial Times Headline	Headline Article	Front Page	VIX	Day of event VIX FTSE10 0	Next day of event (day published in FT) VIX FTSE100	Day of event Sterling EER	Next day of event (day published in FT) Sterling EER	Dummy
23/1/13	Cameron plans for a referendum on British membership of the EU	*"Cameron takes big gamble over EU"*	title		0.03	-0.558	-0.563	-0.1048	-0.5356	**1**
22/2/16	The PM announces the EU referendum date	*"Sterling tumbles as Cameron takes on party rebels over Brexit"*	title		-1.15	-2.194	0.896	-0.5246	-0.1778	**1**
23/6/16	UK referendum EU membership	*"Britain breaks with Europe"*	title		-3.92	-3.931	-1.424	0.3455	-5.96	**1**
13/7/16	Theresa May the new UK PM	*"Obama launches trade complaint amid growing tension with China"*	No	title / text	-0.51	1.394	-2.33	0.0618	0.6054	
3/11/16	High court rules UK parliament must have a say	*"Clinton and Trump in last minute scrabble for votes as polls narrow"*	No	title / text	2.76	0.472	1.563	0.9356	0.4772	
24/1/17	Supreme Court rejects the UK Government's appeal of the Gina Miller case	*"Trump backs oil pipelines in fresh swipe at Obama legacy"*	No	title / text	-0.7	-0.273	-0.781	0.1049	0.6799	
29/3/17	UK Prime Minister triggers Article 50 of the Treaty on European Union	*"Thank you and Goodbye"*	title		-0.11	-0.379	-0.403	-0.2424	0.5324	**1**
30/3/17	UK Government publishes the "Great Repeal Bill White Paper"	*"Record debt sales signal surge in optimism for merging nations"*	No	text in briefing	0.12	-0.403	0.713	0.5324	0.287	
18/4/17	UK PM calls a General Election	*"May calls snap election in bit to strengthen hand in Brexit talks"*	title		-0.24	1.526	-0.551	1.2207	0.2559	**1**

8/6/17	UK General Election results	*"May clings on after poll disaster with pro-EU forces set to strike"*	title		0.54	-1.198	0.627	-1.0848	-0.5024	**1**
19/6/17	UK-EU exit negotiations begins (first round)	*"Russian threat to target US forces as Syria jet shot down*	No	title / text	-0.01	-0.77	1.437	-0.1145	-0.6055	
22/9/17	UK PM delivers key Brexit speech	*May's speech wins guarded EU welcome"*	title		-0.08	0.096	0.555	-0.3079	0.195	**1**
13/11/17	Government outlines plans for a Withdrawal Agreement and Implementation Bill.	*"GE Splash dividend and splash off oldest divisions in revival push"*	No	text in briefing	0.21	0.225	0.034	-0.6034	-0.2513	
8/12/17	Publication of UK-EU Joint Report on progress made during Phase 1 of negotiations.	*"May warned on tough choices ahead"*	title		-0.58	0.156	0.265	-0.0869	-0.2635	**1**
2/3/18	PM's speech on UK's future partnership with the EU	*"Defiant Trump hails prospect of trade war"*	No	title	-2.88	3.731	-2.761	-0.2437	0.3754	
19/3/18	Publication of the amended Draft Withdrawal Agreement	*"Uber halts self-drive tests after autonomous car kills pedestrian"*	No	title / text	3.22	1.295	-1.232	0.4734	0.1268	
9/7/18	UK's Brexit Secretary resigns, and a new Secretary of State for Exiting the EU is appointed	*"Double Brexit blow for May after resignation of two key ministers"*	title		-0.68	-1.261	-0.14	-0.1682	0.2413	**1**
24/7/18	Government publishes White Paper on future UK-EU relations.	*"Lira plunges as rates freeze raises fears over Erdogan's economic role"*	No	text in briefing	-0.21	-0.686	0.484	0.2748	0.0333	
20/9/18	EU leaders' informal summit in Salzburg	*"Markets at record high as boom in US drives investor confidence"*	No	title / text	0.05	-0.32	-0.503	0.2546	-0.9631	
14/11/18	The Withdrawal Agreement is agreed and published.	*"Germany's contracting policy sets puzzle for ECB's policymakers"*	No	title / text	1.23	5.128	-1.721	-0.0896	-1.4657	
15/11/18	Brexit Secretary resigns as Secretary of State for Exiting EU	*"May vows to push through Brexit deal as split rocks ruling party"*	title		-1.27	-1.721	-1.899	-1.4657	0.0157	**1**

25/11/18	EU27 leaders endorse the Withdrawal Agreement	*“May embarks on Brexit hard sell after EU leaders back deal terms”*	title		-2.62	-0.031	-0.031	0.1659	-0.3096	**1**
5/12/18	Publication of the Attorney General’s legal advice to Cabinet regarding the on the Protocol to the Withdrawal Agreement on Ireland and Northern Ireland.	*“US and China bolster trade truce message in bid to soothe markets”*	No	text in briefing	0.45	2.723	2.243	0.1389	0.1272	
10/12/18	CJEU judgment on the Wightman case. PM statement and announcement of a delay	*“India central bank governor quits after dispute over independence”*	No	title / text	-0.59	-0.703	-2.798	-1.1896	0.1455	
11/12/18	Urgent Question and Emergency Debate	*“China moves to cut US car tariffs in first sign of trade war détente”*	No	title / text	-0.88	-2.798	-0.927	0.1455	0.6075	
8/1/19	Report Stage and Third Reading of Finance (No. 3) Bill	*“Deutsche's dire year puts bankers at risk of double-digit bonus below”*	No	text in briefing	-0.93	-2.658	1.017	-0.0938	-0.2404	
15/1/19	“Meaningful Vote”: the government losses by a 230 majority	*“Congo election tainted by fraud as leaked data show Fayula won vote”*	No	title / text	-0.47	-2.359	0.499	-0.5101	0.4762	
21/1/19	PM presents the ‘Plan B’	*“China growth cut to 3-decade low by trade war and debt crackdown”*	No	title / text	3	0.912	0.681	-0.0321	0.4531	
29/1/19	MPs debate ‘Plan B’ deal	*“May seeks to reopen Brexit deal in Brussels as hardliners force U-turn”*	title		0.26	0.227	-0.834	0.0375	-0.5377	**1**
14/2/19	Voting in the House of Commons of amendments	*Amazon pulls plans for New York base in face of fierce local hostility*	No	title	0.57	-0.59	0.684	-0.5143	0.444	
26/2/19	PM statement to the House of Commons promising a vote delaying Brexit in case she loses the 2nd “Meaningful Vote”.	*“AT&T lands blow on White House stand to block Time Warner tie-up”*	No	title / text	0.32	0.165	1.083	1.0105	0.4687	

12/3/19	The PM loses the 2nd "Meaningful Vote"	*"Boing reels as European ban follows Asia curbs on 737 Max"*	No	title / text	-0.56	0.625	0.53	-0.8334	1.2293	
13/3/19	MPs vote to rule out a "no-deal Brexit"	*"US caves into global pressure and grounds Boing's Max"*	No	title / text	-0.36	0.53	-1.104	1.2293	0.3796	
14/3/19	MPs debate amendments	*"Trump rebuked by Senate in vote blocking border wall emergency"*	No	title / text	0.09	-1.104	-0.789	0.3796	-0.1596	
20/3/19	The PM writes to European Council President and asks an extension for Article 50 until 30-6-2019	*"EU slaps €1.5bn fine on Google for decade of blocking online ad rivals"*	No	title / text	0.35	0.219	0.159	-0.4972	-0.7857	
21/3/19	Meeting of the European Council, where an extension is agreed on terms	*"Washington warns over China's tougher position on trade talks"*	No	title / text	-0.28	0.159	1.654	-0.7857	1.3074	
27/3/19	The MPs debate and vote on eight indicative votes.	*"Swedbank €135bn dirty money scandal widens with US probes"*	No	title / text	0.47	0.466	0.127	0.0245	-0.5297	
29/3/19	The PM loses the 3rd "Meaningful Vote"	*"UK faces cliff edge after May defeat"*	title		-0.72	-1.399	-0.002	-0.328	0.6725	**1**
2/4/19	The PM announces she will seek a further extension to the Article 50 and offers to discuss with the Leader of the Opposition, to finalize a plan	*"Brussels poised to offer Britain long Brexit delay with conditions"*	title		-0.04	-0.14	-0.564	-0.4915	0.5565	**1**
5/4/19	The PM ask writes to Donald Tusk, a further extension to the Article 50	*"Trump takes aim at Fed policies"*	No	title / text	-0.76	-0.588	0.578	-0.436	0.0688	
10/4/19	The European Council meets. The UK and EU27 agree to extend Article 50 until 31-10- 2019.	*"Microsoft under fire over AI work with Chinese military university"*	No	text in briefing	-0.98	-0.005	-2.024	0.3451	-0.0732	
21/5/19	The PM unveils her new Brexit deal.	*"May concession on fresh Brexit referendum sparks backlash"*	title		-1.36	0.794	-0.381	0.285	-0.6849	**1**

