EUROPEAN CENTRAL BANK
EUROSYSTEM

Working Paper Series

Alina Bobasu, André Geis,
Lucia Quaglietti, Martino Ricci

Tracking global economic uncertainty: implications for the euro area

Revised June 2021

No 2541 / April 2021

Abstract

This paper sheds light on the impact of global macroeconomic uncertainty on the euro area economy. We build on the methodology proposed by Jurado et al. (2015) and estimate global as well as country-specific measures of economic uncertainty for fifteen key euro area trade partners and the euro area. Our measures display a clear counter-cyclical pattern and line up well to a wide range of historical events generally associated with heightened uncertainty. In addition, following Piffer and Podstawski (2018), we estimate a Proxy SVAR where we instrument uncertainty shocks with changes in the price of gold around specific past events. We find that, historically, global uncertainty shocks have been important drivers of fluctuations in euro area economic activity, with one standard deviation increase in the identified uncertainty shock subtracting around 0.15 percentage points from euro area industrial production on impact.

Keywords: Uncertainty, Forecast Errors, Stochastic Volatility, Proxy SVAR, Economic Activity.

JEL-Classification: D81, C11, C55, E32, F41, F62.

Non-technical summary

The outlook for euro area activity has become increasingly uncertain in recent years, reflecting global and domestic headwinds such as escalating trade conflicts, moderating Chinese demand, (geo-) political tensions and stress in several emerging economies. More recently, the Covid-19 pandemic has triggered an unprecedented rise in uncertainty, globally and in the euro area, with elevated uncertainty frequently singled out by the European Central Bank (ECB) and international institutions as an important driver of euro area economic developments. This paper sheds light on the impact of fluctuations in global uncertainty on the euro area economy. We follow a two-pronged approach where we estimate global as well as country-specific measures of economic uncertainty for fifteen key euro area trade partners and the euro area. The measures, which can be tracked over time and relate to fluctuations in real economic activity, are based on a specific notion of uncertainty. Specifically, in our set-up high uncertainty is associated with an inherent difficulty to predict economic outcomes. Our measures line up well to a wide range of historical events generally associated with heightened uncertainty and display a clear counter-cyclical pattern. In a second step, we estimate a Proxy Structural VAR to gauge the impact of global uncertainty shocks on the euro area economy, employing changes in the price of gold around specific past events as an external instrument. In addition to our uncertainty indicator, the model, estimated over the period July 2000 to December 2019, also includes a set of monetary, real and nominal variables. We find that, historically, global economic uncertainty shocks have been important drivers of fluctuations in euro area activity. A one standard deviation increase in the identified global uncertainty shock adversely affects euro area industrial production for up to 10 months. The biggest decline is observed on impact, when the dent to industrial production amounts to around 0.15 percentage points. Results suggest that economic uncertainty has been an important determinant of euro area industrial production also in recent years.

1 Introduction

By demanding "rigidly defined areas of uncertainty and doubt" philosopher Vroomfondel in Douglas Adam's "The Hitchhiker's Guide to the Galaxy" inadvertently captures one of the key features of uncertainty: it seems familiar to everybody but its quantification can be elusive. This reflects the intrinsically diffuse nature of the concept, which originates from a multitude of sources along different geographical dimensions. While the majority of existing studies analyse the effects of uncertainty in individual countries, financial globalization and the diffusion of new technologies have prompted the emergence of a recent literature which classifies instead uncertainty as a global phenomenon and assesses its effects on the global economy and on individual countries. Our paper feeds into this recent literature, and contributes to it in two ways. First, we develop econometric estimates of global uncertainty that are independent from any structure imposed by specific theoretical models as well as from single (or small number of) observable economic indicators. Second, we are the first to assess the impact of global macroeconomic uncertainty on the euro area economy by relying on a Proxy VAR, thereby offering an analytically sound identification of uncertainty shocks.

Several proxies of global uncertainty have been proposed in the literature. Berger et al. (2017) measure global uncertainty through the lens of a dynamic factor model with stochastic volatility covering 20 advanced economies. Their results indicate that uncertainty rose sharply in the past, such as in the early 1970s, in the 1980s and during the great recession. At the broadest degree of aggregation, Carriero et al. (2020) develop a measure of international macroeconomic uncertainty by means of a large vector autoregression to assess its bearing on a comprehensive set of economic and financial variables in advanced economies. Shen et al. (2017) apply the methodology proposed by Jurado et al. (2015) (henceforth JLN) to explore the effects of global uncertainty shocks on an array of global macroeconomic variables as well as on commodity markets. Compared to us, however, they rely on a more limited set of series. In assessing the impact of an increase in domestic uncertainty on the UK economy, Redl (2017) constructs a global measure which serves as a control variable for the effect of global uncertainty shocks. Carrière-Swallow and Céspedes (2013) survey cross-country heterogeneities in the reaction of investment and private consumption to global uncertainty shocks with a focus on differences between developed and emerging economies. At a more granular level, Mumtaz and Theodoridis (2017) and Ozturk and Sheng (2018) consider both common (global) and country-specific measures of uncertainty while Mumtaz and Musso (2019) add a regional angle. Bonciani and Ricci (2020) construct a measure of global financial uncertainty and study the impact on 44 economies. They find that sudden increases in global financial uncertainty depress both real and nominal variables, while the magnitude of the response varies with country specific characteristics and the state of the economy. Pfarrhofer (2019) analyses the impact of international macroeconomic uncertainty shocks using a Bayesian model with drifting coefficients and stochastic volatility in the errors, and finds that the impact of such shocks are sizable across countries. Cuaresma et al. (2019) investigate the macroeconomic consequences of international uncertainty shocks on $G7$ countries with a large-scale Bayesian vector autoregression featuring factor stochastic volatility and discover large effects in all economies considered. Finally, by scrutinising spillovers of uncertainty shocks in the United States and the euro area to third countries, Belke and Osowski (2019) introduce a cross-border perspective.

In this paper, we extend the methodology developed by JLN for the US to a large group of advanced and emerging economies covering 74 per cent of global output. Specifically, we estimate global as well as country-specific measures of economic uncertainty for fifteen key euro area trade partners and the euro area. Our indicators of uncertainty can be tracked over time and relate to fluctuations in real economic activity. Differently from alternatives based, for instance, on dispersion of forecasts from professional forecasters or on news, the approach used by JLN yields an *objective* measure of uncertainty. In line with JLN, we start from the premise that what matters for economic decision making is not whether particular economic indicators have become more or less variable or dispersed, but whether the economy has become more or less predictable. Compared to existing studies, our analysis is grounded on a much more sizeable data-set, affording robustness, with a notable rise or fall in uncertainty only occurring in the event of shifts in the conditional volatility of a large number of series. This is in line with uncertainty-based theories of the business cycle which typically predicate the existence of common (and often counter-cyclical) variation in uncertainty on a large number of series. To quote JLN - one "would expect to find evidence of an aggregate uncertainty factor, or a common component in uncertainty fluctuations that affects many series, sectors, markets, and geographical regions at the same time".

Our paper also contributes to the academic literature related to the identification of uncertainty shocks, since it pins down the direction of causality between uncertainty and economic variables with the aim to assess the magnitude of its impact. Among existing studies that identify uncertainty shocks, Bloom (2009) relies on a recursive strategy. This approach is questioned by Stock and Watson (2012), among others, as the exclusion restrictions implied by recursive identification postulates by definition that no shocks other than uncertainty contemporaneously affects activity. Other avenues suggested in the literature include imposing restrictions on structural shocks, such as for example in Caldara et al. (2016) who employ a penalty function within a VAR framework to disentangle financial from uncertainty shocks. Instrumenting for uncertainty is also a popular option in the literature. Baker et al. (2016) and Baker and Bloom (2013) instrument changes in the level and volatility of stock prices by natural disasters, terrorist attacks or political upheaval to determine the causal relationship between uncertainty and growth. Miescu (2019) approximates country-specific uncertainty shocks by the mean of global uncertainty to obtain a measure that is exogenous to domestic economic conditions. Piffer and Podstawski (2018) use variations in the price of gold, deemed a safe haven asset and thereby likely to be highly correlated with underlying uncertainty shocks, to identify uncertainty in the United States. In line with Piffer and Podstawski (2018), we propose an instrumental approach to identify uncertainty shocks within a structural Proxy VAR model. Alike them, we exploit variations in the price of gold around selected events and uses this as an instrument in the estimation. But we expand the scope of the original compilation of events by adding further episodes that may have resulted in elevated uncertainty, including in the 2016 to 2019 period. Thereby, we obtain variations in uncertainty that are occurring exogenously relative to the state of the economy.

Finally, our paper contributes to the literature that quantifies the impact of uncertainty on euro area economy activity. By now, several channels have been established that may serve as a conduit for uncertainty to affect the real economy, including adverse effects on investment and hiring decisions of companies, on savings and consumption preferences of households as well as on the availability and the cost of credit. Geographically, the empirical literature has typically focused on the US (Bloom, 2009), or on individual European countries (Adina and Smets (2010); Stephanie and Kannan (2013) Raïsa and Geert (2014)). For the euro area, studies have shown that uncertainty of households regarding their expected financial situation dampens private consumption. Uncertainty about production expectations and policy uncertainty has instead a negative impact on investment (2008Q1–2011Q4). More recently, Gieseck and Largent (2016) have provided a quantitative assessment of the impact of macroeconomic uncertainty on the euro area between 1999–2015 by using a multivariate structural VAR approach. They find that heightened macroeconomic uncertainty has a substantial negative impact on the euro area but the severity and duration of the effect differ depending on the uncertainty measure used in the analysis. Analysis of the impact of global uncertainty on the euro economy, the focus of our paper, has been comparatively scant.

The remainder of the paper is structured as follows: Section 2 describes our methodology. Section 3 presents the results of our analysis for the euro area while Section 4 concludes.

2 Econometric framework

2.1 Data

We rely on a rich dataset of monthly indicators, featuring country-specific and global macroeconomic variables. Specifically, we collect around 350 monthly indicators across sixteen advanced and emerging economies, including the euro area, for the period January 2000 to December 2019. Taken together, the countries we cover in the analysis represent around 74 per cent of world GDP. We complement our individual country data with a common panel of 24 global macroeconomic and financial variables. The indicators we select represent a wide range of macroeconomic time series, such as real output and income, employment, manufacturing production and retail sales, consumer spending, price indexes, credit growth and interest rates, all chosen on the basis of their timeliness and availability. The datasets remain unbalanced across countries, with advanced economies generally featuring more indicators due to better data availability. In order to avoid over-representing financial variables, which can easily dominate aggregate uncertainty as they are far more volatile than macroeconomic series, we only include a small set in each individual country panel, including interest rates across different maturities and stock market indexes. All indicators have been seasonally adjusted and made stationary where needed. In line with JLN, our estimation uses historical data, i.e. final data releases, thereby abstracting from preliminary series. A detailed description of the series is provided in Appendix A Section A.1.

2.2 Construction of Local and Global Uncertainty Measures

Following JLN, we derive global as well as country-specific measures of economic uncertainty for fifteen key euro area trade partners and the euro area that can be tracked over time. Formally, this requires us to estimate time varying volatilities for a large number of macroeconomic and financial series for each country and aggregate them at the country and global level. The remainder of this section explains the procedure to construct our uncertainty measures.[1]

[1]The exposition below draws substantially on JLN and Redl (2017) who also extends the procedure to a global context. Our exposition mainly modifies notation as we consider more countries as well as global variables to estimate the common factors. In addition, we depart from Redl (2017) for the methodology employed to estimate the global factor.

In order to estimate time-varying volatilities, we rely on a factor-augmented forecasting model which features for each country i a large number of macroeconomic series $y_{j,i,t} \in u_t = (y_{1,t}, y_{2,t}, ..., y_{N_i,t},)$, where N is the number of country-specific series used. In line with JLN and Ludvigson et al. (2015), the model can be summarised as follows:

$$y_{j,i,t+1} = \phi^y_{j,i}(L) y_{j,i,t} + \phi^F_{j,i}(L)\widehat{F}_{i,t} + \phi^W_{j,i}(L)\widehat{W}_{i,t} + v^y_{j,i,t+1}, \tag{1}$$

where $\phi^k_{j,i}(L)$ are finite order lag polynomials of order p_k for $K = \{y, F, W\}$. In practice, for each individual series we take a forecast $E[y_{j,i,t+1}]$ conditional on the information set $I_{i,t}$ available to the agents at time t. In equation 1, $\widehat{F}_{i,t}$ are common factors while $\widehat{W}_{i,t}$ contains factors which are drawn from the squares of the data and the squares of the first component of $\widehat{F}_{i,t}$, taken into consideration to capture potential non-linearities. This approach allows both the prediction errors and the factors $[\widehat{F}_{i,t}, \widehat{W}_{i,t}]$ to have time-varying volatility. Therefore, uncertainty is the result of stochastic volatility both in the series and the predictors. Differently from Redl (2017), each country data panel also contains a number of global variables $y^G_{j,t} \in \Upsilon^F_t = (y_{1,t}, y_{2,t}, ..., y_{M,t},)$ common to all countries. To a certain extent, this assumption is consistent with the evidence of globally synchronised business cycles (Imbs, 2003), as well as with the observed global co-movement of financial variables (Miranda-Agrippino and Rey, 2020) and their responsiveness to shocks in a center economy (i.e. the US).[2] Formally, uncertainty for each county i and each series j is defined as $u_{j,i,t}$:

$$u_{j,i,t} = \sqrt{E[(y_{j,i,t+1} - E[y_{j,i,t+1}|I_{i,t}])^2 | I_{i,t}]}, \tag{2}$$

the unforecastable component of the future value of the series, conditional on all information known at time t.[3]

Finally, to obtain country-specific and global measures of uncertainty we deploy three different methods: (i) a simple average of the identified uncertainty series to obtain country-specific uncertainty measures i and a simple average of those individual country measures to obtain a global measure, (ii) a simple average of the identified uncertainty series to obtain country-specific uncertainty measures for each country i and a weighted av-

[2]Relaxing this assumption does not substantially alter the estimation of the uncertainty measures.

[3]Following JLN, the stochastic volatility parameters are estimated using Markov chain Monte Carlo (MCMC) methods with the STOCHVOL package in R using the ancillarity-sufficiency interweaving approach discussed in Kastner and Frühwirth-Schnatter (2014).

erage of individual country measures employing GDP at purchasing power parity weights to obtain the global measure, (iii) a factor model including global and country-specific components.[4] The three methods are described in details below:

Method (i): Having obtained an uncertainty measure for each single series $u_{j,i,t}$, we compile country measures i by taking a simple average across all country-specific series:

$$u_{i,t} = \sum_{j=1}^{N_i} \frac{1}{N_i} u_{j,i,t}, \tag{3}$$

Global measures are then aggregated using simple averages across country-specific measures:

$$u_t^{global} = \sum_{i=1}^{K} \frac{1}{K} u_{i,t}, \tag{4}$$

where K is equal to the number of countries in our data set, namely 16.

Method (ii): Country-specific uncertainty measures are constructed as in Method (i), but the global measure is aggregated using GDP at purchasing power parity weights:

$$u_t^{global} = \sum_{i=1}^{K} \omega_{i,t} u_{i,t}, \tag{5}$$

where K, is equal to the number of countries in our data set, namely 16, and $\omega_{i,t}$ are time-varying GDP weights.