23/5/19	European Parliament elections: UK votes	*“Landslide victory clears Modi's way for new India reform drive”*	No	text in briefing	2.17	0.717	-0.3	0.081	-0.1411	
23/7/19	Boris Johnson wins the Conservative Party leadership	*“IMF warns over no-deal Brexit as Johnson wins race for UK leader”*	title		-0.92	-	-	-0.0471	0.378	**1**
25/7/19	PM Johnson statement in the House of Commons and commits to the October date for Brexit	*“Draghi paves the way for stimulus package to revive ailing eurozone”*	No	title / text	0.67	-	-	-0.0581	-0.4919	
4/9/19	The EU (Withdrawal) (No. 6) Bill passes. Motion for early General Elections defeated	*“Google accused of covertly passing users' personal data to advertisers”*	No	title / text	-2.33	-	-	0.2635	0.7912	
24/9/19	Unanimous judgment of Supreme Court for the case of Gina Miller	*“Johnson faces calls to resign as judges rule parliament's closure "unlawful"”*	title		2.14	-	-	0.2598	-0.432	**1**

Notes to Appendix A:
The column “Dummy” presents the events that where finally selected for our binary variable. For the period between January 2013 to September 2019 we first identify significant Brexit-related events leading to the UK’s exit from the EU, based on the timeline suggested by Walker (2020). Then, from these events, we select the events that were covered in the front page of Financial Times (US edition) on the following day. Next, from these events we keep and include in our dummy variable only events that appear as Headline Articles in the Financial Times (FT) front page. The Column “Event” presents the Brexit related event/announcement from the timeline of Walker (2020) that also appeared in the front page of the FT. The column “Financial Times Headline” presents the title of the “top story” on the front page of the Financial Times on that day. The column “Headline Article” indicates where the Brexit event is mentioned in the top story on the front page of the Financial Times (title, subtitle or main text); “Front page” indicates where the Brexit event is mentioned in the on the front page of the Financial Times, if not in the “top story” (title, subtitle or main text). “VIX” indicates the change in the VIX on the day of the event; FTSE100 indicates the change in “VIX FTSE100” on the day of event while the next column reports the change in “VIX FTSE100” on the next day of the event; “Sterling EER” indicates the change in the effective exchange rate index (Sterling/$) which capture volatility on the day of event while the next column reports the change in “Sterling EER” on the next day of the event, “dummy” indicates the impulse dummy. For the days with no available data on the indices depicted, we use next available day's value.

APPENDIX B
Main dataset

Long-term interest rates, Short-term interest rates
M1, M2, M3
Economic sentiment indicator
5yr sovereign CDS spreads
Gross domestic product at market prices
Gross fixed capital formation
ZEW Sentiment Indicator for Germany; Eurozone; France; UK; Italy
Consumer confidence indicator
Economic Policy Uncertainty for France; Germany; Greece; Ireland; Italy; the Netherlands; Spain; Sweden; UK
Proportion of CFOs reporting 'high' or 'very high' levels of uncertainty (UK)

Production in industry

Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; intermediate goods; capital goods*; capital goods*; durable consumer goods*; non-durable consumer goods*; Manufacturing*

Consumption

Households and non-profit institutions consumption expenditure

Unemployment

Percentage of active population, Total; Percentage of active population, Males; Percentage of active population, Females; Less than 25 years, Total; From 25 to 74 years, Total

Imports & Exports

International trade - Balance for values / Ratio for indices, Imports; Total, Exports; Total.

HICP

All-items; Food and non-alcoholic beverages; Food; Electricity, gas and other fuels; Health; Transport; Energy

Exchange rates

EURO TO UK £; US $ TO UK £; EURO TO US $.

Equity Market Indexes

FTSE100; IBEX35; PT PSI; FTSE MIB; AEX; ATHEX COMPOSITE; FRANCE CAC40; OMX HELSINKI; BEL20; ATX; ISEQ ALL SHARE; DAX30; OMXS30

EU area

Euribor 6-month; EU 19 - Production in industry - Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; EURO STOXX 50; VSTOXX; EU 19- Unemployment according to ILO definition - Total

Global

ECB Commodity Price index, import weighted; Global price of Brent Crude; S&P 500 COMPOSITE; CBOE SPX VOLATILITY VIX (NEW)

Notes to Appendix B

The dataset includes 452 macro and financial variables for the EU FAVAR model. Variables with an asterisk (*) indicate Ireland's exclusion from the sample due to data limitations.

Table 1
Contribution of the shock to Variance of the Common Component, UK-based variable *y**

	GDP		GFCF		TB		ESI		CONS		STOCK		CDS	
	VD	R^2	**VD**	R^2	**VD**	R^2	**VD**	R^2	**VD**	R^2	**VD**	R^2	**VD**	R^2
UK	0.086	0.385	0.012	0.129	0.002	0.038	0.008	0.104	0.019	0.196	0.013	0.398	0.003	0.093
SD	0.017	0.208	0.018	0.148	0.002	0.033	0.023	0.076	0.026	0.171	0.014	0.435	0.001	0.038
SP	0.063	0.469	0.006	0.181	0.001	0.038	0.007	0.105	0.050	0.368	0.015	0.442	0.005	0.111
PT	0.051	0.227	0.017	0.162	0.000	0.006	0.017	0.165	0.006	0.094	0.001	0.039	0.004	0.109
IT	0.074	0.450	0.085	0.386	0.001	0.018	0.009	0.128	0.053	0.385	0.014	0.443	0.004	0.092
NL	0.035	0.248	0.001	0.019	0.001	0.026	0.008	0.144	0.021	0.154	0.018	0.516	0.002	0.051
IE	0.004	0.140	0.002	0.047	0.000	0.011	0.007	0.202	0.017	0.128	0.016	0.416	0.004	0.084
GR	0.057	0.177	0.001	0.017	0.002	0.033	0.001	0.014	0.002	0.013	0.009	0.290	-	-
DE	0.023	0.211	0.006	0.055	0.002	0.116	0.013	0.207	0.022	0.159	0.017	0.521	0.002	0.028
FR	0.033	0.126	0.160	0.345	0.001	0.011	0.004	0.077	0.008	0.060	0.018	0.538	0.004	0.074
FI	0.089	0.373	0.026	0.184	0.004	0.118	0.005	0.057	0.025	0.106	0.012	0.396	0.002	0.056
BG	0.018	0.163	0.000	0.006	0.000	0.013	0.006	0.157	0.011	0.111	0.014	0.422	0.003	0.053
AT	0.070	0.281	0.015	0.073	0.000	0.005	0.001	0.023	0.024	0.107	0.019	0.539	0.002	0.026

Notes to Table 1
The Brexit variable is constructed with UK economic variables. *VD*: Variance Decomposition (fraction of variance of forecast error explained by an uncertainty shock). R^2: the fraction of variance explained by the common factors.; *GDP*: Gross Domestic Product; *GFCF*: Gross Fixed Capital Formation, *TB*: Trade Balance; *ESI*: Economic Sentiment Indicator; *CONS*: Consumption; *STOCK:* Stock Index returns; *CDS*: CDS spreads. The sample countries are UK, Spain (SP), Portugal (PT), Italy (IT), Netherlands (NL), Greece (GR), France (FR), Finland (FI), Belgium (BG), Austria (AT), Ireland (IE), Germany (DE), Sweden (SD). The stock indices used are FTSE100, IBEX35, PT PSI, FTSE MIB, AEX, ATHEX COMPOSITE, FRANCE CAC40, OMX HELSINKI, BEL20, ATX, ISEQ ALL SHARE, DAX30, OMXS30, respectively. Due to lack of data the 5yr CDS spreads for Greece are not included in the sample.