Method (iii): The third method relies on a two-level factor model, estimated by sequential-principal components, as explained in Breitung and Eickmeier (2014) and similarly to Bonciani and Ricci (2020):

$$u_{j,i,t} = \lambda'_{j,i} f_t^{global} + \gamma'_{j,i} f_t^{country} + \xi_{j,i,t} \tag{6}$$

where f_t^{global} represent the vector of global factors and $\lambda'_{j,i}$ the respective loadings with global factors assumed to load on all $u_{j,i,t}$. Conversely, $f_t^{country}$ and $\gamma'_{j,i}$ are country-specific factors and their respective loadings and are assumed to load on country i only. Finally, $\xi_{j,i,t}$ represents an idiosyncratic or variable-specific component. Following this approach, the global uncertainty measure u_t^{global} is the first principal component in f_t^{global}

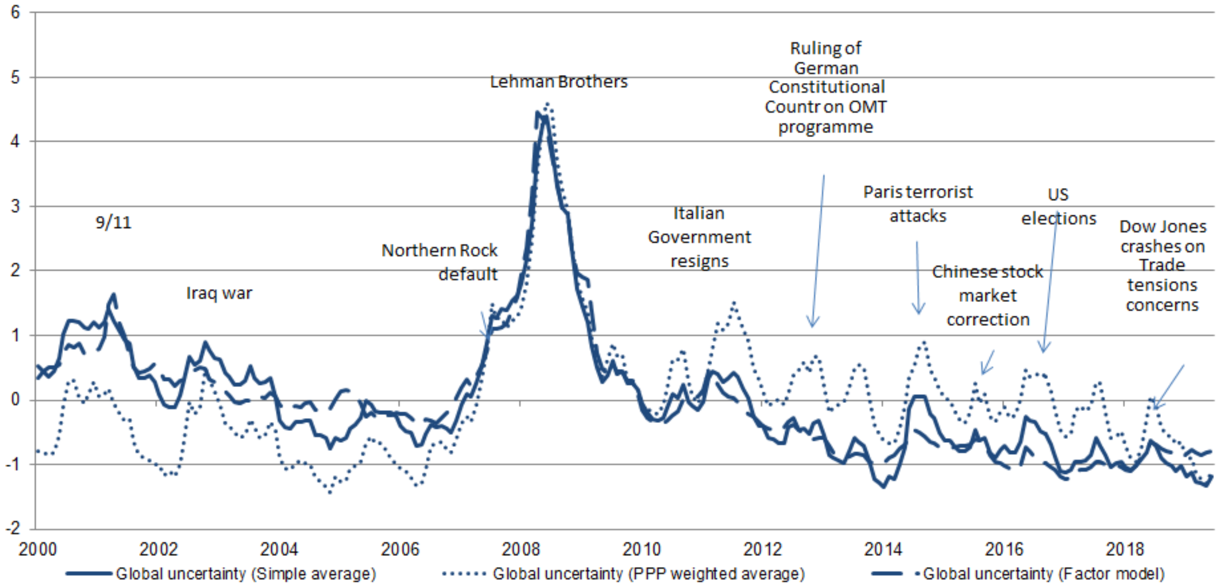
[4] In Appendix B Section B.3, we also show impulse responses related to the impact of a global uncertainty measure derived by using time-varying weights of each country's share in euro area foreign demand; loosely interpreted, this proxy can be seen as a measure of euro area foreign uncertainty.

and we consider this to be our baseline measure of global uncertainty, while country-specific measures of uncertainty $u_{i,t}$ are the first principal component in $f_t^{country}$. The advantage of this approach compared to other methods is that it allows for country-specific uncertainty shocks to also drive each series volatility.[5]

In Figure 1, our three measures of global economic uncertainty are plotted and juxtaposed against a variety of events commonly associated with elevated uncertainty, including the 9/11 attacks, the Iraq war, the failure of Lehman Brothers, the euro area sovereign debt crisis as well as the 2016 US presidential election. All measures are lining up reassuringly well with these events, with the escalating trade tensions between the US and China marking the latest increase at the end of our sample period.

Compared to other well known proxies from the literature, our baseline measure correlates well with the CBOE Volatility Index (VIX), a commonly used proxy for uncertainty (Figure 2) but shows more persistence and fewer spikes than news-based indicators, such as the Global Economic Policy Uncertainty (GEPU) index constructed by Baker et al. (2016), particularly in recent years and in periods of macroeconomic quiescence.

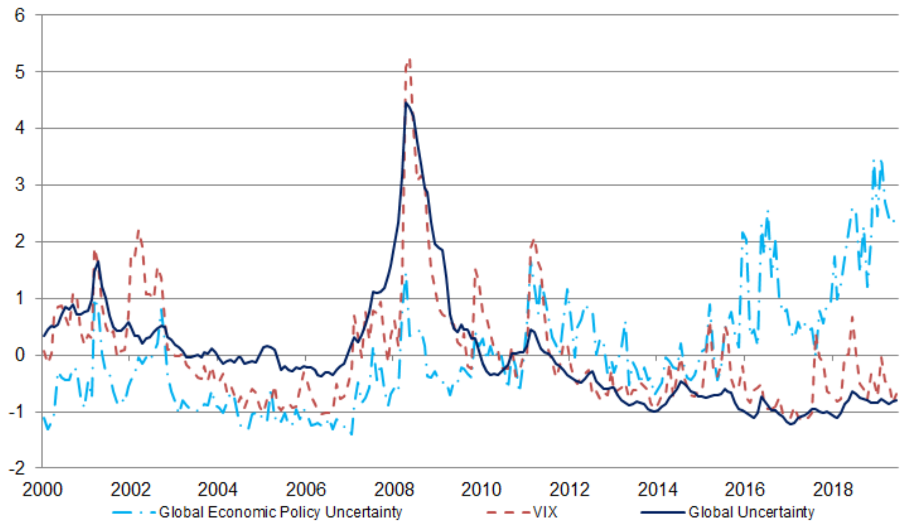
Figure 1: Global uncertainty measures against selected events



Note: Measures are standardised. Data are monthly and span the period 2000:7 to 2019:12.

[5]Details related to the estimation procedure of the factor model can be found in Appendix B.1.

Figure 2: Measures of Uncertainty

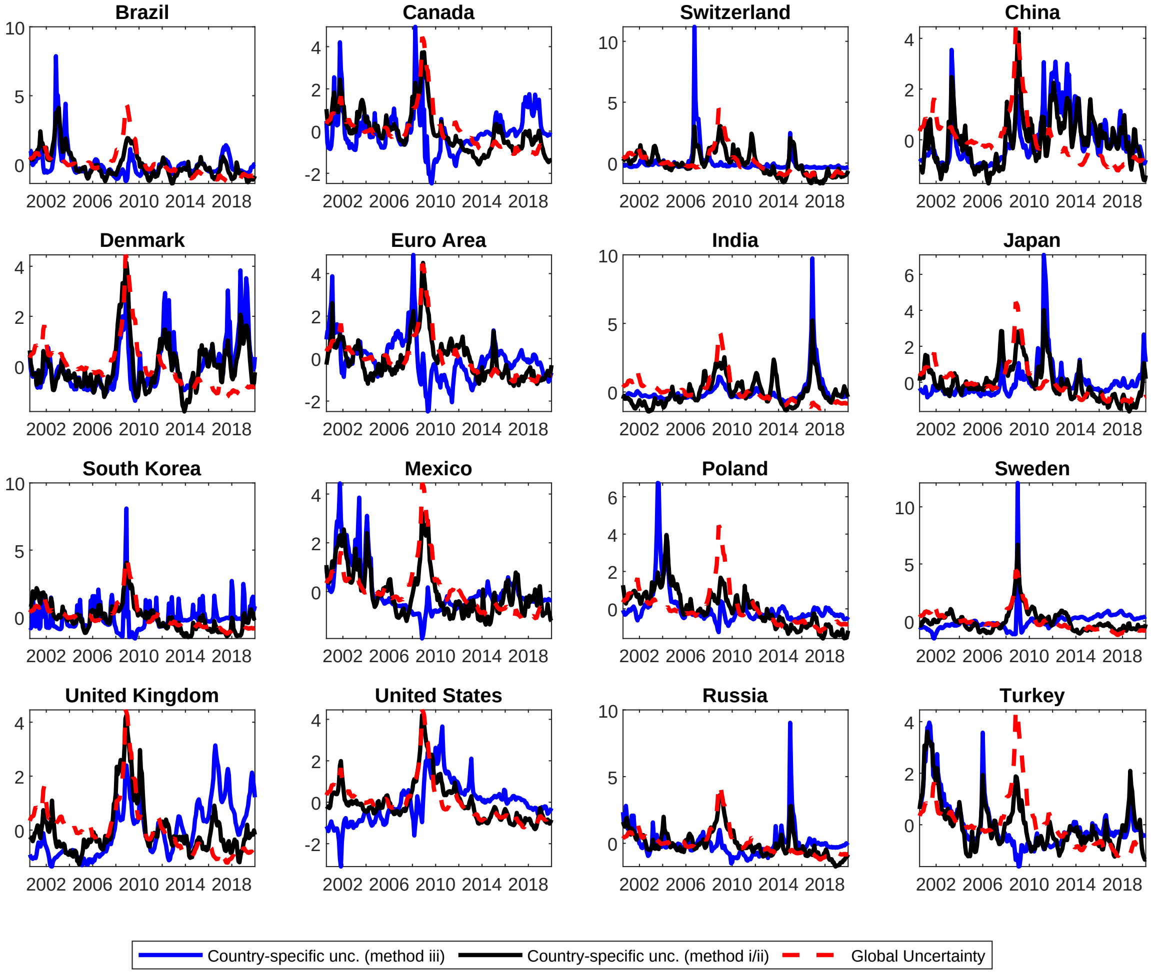


Note: Measures are standardised. Data are monthly and span the period 2000:7 to 2019:12. VIX refers to the CBOE Volatility index; the Global Economic Uncertainty Index has been constructed by Baker et al. (2016). The global uncertainty measure is the one obtained using the factor model as in Method (iii) (see equation 6) and depicted as the dark blue dotted line in Figure 1.

Figure 3 shows individual country measures of uncertainty obtained following JLN and Redl (2017) as defined in equation 3, against the country-specific uncertainty measures obtained from equation 6 and the baseline global uncertainty measure obtained following the same method. Reassuringly, those measures generally react to events that are likely to be associated with increases in global or local uncertainty. For example, in the United States and in its trading partners, including Canada, China, Japan and Mexico, uncertainty rose in response to the assertive trade policies of the Trump administration. Likewise, challenges to implement the Brexit referendum results lifted uncertainty in the United Kingdom in 2018. In the group of emerging markets, Turkey experienced a steep rise in uncertainty in mid-2018 on the back of political tensions that also triggered financial market stress and large capital outflows. In the case of Brazil, uncertainty increased in the run-up to the presidential elections of October 2018.

Our analysis also suggests that during periods of global stress and in their immediate aftermath, movements in uncertainty tend to be synchronised across countries. This is in line with recent evidence in the literature that deepening global financial integration over the last 30 years has increased the exposure of individual countries to common fi-

Figure 3: Country-specific Macroeconomic Uncertainty Measures



Note: Measures are standardised. Data are monthly and span the period 2000:7 to 2019:12. The blue line shows the country-specific uncertainty measures obtained using the factor model - Method (iii). The black line shows country-specific uncertainty measures obtained using equal weights across all $u_{i,j,t}$ *- Method (ii) and (iii). The red line shows our baseline global uncertainty measure, namely the one obtained using the factor model - Method (iii).*

nancial shocks (Miranda-Agrippino and Rey, 2020). The results generally point to a co-movement of country-specific uncertainty indicators with the global common factor, particularly around large-scale systemic events like the global financial crisis, when most countries in our sample experienced a surge in uncertainty. However, they also highlight the importance of idiosyncratic factors in shaping uncertainty in individual countries. It is interesting to note that country-specific uncertainty measures change along with the estimation method. For example, following equation 6, country-specific factors are by construction orthogonal to the global factor. Thus, we observe that countries with a high load on the global factor, such as the U.S., are only mildly correlated with measures constructed on the basis of Methods (i) and (ii). This reflects the fact that in countries with a strong global influence, uncertainty gets picked up by the global factor.

2.3 A Proxy SVAR with Global Uncertainty

In order to gauge the impact of global uncertainty shocks on the euro area economy we use the proxy SVAR methodology developed by Stock and Watson (2012) and Mertens and Ravn (2013). This method takes advantage of information "external" to the model to solve the identification problem embedded in structural VARs. Adapting Piffer and Podstawski (2018), we use changes in the price of gold around unanticipated, exogenous events that can be expected to have increased or reduced uncertainty. We establish that changes in the price of gold represent a reasonable proxy also in a global context. This reflects the fact that asset prices are perceived as safe havens, and tend to react to events which generate unexpected variations in uncertainty, independently of the geographical origin of the shock. This can occur when agents in one specific country respond to high uncertainty abroad by re-balancing their international portfolio towards safe assets for example, thus increasing their demand. We expand and refine the compilation of events originally proposed by Piffer and Podstawski (2018), building a new proxy consisting of thirteen events over the period January 2000 to December 2019. The events are listed in Appendix C. Figure 4 compares Piffer and Podstawski (2018)'s proxy of global uncertainty shocks to ours. The proxies are almost identical over the common period (2000-2015), with differences originating mainly from the fact that we re-balanced our sample towards global events, thereby de-emphasising country-specific idiosyncratic developments. In order to extend Piffer and Podstawski (2018)'s sample to the 2016-2019 period, we identify four additional events whose peaks, in general, appear intuitive when considering the nature of the underlying event. To pinpoint the precise time of impact of each event on the gold market, we rely on news releases from the Bloomberg News agency. Following Piffer and Podstawski (2018), we use intra-day physical gold prices quoted on the London spot market in the two daily auctions. We compute the proxy as the percentage variation of the price of gold between the last available auction price before the event and the first available auction price after the event. We then aggregate the daily price changes into a monthly time series which takes the value of zero in months where no event has been identified.

We use this proxy to identify uncertainty shocks within a monthly Structural VAR model featuring six variables: the change in the log of euro area industrial production, of euro area HICP, of euro area unemployment and of euro area stock prices as well as the shadow euro area short-term policy rate as derived by Wu and Xia (2016) and the baseline specification of our measure of global uncertainty obtained with Method (iii) in Section 2. We select this measure from the three outlined in Section 2 in light of its higher correlation with our proxy. The VAR is estimated using twelve lags over a sample spanning 2000M7 to 2019M12. The data included in the VAR model is reported in the Appendix B Section B.2.[6]

More formally, the reduced form model can be generalised as follows:

$$y_t = \lambda + A(L)y_{t-1} + u_t, \tag{7}$$

$$u_t = B\epsilon_t, \tag{8}$$

where y_t is the $k \times 1$ vector of endogenous variables, λ is the constant, $A(L)$ is a polynominal lag matrix and u_t is the vector of reduced error terms. The structural shocks are related to the VAR residuals u_t via equation 8, where ϵ_t is a $k \times 1$ vector of structural shocks whose variance–covariance matrix is normalised to the identity matrix. The aim is to identify the uncertainty shock ϵ_t^k. Let us consider the other structural shocks in the model as denoted by $\epsilon^{\backslash k}$.

Rewriting equation 8 above leads to:

$$u_t = B_u\epsilon_t^k + B_o\epsilon^{\backslash k}, \tag{9}$$

where B_u is the impulse vector of the uncertainty shock and B_o represents the impulse responses for the other structural shocks in the model. In order to identify the uncertainty shock one has to estimate B_u.

In order to serve as a valid instrument within our set up, the proxy Z_t needs to satisfy two main conditions at the same time: (i) it needs to be contemporaneously correlated with the structural shock of interest and (ii) should not be correlated with the other structural shocks.The two are respectively known as relevance and exogeneity conditions.

[6]The model is estimated using standard Bayesian techniques as well as standard priors using the Toolbox developed by Canova and Ferroni (2020). Additional details can be found in the Appendix B Section B.2.

More formally, in order to identify a structural shock ϵ_t^k, the valid instrument Z_t simultaneously needs to satisfy the two conditions:

$$E(Z_t \epsilon_t^k) \neq 0, \tag{10}$$

$$E(Z_t \epsilon_t^{\setminus k}) = 0, \tag{11}$$

Given the similarity of our proxy to the one built by Piffer and Podstawski (2018) over the sample 2000-2015 we mainly rely on the results of the exogeneity test performed by Piffer and Podstawski (2018).[7] Instead, we test for the relevance condition, reflecting the different focus and specification of our VAR model, by following Gertler and Karadi (2015) which test for whether the proxy is sufficiently correlated with the estimated reduced form shocks u_t. Formally, this entails regressing the reduced form shocks for each of the six variables included in our reduced form VAR on the proxy.

Table 1 shows the correlation and statistical significance of the instrument with the residuals of our baseline reduced form VAR. The results indicate that our instrument is positively, and highly significantly, correlated with the reduced form residuals associated with our measure of global uncertainty. Indeed, the value obtained from the F-Test is large and significantly above the threshold of 10. By contrast, the other variables featuring in our VAR are either negatively correlated with the instrument or statistically not significant, as indicated by the considerably lower F statistics. Moreover, Table 1 also suggests that our newly developed measure of global economic uncertainty does a better job of capturing uncertainty than other uncertainty proxies generally used in the literature. In order to test the correlation of the instrument with alternative uncertainty measures we re-ran our analysis by substituting the VIX and the economic policy uncertainty gauge of Baker et al. (2016) into the SVAR model, yielding lower values for the F-Test than our global uncertainty indicator in both cases. Finally, figure 4 plots the estimated structural shocks against the reduced form shocks and the proxy. The latter two share several peaks including, most notably, the 9/11 attack in 2001, and the collapse

[7] In addition, we perform further exogeneity tests by relying on shocks available in the literature, including oil, monetary, productivity and financial shocks. We also test for the correlation between our identified uncertainty shock and other structural shocks in the literature and find in general low correlations. The results are available upon request.

of Lehman Brothers in 2008.