Table 2
Contribution of the shock to Variance of the Common Component, UK-based variable *y, US FAVAR**

	Ordering: US block, Brexit Uncertainty		Ordering: Brexit Uncertainty, US block,	
	VD	**R^2**	**VD**	**R^2**
GDP	0.005	0.188	0.002	0.188
GFCF	0.013	0.502	0.013	0.502
CONS	0.095	0.118	0.004	0.118
STOCK	0.007	0.398	0.010	0.398
MCSI	0.008	0.020	0.001	0.020
TRADE	0.032	0.039	0.001	0.039
CDS	0.017	0.034	0.001	0.034

Notes to Table 2
VD: Variance Decomposition (fraction of variance of forecast error explained by an uncertainty shock). R^2: the fraction of variance explained by the common factors.; GDP: Gross Domestic Product; GFCF: Gross Fixed Capital Formation; CONS: Consumption; STOCK: Stock returns (S&P500); MCSI: Michigan Consumer Sentiment Indicator; TB: Trade Balance; CDS: CDS spreads. See also Notes to Table 1.

Table 3
Contribution of the shock to Variance of the Common Component, EU-based variable *y**

	GDP		GFCF		TB		ESI		CONS		STOCK		CDS	
	VD	R^2	VD	R^2	VD	R^2	VD	R^2	VD	R^2	VD	R^2	VD	R^2
UK	0.114	0.369	0.016	0.148	0.001	0.038	0.007	0.101	0.019	0.193	0.011	0.396	0.003	0.090
SD	0.018	0.207	0.012	0.129	0.001	0.065	0.018	0.081	0.029	0.167	0.013	0.439	0.001	0.036
SP	0.049	0.458	0.008	0.169	0.001	0.038	0.007	0.115	0.043	0.365	0.012	0.441	0.002	0.127
PT	0.041	0.221	0.017	0.161	0.000	0.009	0.035	0.118	0.004	0.122	0.001	0.039	0.003	0.114
IT	0.059	0.465	0.073	0.383	0.000	0.015	0.007	0.119	0.041	0.381	0.013	0.445	0.002	0.100
NL	0.035	0.242	0.000	0.022	0.001	0.025	0.008	0.124	0.014	0.165	0.015	0.517	0.003	0.037
IE	0.006	0.158	0.001	0.049	0.001	0.024	0.009	0.272	0.013	0.136	0.013	0.413	0.002	0.118
GR	0.066	0.175	0.001	0.019	0.000	0.014	0.001	0.012	0.001	0.012	0.008	0.289	-	-
DE	0.019	0.220	0.004	0.055	0.003	0.096	0.008	0.239	0.017	0.155	0.016	0.525	0.001	0.041
FR	0.028	0.129	0.126	0.360	0.000	0.010	0.002	0.089	0.006	0.052	0.016	0.538	0.002	0.123
FI	0.055	0.418	0.020	0.175	0.003	0.121	0.003	0.064	0.019	0.102	0.012	0.399	0.002	0.057
BG	0.014	0.159	0.000	0.014	0.000	0.009	0.004	0.154	0.007	0.111	0.013	0.424	0.002	0.061
AT	0.063	0.281	0.012	0.084	0.000	0.006	0.001	0.029	0.019	0.107	0.016	0.536	0.001	0.043

Notes to Table 3
The Brexit variable is constructed with economic variables from each local economy. VD: Variance Decomposition (fraction of variance of forecast error explained by an uncertainty shock). R^2: the fraction of variance explained by the common factors.; GDP: Gross Domestic Product; GFCF: Gross Fixed Capital Formation, TB: Trade Balance; ESI: Economic Sentiment Indicator; CONS: Consumption; STOCK: Stock returns; CDS: CDS spreads. See also Table 1. Due to lack of data the 5yr CDS spreads for Greece are not included in the sample.

Table 4
Spillover (Connectedness) matrix for the EU countries

	EPU Germany	EPU France	EPU Greece	EPU Ireland	EPU Italy	EPU the Netherlands	EPU Sweden	EPU Spain	EPU UK	**From Others**
EPU Germany	46.5	15.2	4.1	0.3	4.4	2.2	6.9	0.9	19.6	53.5
EPU France	14.3	47.2	8.6	0.4	5.4	3.1	4.0	1.1	15.8	52.8
EPU Greece	1.3	4.4	81.5	2.5	3.9	0.7	3.5	1.5	0.8	18.5
EPU Ireland	1.1	3.9	3.3	77.8	0.5	1.4	0.7	0.5	10.8	22.2
EPU Italy	5.6	4.9	3.2	0.3	63.6	12.9	1.2	4.8	3.5	36.4
EPU Netherlands	2.7	4.2	0.8	3.6	11.9	65.7	4.8	1.2	5.1	34.3
EPU Sweden	9.5	4.4	2.5	0.7	1.4	3.3	77.2	0.3	0.7	22.8
EPU Spain	1.7	3.0	0.3	0.7	7.4	11.8	0.2	67.9	7.0	32.1
EPU UK	12.2	12.3	1.1	1.8	2.7	8.2	2.0	0.9	58.7	41.3
Contribution to others	48.4	52.5	23.9	10.3	37.6	43.5	23.4	11.3	63.2	314.0
Contribution (including own)	94.9	99.7	105.3	88.1	101.2	109.2	100.6	79.2	121.9	**34.9%**

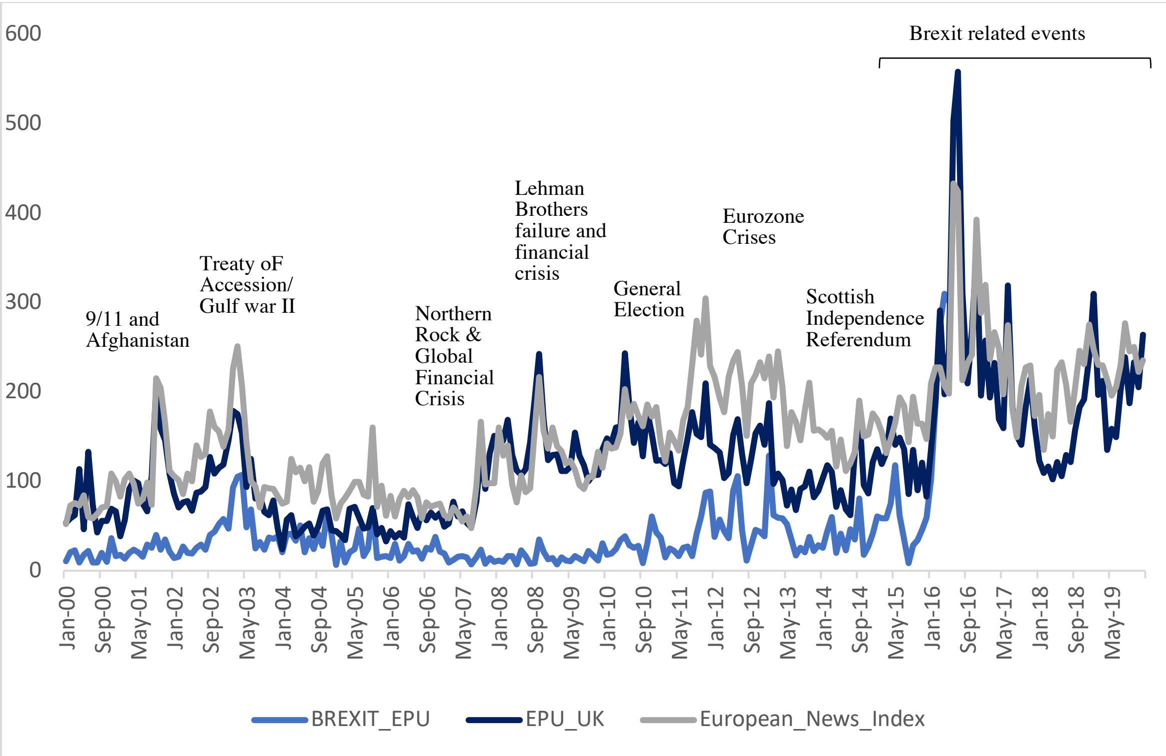
Notes to Table 4
Column variables are impulse origin variables, while row variables are respondents to the shock. Values across a row add up to 100 (by construction). The "From Others" value at the end is the percentage that isn't due to "own" shocks. The "Contribution to Others" at the bottom is the sum of each column of the percentages that are from that shock to other respondents of the shock. The "From Others" column sum should equal the "To others" row sum. The 34.9% equals 314 divided by the overall total of 900 (100 per variable). The EU countries included in this analysis are Germany, France, Greece, Ireland, Italy, the Netherlands, Sweden, Spain and UK.