Figure 4: Uncertainty Shocks and Instruments

Note: Positive values of the instrument and the shocks are associated with higher uncertainty. The lower panel compares our proxy with the one constructed by Piffer and Podstawski (2018) which ends in 2015 and is displayed at a value of zero thereafter. The shocks are extracted from our baseline SVAR.

Increases in uncertainty might also be associated with news shocks as suggested by Baker et al. (2016). In order to control for this, Piffer and Podstawski (2018) identify both an uncertainty shock and a news shock within a unified proxy SVAR framework, using the first principal component of an array of news shocks estimated in the literature and the proxy based on changes in the price of gold to identify news and uncertainty shocks respectively. The proxy based on the price of gold effectively picks up uncertainty shocks rather than financial or news shocks, with the latter displaying a stronger impact

Table 1: Tests on the Strength of the Instrument

	Equities	Uncertainty	Activity	CPI	Interest rates	Unemployment	VIX	EPU
IV (b)	-1.72**	9.75***	-0.3*	-0.01	-6.10*	0.01	21.8 **	25.36***
IV (se)	(0.57)	(1.84)	(0.13)	(0.02)	(2.62)	(0.02)	(6.14)	(5.69)
Obs.	221	221	221	221	221	221	221	221
F-Test	8.96	27.86	4.65	0.93	3.76	0.06	12.67	19.3

Notes: The correlations are computed with the reduced form residuals from a VAR with six variables, shown in column 1 to 6. IV refers to the instrumental variable in the model (the proxy). The residuals for the VIX and the EPU have been obtained by running the same model but with the VIX or EPU used instead of our uncertainty measure as estimated in the previous section; activity is industrial production; monthly observations are used. * p ¡ 0.05, ** p ¡ 0.01, *** p ¡ 0.001.

on financial variables compared to uncertainty shocks. By construction, our measure of global uncertainty and the proxy we use as instrument emphasise the uncertainty-related component of events, allowing us to correctly identify uncertainty shocks.[8]

3 Results

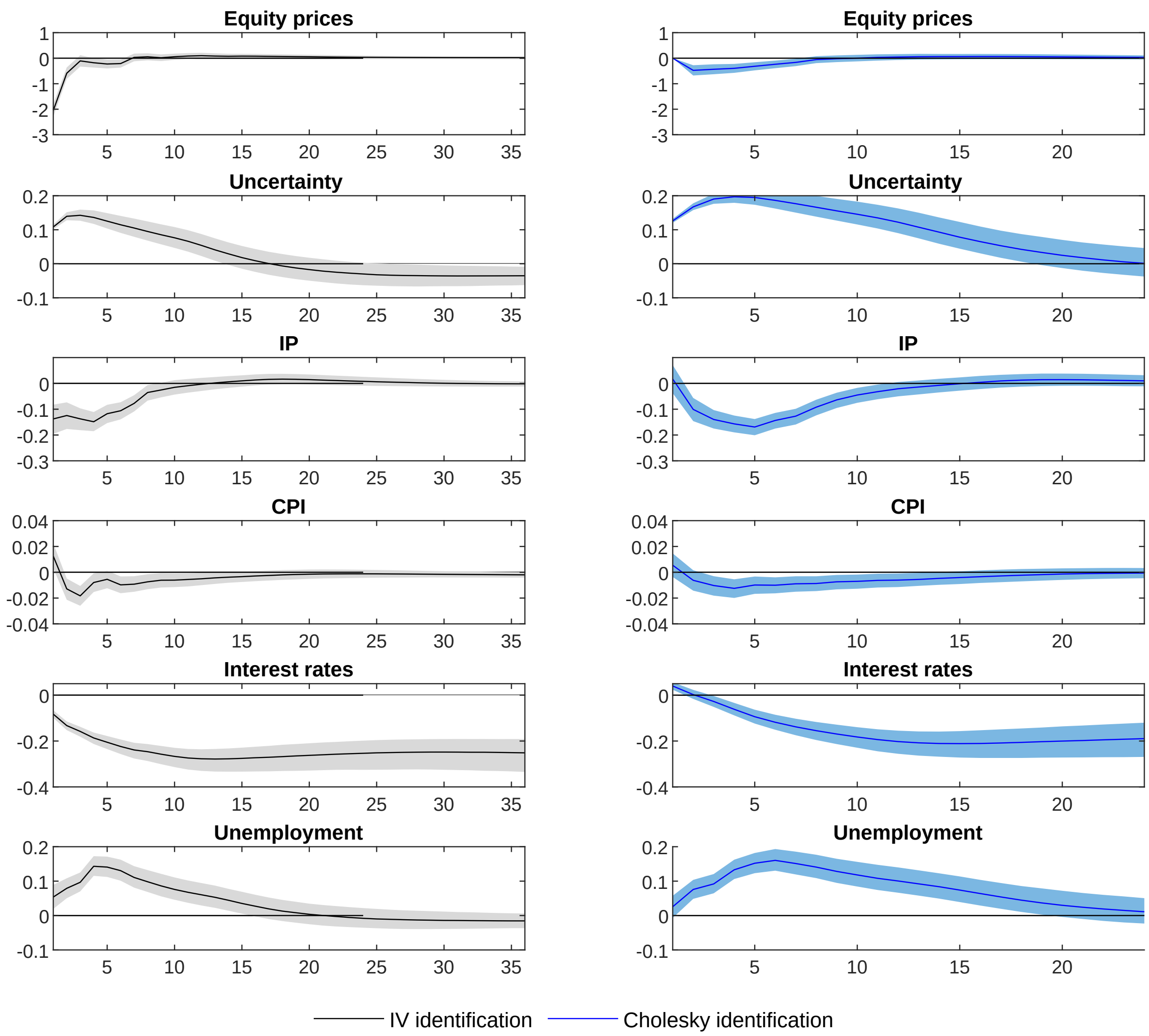
Results from the estimation suggest that global uncertainty shocks do matter for euro area activity and are significant in size. The left side of Figure 5 shows responses to a shock to global uncertainty as identified by our Proxy SVAR. A one standard deviation increase in the identified global uncertainty shock results in around 0.1 standard deviation increase in our global uncertainty measure, with the impact starting to dissipate after one year. Euro area industrial production declines by around 0.15 percentage points on impact before gradually rebounding to its pre-shock level within about ten months. Likewise, equity prices show a notable fall of about 2 percent but return to their pre-shock level after only four months, much more rapidly than the other variables in the model. By contrast, inflation rises only marginally, by around 0.02 percent on impact, and turns slightly negative thereafter. This result is consistent with previous studies which found little effect of uncertainty shocks on nominal variables. Reflecting subdued output dynamics, unemployment rise by around 0.2 percentage points. The central bank reacts to a larger output gap by reducing interest rates by around 0.3 percentage points.

On the right side of Figure 5, we compare the impulse-response functions obtained in our baseline specification with those from an identical VAR where the impact of uncertainty shocks is estimated by Cholesky ordering where our newly developed measure of

[8]For robustness purposes we have checked the correlation between the uncertainty shock identified in our proxy SVAR and the news shock identified by Piffer and Podstawski (2018). The correlation is extremely low, namely 0.02, proving that the global uncertain measure does not pick up news shocks.

global uncertainty is put second after equity prices.[9] Overall, global uncertainty shocks generate milder dynamics within a Cholesky identification. Most euro area variables, including activity, prices and financial variables react less to the uncertainty shock than in the proxy setup with some variables not reacting at all on impact, in line with the contemporaneous restrictions implied by Cholesky ordering.

Figure 5: Baseline: The Impact of Global Uncertainty Shocks on the Euro Area

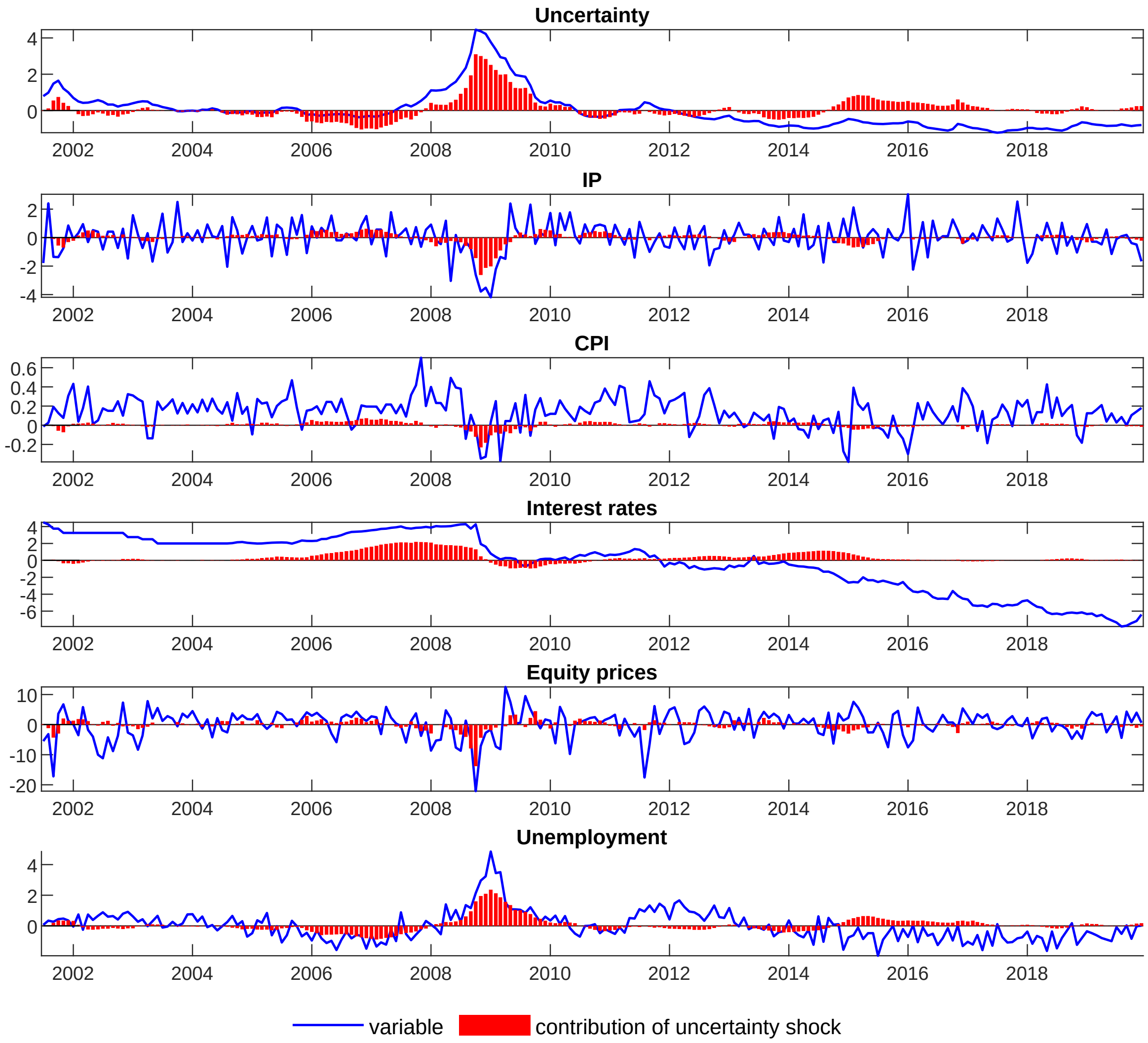


Note: The panels show impulse responses for a one standard deviation increase in the the identified shock to global uncertainty. The shaded areas show 68% credibility intervals.

To complement the impulse-response analysis above, we investigate the contributions of global uncertainty shocks in recent years by the mean of a historical decomposition

[9]Cholesky ordering is considered standard in the literature, see for example Bloom (2009) and JLN. For an alternative ordering, see Section B.4 in the Appendix.

Figure 6: Historical Decomposition



Note: The historical decomposition is obtained from our Proxy SVAR baseline model. Data are monthly and span the period 2000:7 to 2019:12. The actual series (solid lines) are expressed in deviations from their respective estimated means.

(Figure 6). The top panel indicates that changes in our measure of global economic uncertainty reflect not only uncertainty but also other shocks not identified by our model. During the global financial crisis, for instance, uncertainty shocks accounted for the bulk of the rise in global uncertainty. By contrast, during the taper tantrum in 2013 and the slowdown in Chinese economic activity in 2015, a combination of shocks was at play. In 2019, uncertainty shocks have been responsible for around 20 percent of the increase in the indicator.

Turning to euro area industrial production, global uncertainty shocks contributed to its weakness during the global financial crisis, subtracting around one third from its level. With the dissipation of the shock, industrial production recovered by a similar amount. In the second half of 2019, global uncertainty was again a drag on euro area economic activity, detracting 0.14 percentage points from the level of industrial production.

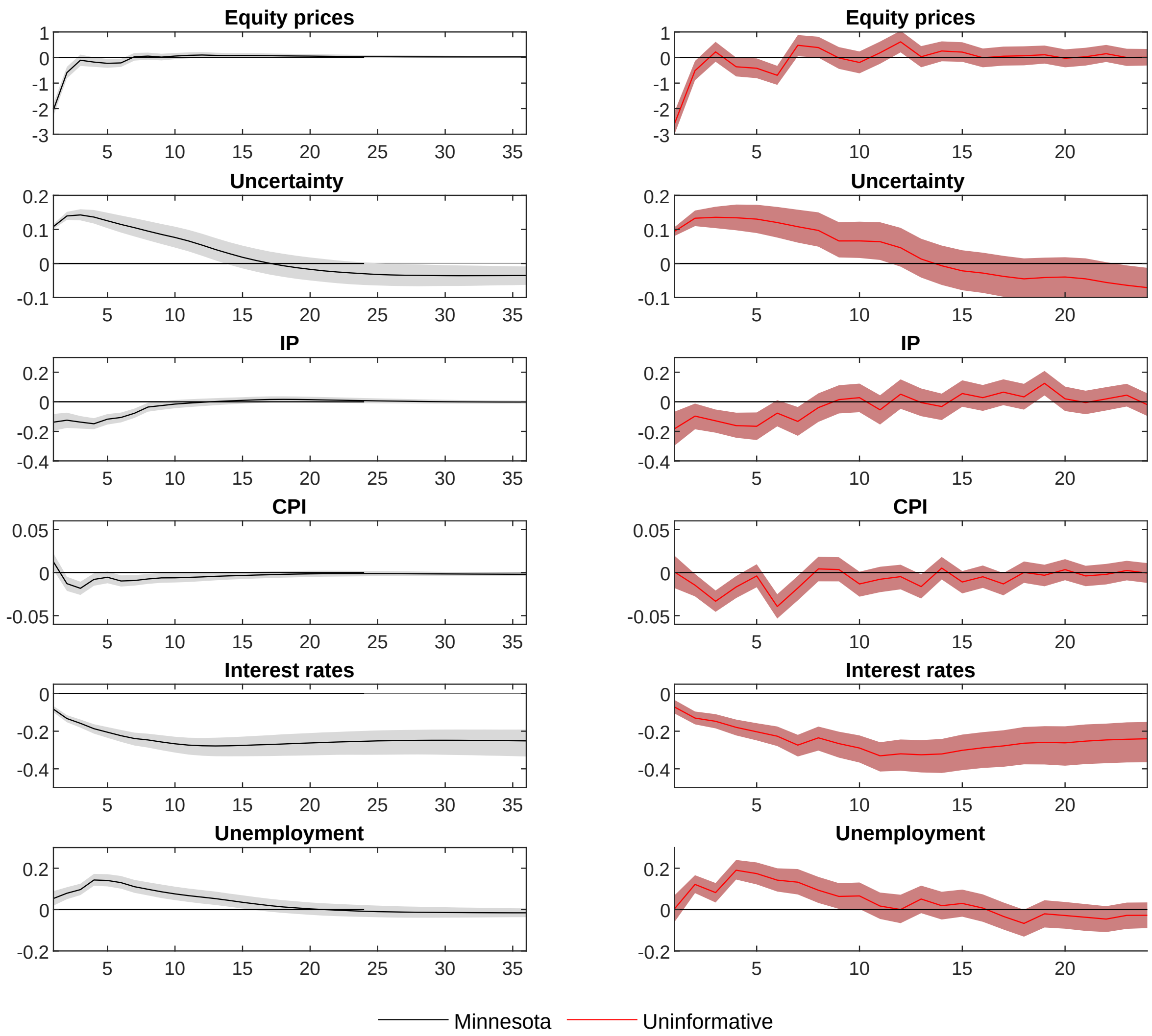
3.1 Robustness Tests

In order to check the accuracy of our results, we perform several tests which demonstrate the overall robustness of our findings to different specifications, types of priors and aggregation schemes for our global uncertainty measure. In a first exercise, we compare our results with the outcome of an alternative model using uninformative priors (Figure 7). Effects of uncertainty shocks are rather similar to the ones obtained in our baseline specification, although the uninformative priors yield more volatile impulse-response functions than the Minnesota approach embedded in our model.