Table 5
Spillover (Connectedness) matrix for the G7 countries

	EPU Canada	EPU France	EPU_ Germany	EPU Italy	EPU Japan	EPU UK	EPU US	**From Others**
EPU Canada	45.4	2.1	6.7	0.9	3.9	22.2	18.7	54.6
EPU France	4.4	42.5	11.9	3.9	13.4	12.3	11.5	57.5
EPU Germany	8.2	11.9	37.4	2.2	18.7	12.2	9.4	62.6
EPU Italy	1.3	5.0	4.3	77.0	8.2	1.3	2.8	23.0
EPU Japan	1.9	7.5	6.3	6.1	65.6	4.5	8.1	34.4
EPU UK	11.4	6.7	5.8	2.6	14.6	50.0	8.9	50.0
EPU US	15.4	7.7	7.7	2.0	9.8	14.4	43.1	56.9
Contribution to others	42.6	40.9	42.6	17.7	68.6	67.1	59.4	338.9
Contribution (including own)	88.0	83.4	80.0	94.8	134.1	117.1	102.5	**48.4%**

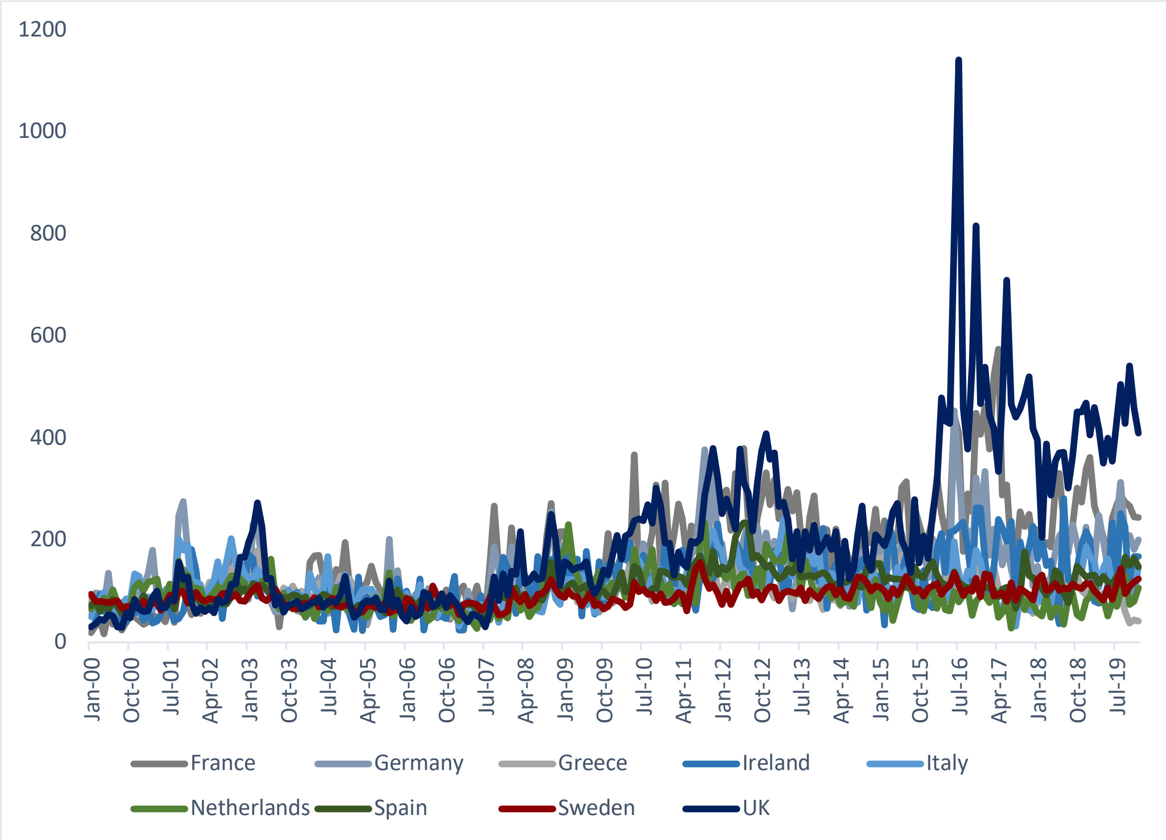
Notes to Table 5
Column variables are impulse origin variables, while row variables are respondents to the shock. Values across a row add up to 100 (by construction). The "From Others" value at the end is the percentage that isn't due to "own" shocks. The "Contribution to Others" at the bottom is the sum of each column of the percentages that are from that shock to other respondents of the shock. The "From Others" column sum should equal the "To others" row sum. The 34.9% equals 314 divided by the overall total of 900 (100 per variable). The analysis here includes the G7 countries (Canada, France, Germany, Italy, Japan, UK and US).

Figure 1
Economic Policy Uncertainty (European News Index, UK EPU and Brexit EPU)



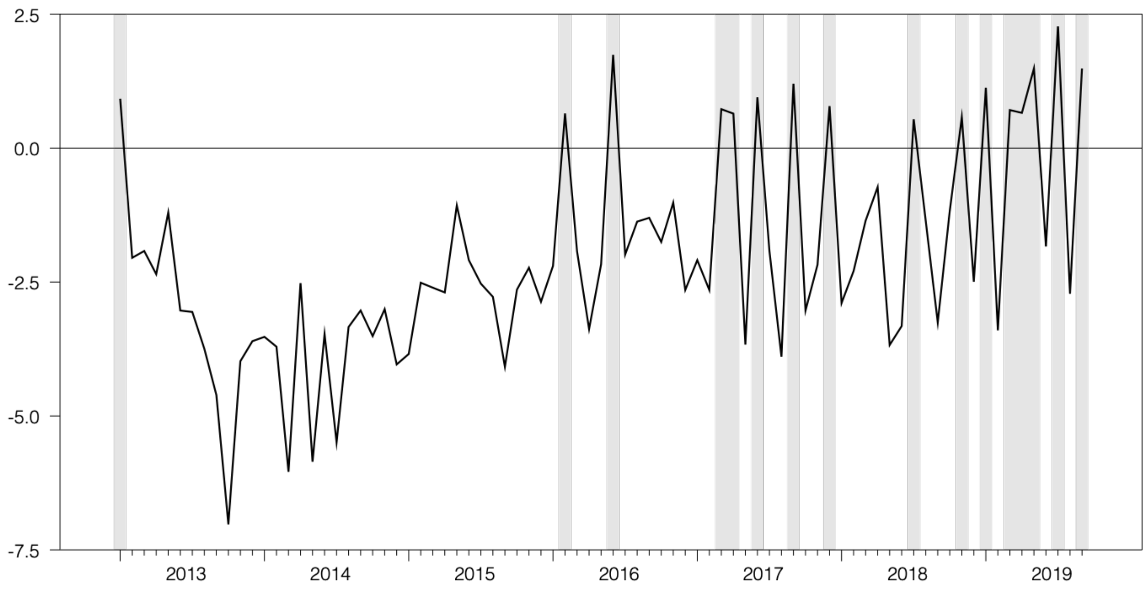
Notes to Figure 1
For more details and source of indexes see: www.PolicyUncertainty.com; Baker, Bloom, and Davis (2016).