Secondly, we test the robustness of our results against two different specifications of the Proxy SVAR featuring two alternative weighting schemes used to derive our global uncertainty measure (see Section 2.2). Figures 8 and 9 suggest that our results are robust to these alternative specifications, pointing to similar shapes and magnitudes of the impulse-response functions compared to the baseline specification.

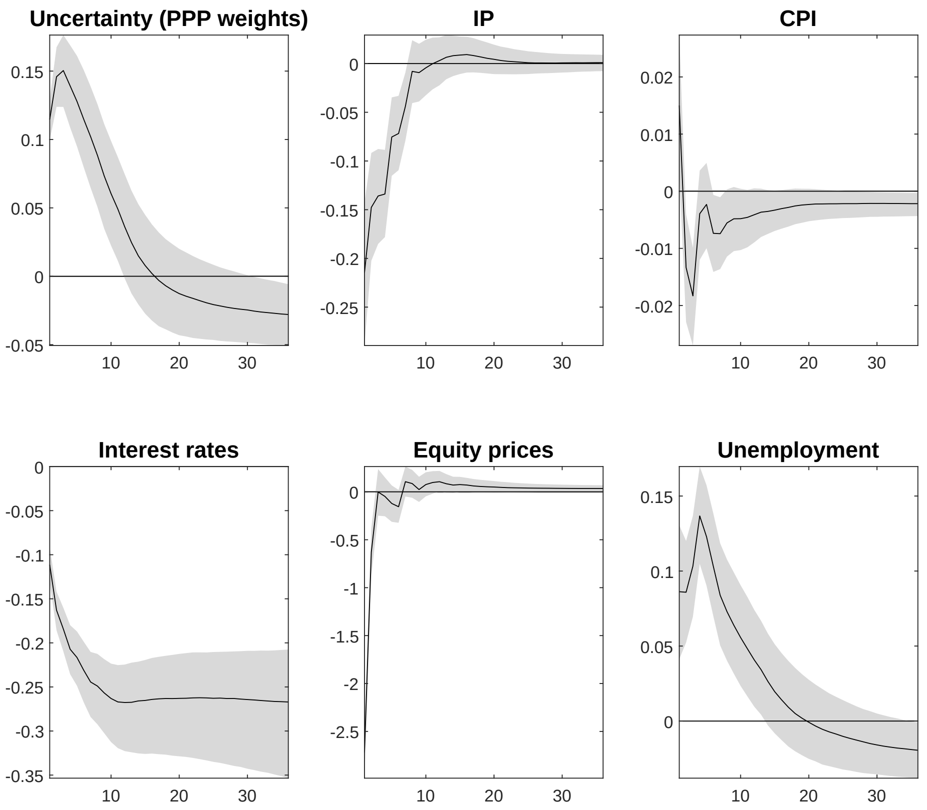
Lastly, we perform additional checks by changing the ordering of the global uncertainty measure in the Cholesky framework and by adding the VIX to the baseline model. We report these results in Appendix B.4. Changing the ordering of the global uncertainty measure in the Cholesky framework does not affect the results. Figure 11 compares our baseline model specification with a Cholesky ordering where uncertainty is placed second to last, before equity prices. Responses to the uncertainty shock are still significant and qualitatively similar to the results presented in Figure 5, suggesting that a different ordering of the uncertainty variable doesn't alter our conclusions. Likewise, adding the VIX to the baseline model does not qualitatively change our results. The impulse-response functions are still significant and preserve their shape (Figure 12), with the VIX picking up only a little of the variation of the variables employed.

Figure 7: Different Prior Specification



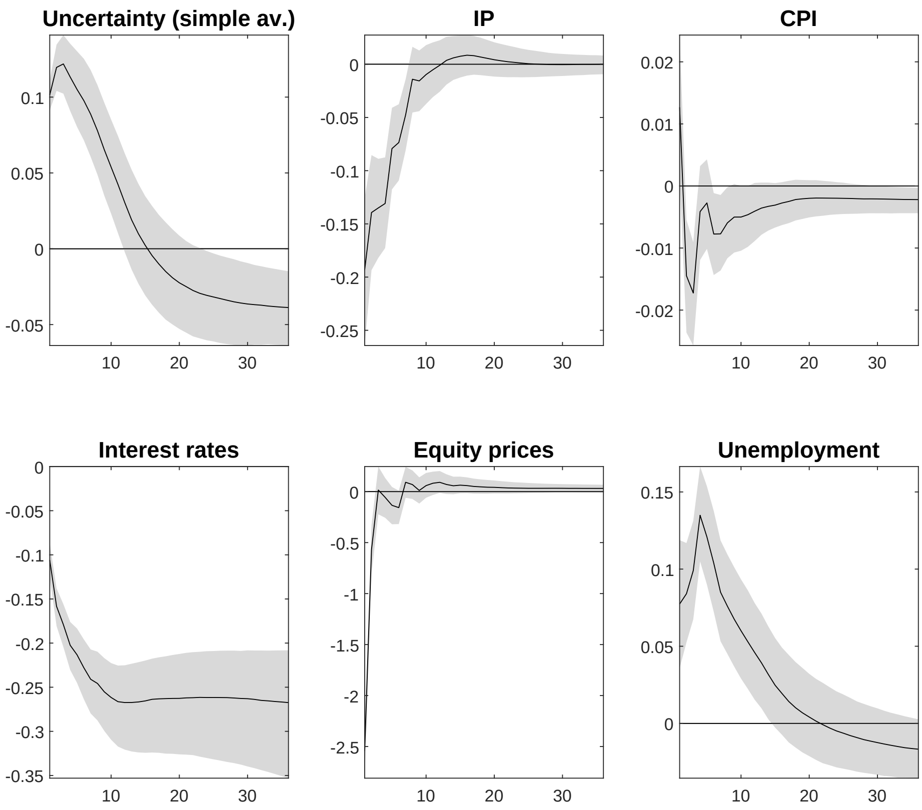
Note: Impulse responses to a one standard deviation increase in the identified shock to global uncertainty. The shaded areas show 68% credibility intervals.

Figure 8: Uncertainty Aggregation with PPP GDP Weights



Note: Impulse responses to a one standard deviation increase in the identified shock to global uncertainty. The shaded areas show 68% credibility intervals.

Figure 9: Uncertainty Aggregation with Equal Weights



Note: Impulse responses to a one standard deviation increase in the identified shock to global uncertainty. The shaded areas show 68% credibility intervals.

4 Conclusions

Despite its size, the euro area remains a relatively open economy, particularly when compared with other major countries. In addition, its trade and financial linkages to the rest of the world have been increasing over time. As a result, rising uncertainty in its trade partners - and globally - has the potential to affect the euro area economy to a significant degree. However, to date the effects of developments in global uncertainty on euro area activity have received little attention compared to those related to uncertainty originating domestically. By providing estimates of the impact of global uncertainty on euro area activity, this paper aims at filling the gap in the literature. We extend the methodology of JLN and estimate global as well as country-specific measures of economic uncertainty for fifteen key euro area trade partners and the euro area that can be tracked over time and relate to fluctuations in real economic activity. Our measures display a clear counter-cyclical pattern when put in relation to economic activity and line up well to a wide range of historical events generally associated with heightened uncertainty. Furthermore, we estimate a Proxy SVAR in which we instrument uncertainty shocks with changes in the price of gold around specific historical events. We find that global uncertainty shocks have been, and continue to be, an important driver of fluctuations in euro area activity. Specifically, our results indicate that a one standard deviation global uncertainty shock subtracts around 0.15 percentage points from euro area industrial production on impact. These results are broadly in line with similar studies in the empirical literature. In addition, we find that economic uncertainty explains a significant part of the variation of euro area industrial production, especially since the global financial crisis. In this regard, our analysis also bears important policy implications: At the most basic level, monitoring and tracking uncertainty is warranted as its fluctuations over time, irrespective or their geographical origin, seem to have a considerable bearing on a wide range of economic variables. Going further, careful policy design that keeps uncertainty in check, both at the national and at the global level can pay large dividends, thereby improving economic outcomes.