Figure 2
Country-specific EPU indices for selected EU economies



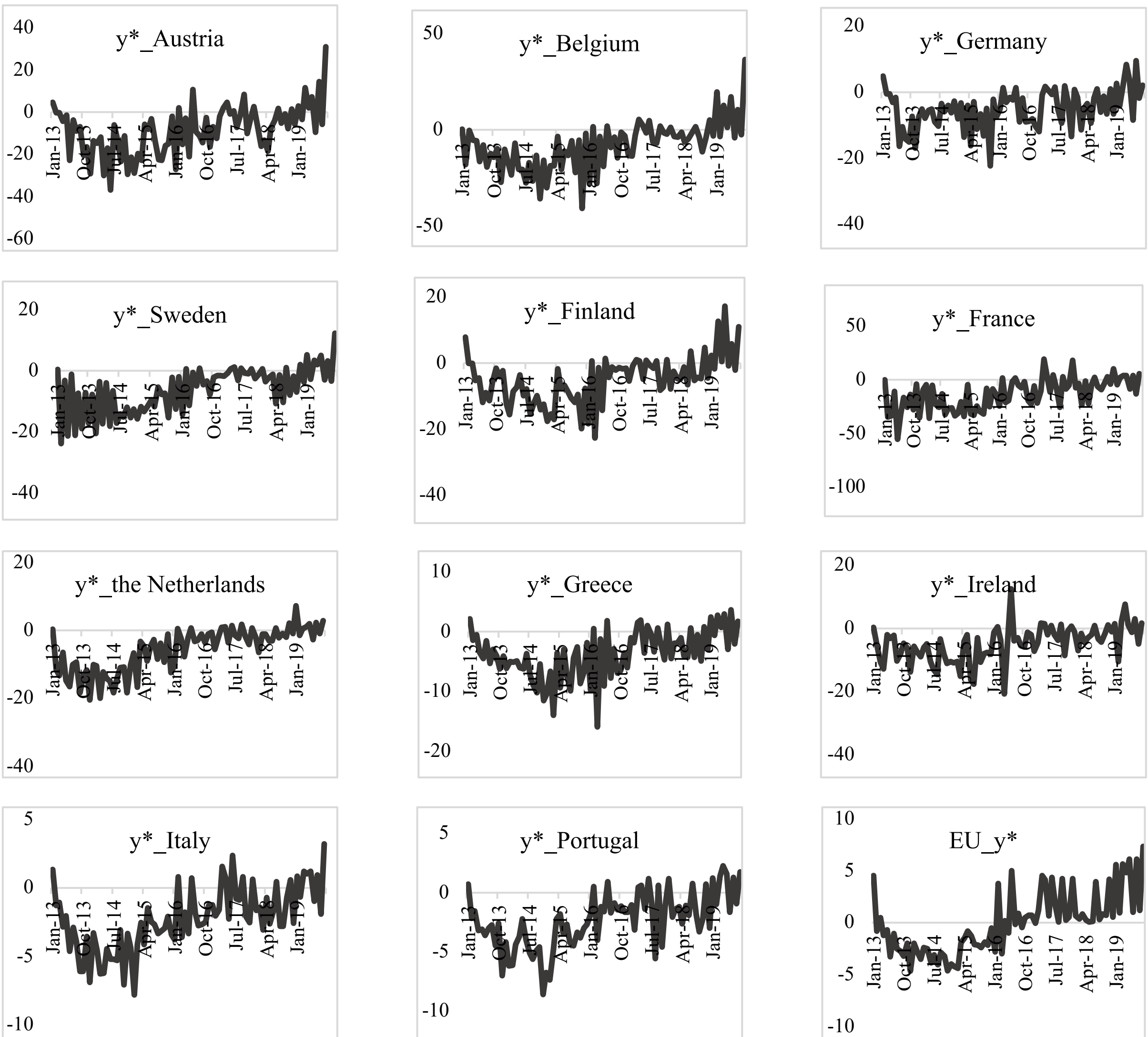
Notes to Figure 2
For more details and source of indexes see: www.PolicyUncertainty.com. The EPU index is available only for 9 of the 13 sample EU countries employed in the paper. The EPU index construction follows the methodology of Baker, Bloom, and Davis (2016). The EPU index for Greece is constructed by Hardouvelis, Karalas, Karanastasis and Samartzis (2018), for Ireland by Zalla (2017), for the Netherlands by Kroese, Kok and Parlevliet (2015), for Spain by Ghirelli, Perez, and Urtasun (2019) and for Sweden by Armelius, Hull, and Köhler (2017).

Figure 3
Brexit related events (shaded) and latent propensity for Brexit Uncertainty



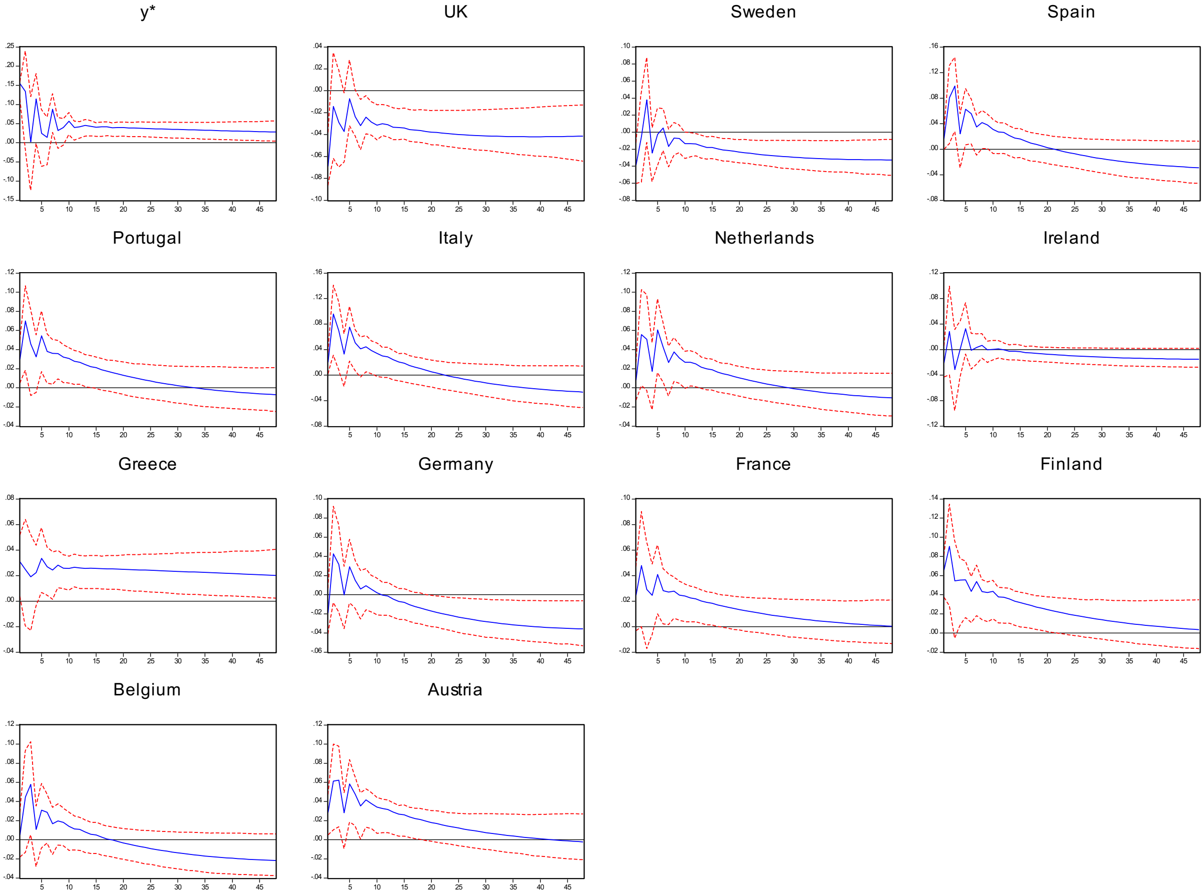
Notes to Figure 3
Brexit related events (shaded) and latent propensity. The latent variable for Brexit Uncertainty is estimated by the Qual VAR model.

Figure 4
Brexit-related Uncertainty (*y) Variable for Various EU Countries**



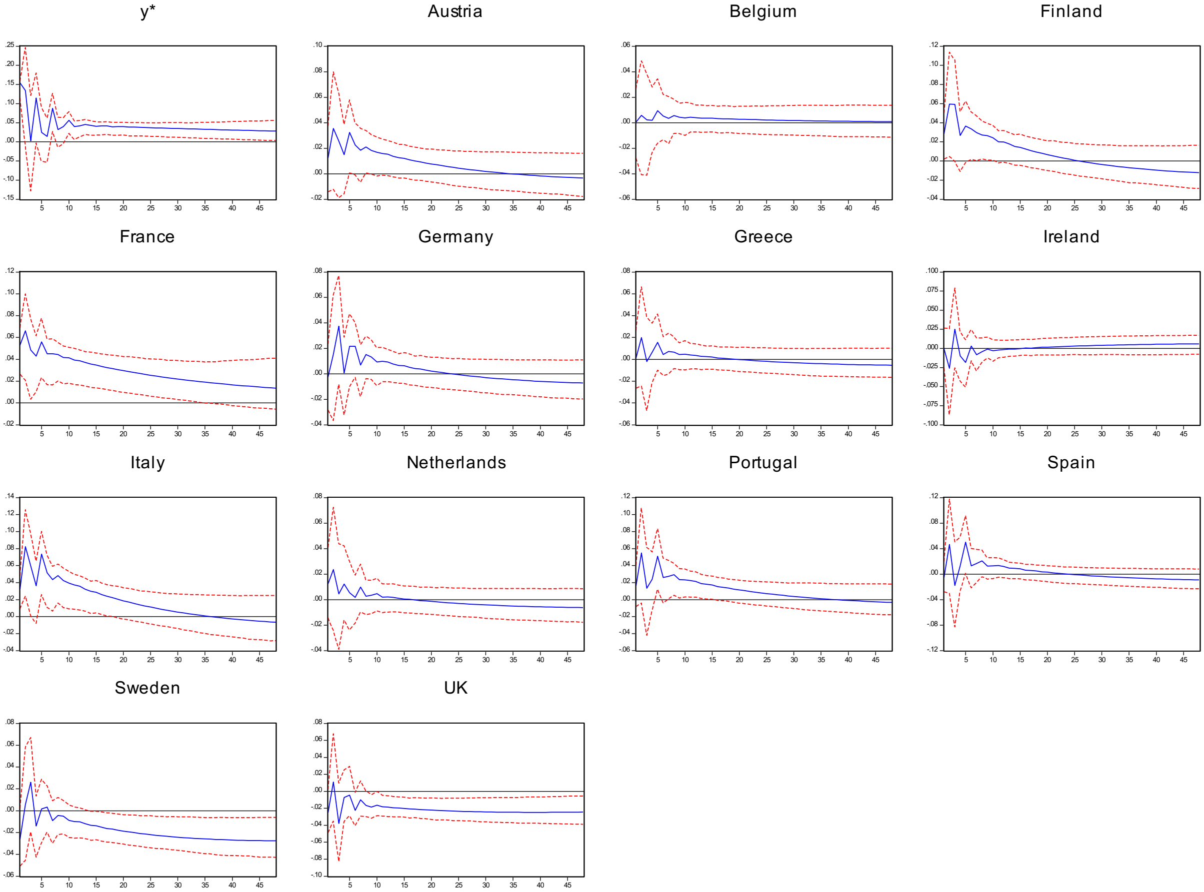
Notes to Figure 4
The latent propensity for Brexit Uncertainty estimated in the Qual VAR model for each EU country capturing the country specific Brexit uncertainty as experienced by each one of the economies individually. The last graph is the aggregate measure for the Brexit Uncertainty in the EU, as the principal component of all country specific y*.

Figure 5
Impulse Response Functions: Gross Domestic Product



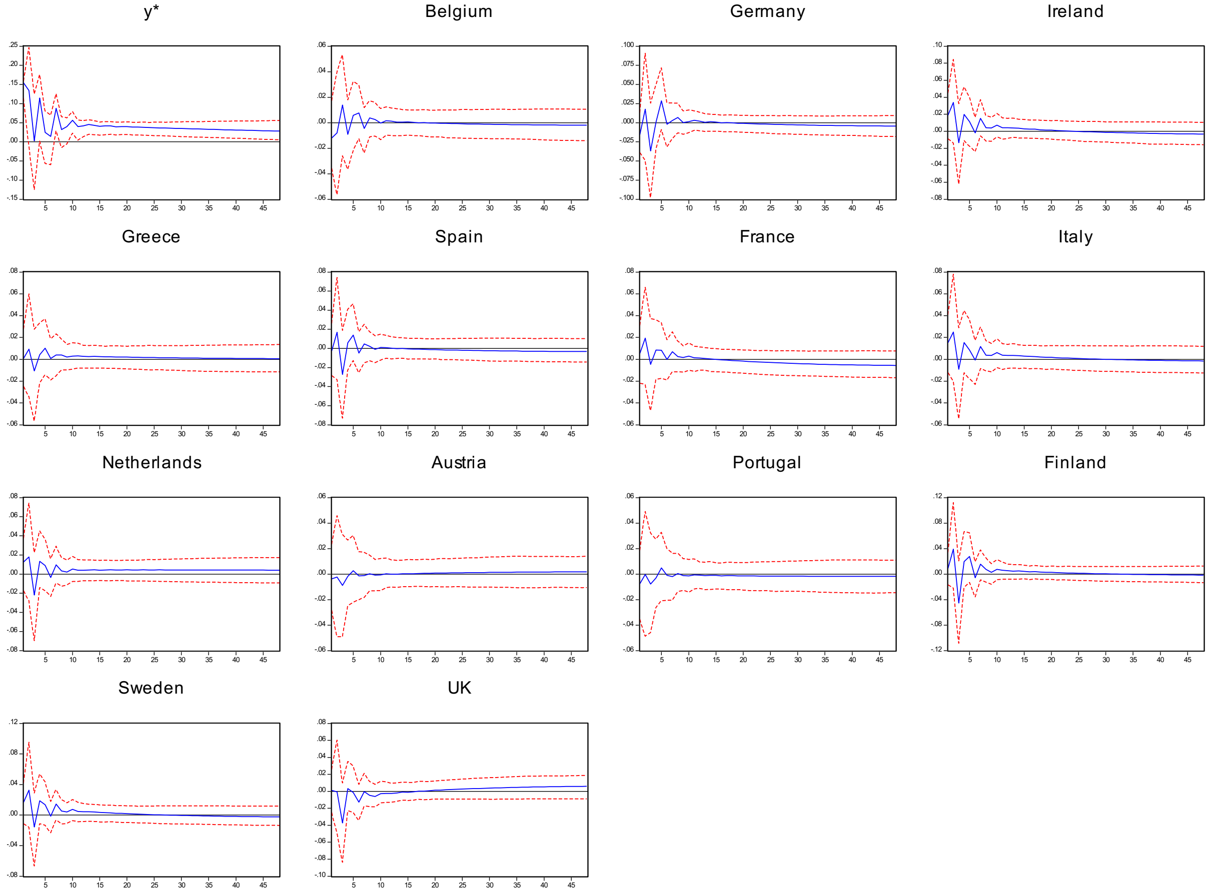
Notes to Figure 5
The Figure presents Impulse Response Functions (IRFs) for Gross Domestic Product (GDP), i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries.

Figure 6
Impulse Response Functions: Gross Fixed Capital Formation



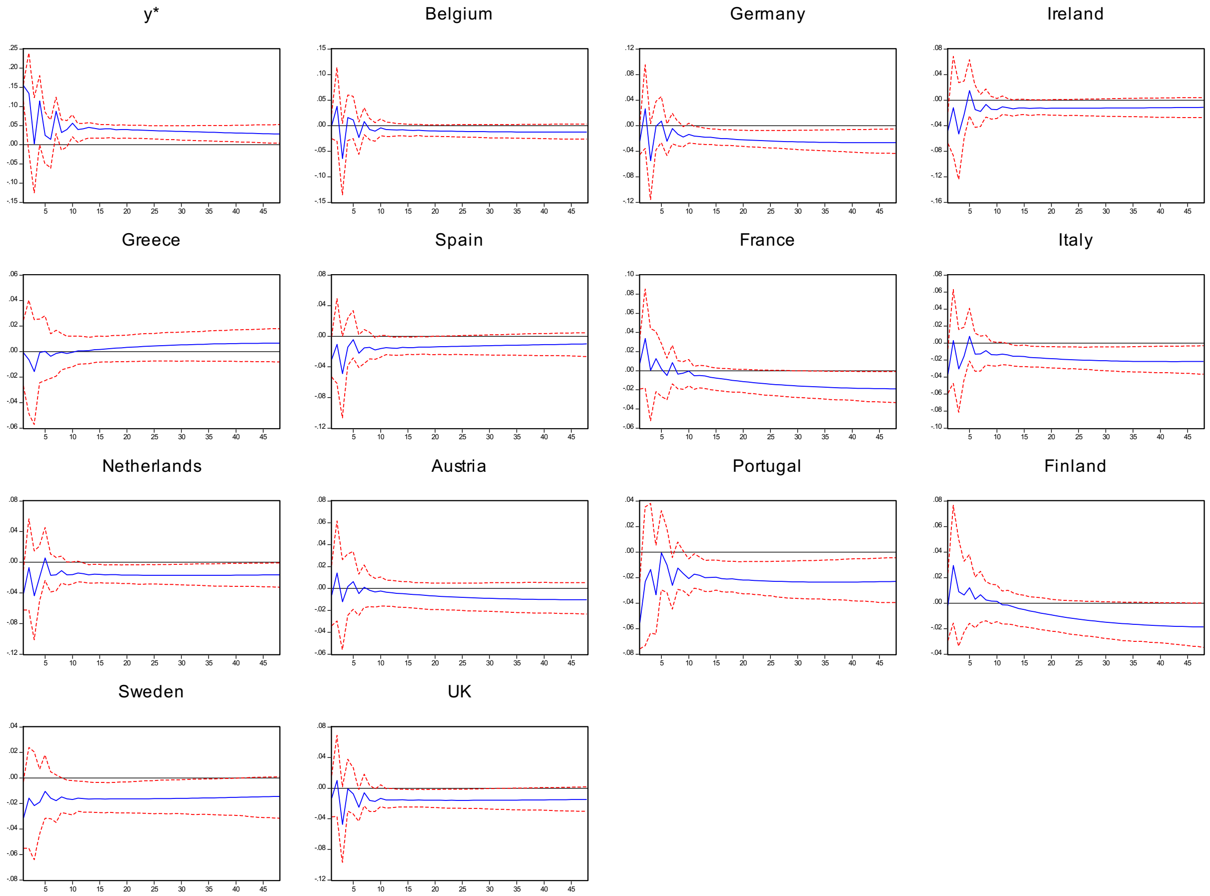
Notes to Figure 6
The Figure presents Impulse Response Functions (IRFs) for Gross Fixed Capital Formation (GFCF), i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries.

Figure 7
Impulse Response Functions: Trade Balance



Notes to Figure 7
The Figure presents Impulse Response Functions (IRFs) for Trade Balance (TB), i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries.

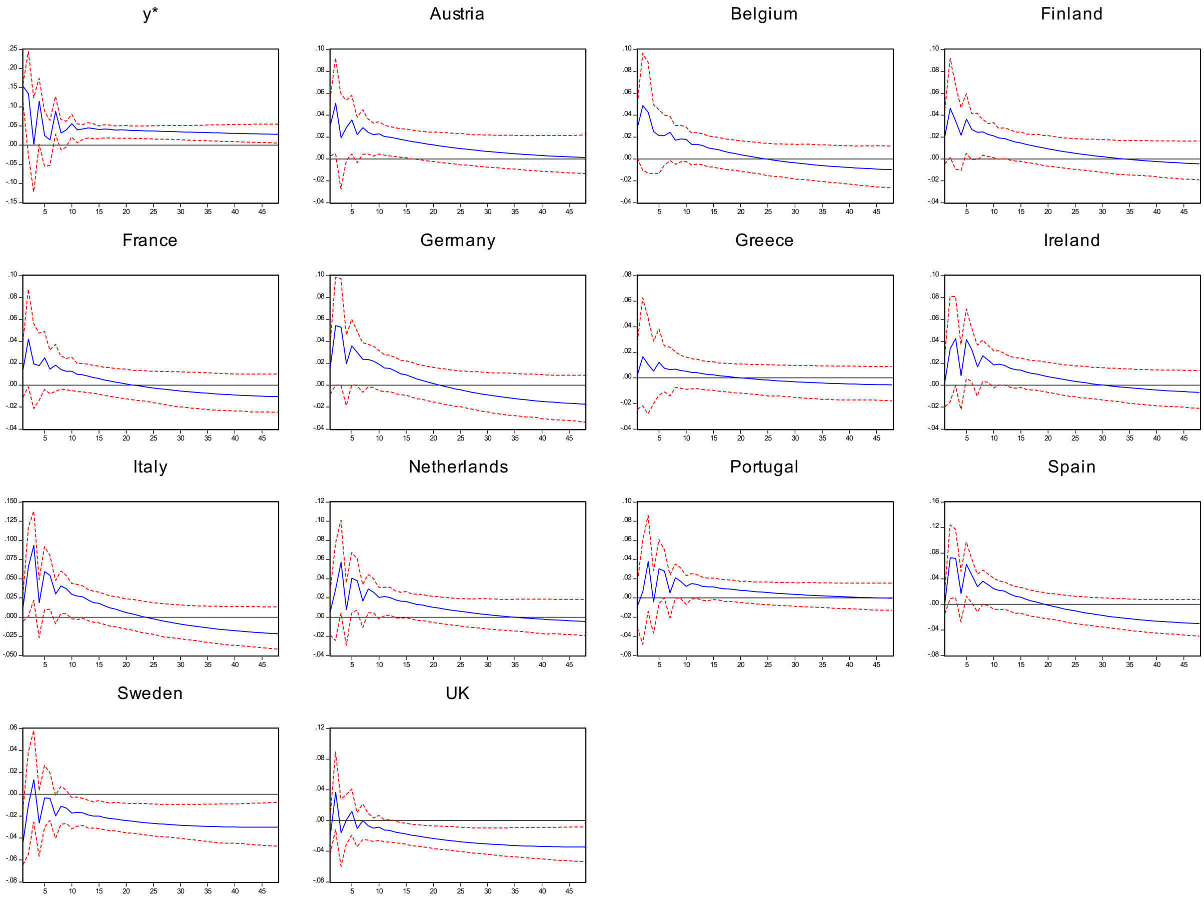
Figure 8
Impulse Response Functions: Economic Sentiment Indicator



Notes to Figure 8

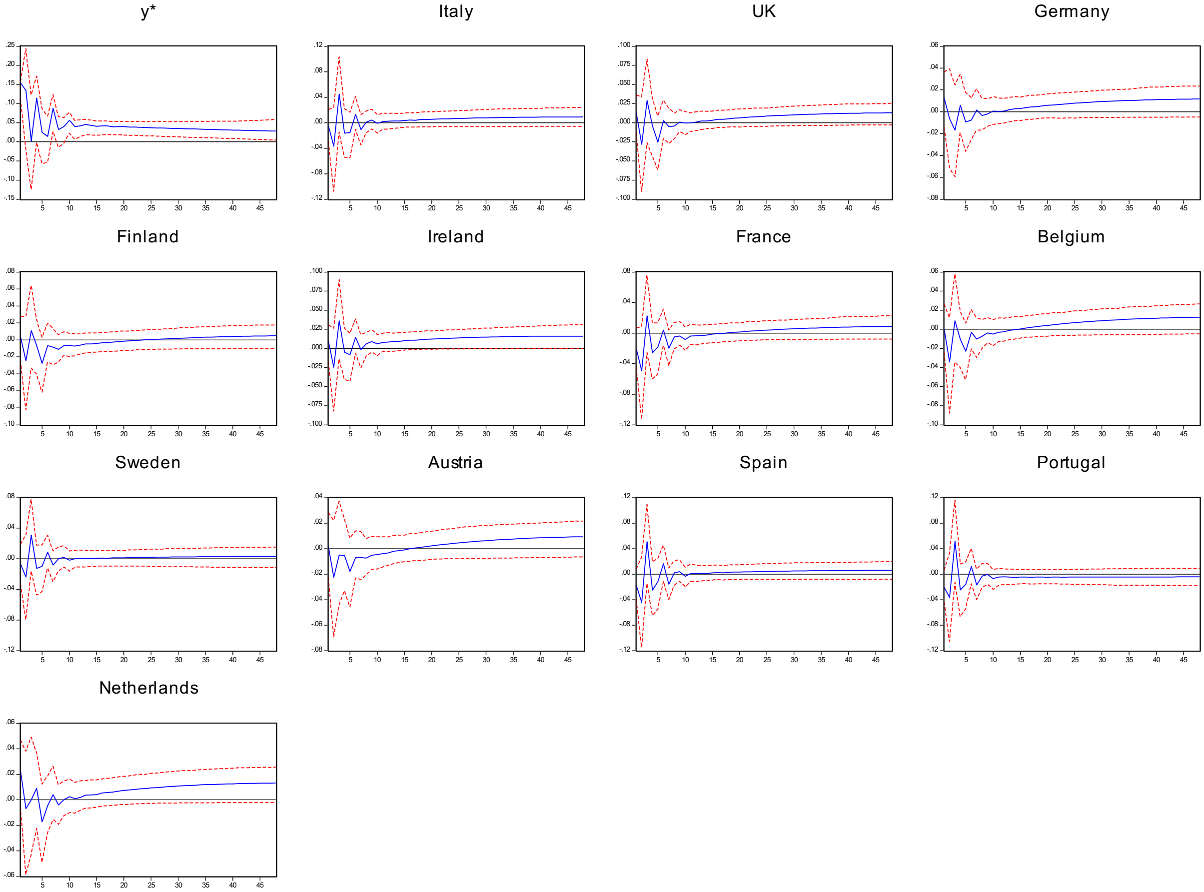
The Figure presents Impulse Response Functions (IRFs) for the Economic Sentiment Indicator (ESI), i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries.

Figure 9
Impulse Response Functions: Consumption



Notes to Figure 9
The Figure presents Impulse Response Functions (IRFs) for Consumption, i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries.

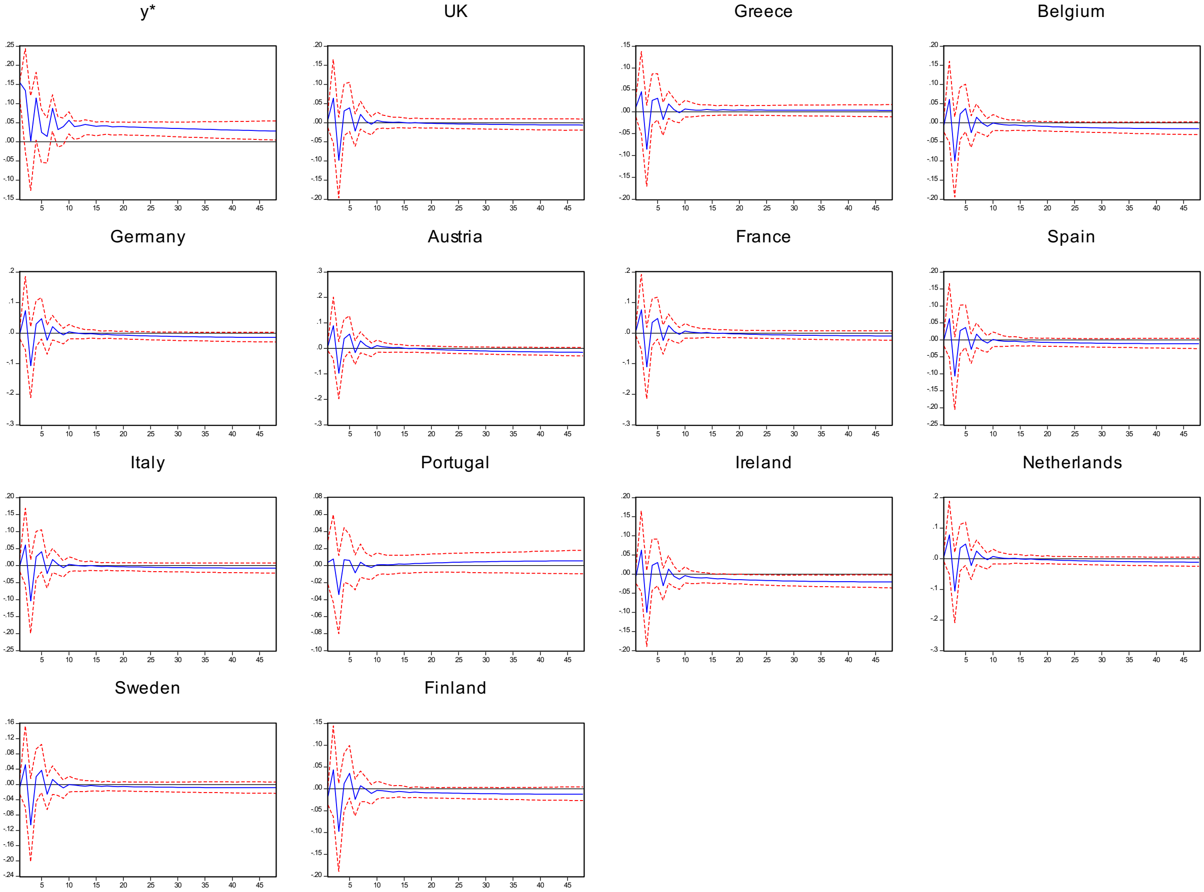
Figure 10
Impulse Response Functions: CDS Spreads



Notes to Figure 10

The Figure presents Impulse Response Functions (IRFs) for CDS Spreads, i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries. The Greek CDS spread is not included in the sample due to missing observations.

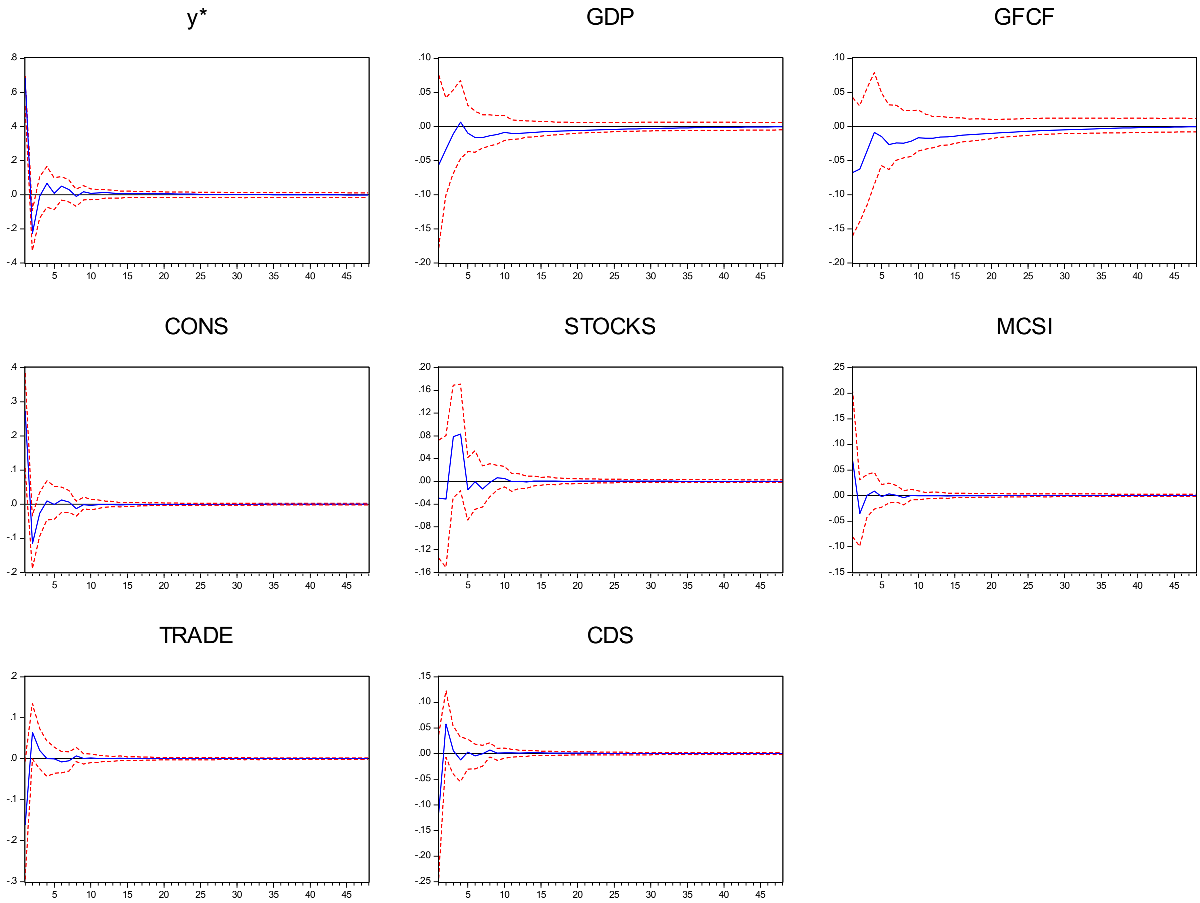
Figure 11
Impulse Response Functions: Stock returns



Notes to Figure 11

The Figure presents Impulse Response Functions (IRFs) for Stock returns, i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the sample countries. The sample countries are UK, Spain (SP), Portugal (PT), Italy (IT), the Netherlands (NL), Greece (GR), France (FR), Finland (FI), Belgium (BG), Austria (AT), Ireland (IE), Germany (DE), Sweden (SD) while the main stock indices used are FTSE100, IBEX35, PT PSI, FTSE MIB, AEX, ATHEX COMPOSITE, FRANCE CAC40, OMX HELSINKI, BEL20, ATX, ISEQ ALL SHARE, DAX30, OMXS30, respectively.

Figure 12
Impulse Response Functions: The US case



Notes to Figure 12
The Figure presents Impulse Response Functions (IRFs) for Gross Domestic Product (GDP), Gross Fixed Capital Formation (GFCF), Consumption (CONS), Stock returns of S&P500 (STOCKS), Michigan Consumer Sentiment index (MCSI), Trade Balance (TRADE) and 5yr CDS spreads (CDS), i.e. the response to a 1 standard deviation shock in the Brexit uncertainty variable, for the US country.