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A Appendix

A.1 Data Sources

Brazil: Capacity Utilization (SA %), Real Turnover in Manufacturing (SA,2006=100), Retail Sales (SA, 2014=100), Exports of goods (SA, Mil.US$),Imports of goods(SA, Mil.US$), Hours worked in Production (SA, 2006=100), Business Confidence Index (SA, Dec-01=100), Monetary Base (EOP, SA, Mil.Reais), Selic Target Interest Rate (EOP %) Foreign Exchange Rate Commercial Bid(Avg, Reais/US$), Total Private Sector credit growth (EOP, NSA, Mil.R$),Total Public Sector credit growth (EOP, NSA,Mil.R$), Stock Price Index Bovespa (29Dec1983=100).

Canada: Terms of Trade (SA, 2010=100), All Industries GDP(SAAR, Mil.Chn.2012.C$), Employment Rate(SA, %) Actual Hours Worked(SA, Thous.Hrs), Dwelling Starts(SAAR, Thous.Units) , Real Shipments in Manufacturing(SA, Mil.2012.$), New Motor Vehicle Sales(NSA, Units), Wholesale Sales(SA, Thous.C$), Residential and Nonresidential Building Permits(SA, Thous.C$), Total Merchandise Exports(NSA, Thous.C$), Total Merchandise Imports(NSA, Thous.C$), Chain Fisher BoC Commodity Price Index(NSA, Jan-72=100), Car and Truck Production (NSA, Units), Target Rate (average, percent), Bank of Canada Rate (AVG, %) 3-Month Treasury Bill Tender(AVG, %), 10-Year and Over Bond Yield(Monthly Avg, %), U.S. Dollar Exchange Rate (Avg, C/US), S&P/TSX Composite, Close, Consumer Credit at Month-End(EOP, SA, Mil.C$),Business Credit(SA, Mil.C$),M1+ (SA, Mil.C$), M1++ (SA, Mil.C$), M1B (SA, Avg, Mil.C$), M2 (SA, Avg, Mil.C$) M1 Component Currency Outside Banks (Avg/Weds, SA, Mil.C$).

Switzerland: Exports [Chained] (SA, 1997=100), Imports [Chained] (SA, 1997=100), Overnight Stays (NSA, Nights), Central Government Finance Expenses (NSA, Mil.Francs), Unemployment Rate (SA,%), SNB Business Cycle Index (%), Business Surveys Business Climate (SA,%), Business Surveys Business Plans (SA,%), Business Survey Order Books Assessment (SA,%), Business Surveys Expected Orders Inflow Next 3 Months (SA, %), Business Survey Export Order Books Assessment (SA, %), KOF Economic Barometer (LT AVG, 2009-2018=100), Sentix Overall Economic Index (NSA, %Bal), Consumer Price Index (NSA, Dec-15=100),Producer Price Index All Items (NSA, Dec-15=100),Export Price Index (NSA, Dec-15=100),Import Price Index (NSA, Dec-15=100), Money Supply, M1 (NSA,EOP, Mil.Francs),Money Supply M3 (NSA,EOP, Mil.Francs), Domestic Bank

Loans Credit Lines (EOP, NSA, Mil.CHF), Domestic Bank Loans to Households Credit Lines (EOP, NSA, Mil.CHF), Total Bank Loans to Nonfinancial Corporations Credit Lines (EOP, NSA, Mil.CHF), Swiss Market Index (AVG, Jun-30-88=1500), 10-Year Government Bond Yield (AVG, %), Nominal Effective Exchange Rate (NSA, Dec-00=100), PMI Manufacturing (SA, 50+=Expansion), PMI Manufacturing Output (SA, 50+=Expansion).

China: Merchandise Exports, fob (NSA, Mil.US$), Merchandise Imports, cif (NSA, Mil.US$), Retail Sales (NSA, Y/Y %change),Investment in Fixed Assets (YTD, NSA, Y/Y %Chg), Real Industrial Value Added (NSA, Y/Y %Chg), Consumer Confidence (NSA, 100+=Optimistic, Money Supply M2 (EOP, SA, Bil.Yuan),Monetary Authority: Reserve Money (EOP, SA, 100 Mil.Yuan),90-day Interbank Rate (Weighted Avg, % per annum),Total Loans (EOP, NSA, 100 Mil.Yuan).

Denmark: Retail Trade excl Motor Veh & Motorcycles (SA, 2015=100), New Passenger Car Registrations (SA, Units),Export Volume Index (NSA, 2015=100),Import Volume Index (NSA, 2015=100), Industrial Confidence Indicator (SA, % Bal),Consumer Confidence Indicator (NSA, %Bal), Harmonized Consumer Price Index (NSA, 2015=100), OMX Copenhagen Stock Exchange Share Prices (Dec-31-95=100), Government Bonds [Redemption Yield] (% per annum), Manufacturing PMI (SA, 50+=Expansion), PMI Manufacturing Output (SA, 50+=Expansion), PMI Manufacturing New Orders (SA, 50+=Expansion).

Euro area: HICP Consumer Prices(SA, 2015=100), Industrial Production Industry Including Construction (SWDA, 2015=100), Industrial Production Manufacturing (SWDA, 2015=100), Unemployment Rate (SA, %), Industrial Turnover in Manufacturing (SWDA, 2015=100), Retail Trade Excluding Autos & Motorcycles (SWDA,2015=100), Consumer Confidence Indicator (SA, %), Industrial Confidence Indicator (SA, %), Money Supply M1 (EOP, SWDA, Bil.EUR),Money Supply M2 (EOP, SWDA, Bil.EUR), Money Supply M3 (EOP, SWDA, Bil.EUR), Sales & Securitization Adjusted Lons(EOP, SWDA, Bil.EUR), 3-Months EURIBOR (%), 10-Year Government Benchmark Bond Yield (AVG, %), EURO STOXX Price Index (Dec-31-91=100), PMI Manufacturing (SA, 50+=Expansion).

India: Industrial Production (SA, Apr.11-Mar.12=100),Merchandise Imports, c.i.f. (SA, Mil.US$),Money Supply M1 (EOP, SA, Bil.Rupees), JPMorgan Real Broad Effective

Exchange Rate Index (2010=100),Rupee/US$ Exchange Rate (AVG), Stock Price Index NSE 500 (AVG, 1994=1000), 91-Day Treasury Bill Implicit Cut-Off Yield (% per annum),364-Day Treasury Bill Implicit Cut-Off Yield (% per annum), 10-Year Government Bond Yield (EOP, % per annum),Money Supply M3 (EOP, SA, Bil.Rupees), Reserve Money (EOP, SA, 10 Mil.Rupees),Commercial Banks Loan to Deposit Ratio (EOP, %).

Japan: Consumer Confidence Index, Small Business Sales Forecast (Diffusion Index),Real Synthetic Consumption Index (SA, 2011=100), New Motor Vehicle Registrations (Thous Units),Machinery Orders Received (SA, Mil.Yen), Mining and Manufacturing Production (SA, 2015=100),Operating Rate in Manufacturing (SA, 2015=100) Real Imports (SA, 2015=100),Capital Goods Producers shipments (SA, 2015=100), Durable Consumer Goods Producers shipments (SA, 2015=100), New Housing Construction Started (SA, Mil.Sq.Meters), Total Employed (SA, 10,000 Persons), Unemployment Rate (SA, %), Ratio of Active Job Openings to Applications (SA, Ratio), Real Effective Foreign Exchange Rate (2010=100),General Consumer Price Index (NSA, 2015=100), CPI Ku-area of Tokyo(NSA, 2015=100),Building Starts Nonresidential (NSA, Bil.Yen), Housing Starts New Construction (SA, Thous Units), Machinery Orders Received (SA, Mil.Yen), Spot Exchange Rate Yen/US$ (AVG, Yen/US$),Average Contract Rate on Total Loans of Domestic License Banks (%), Average Contracted Rate on Long-Term Loans of Domestic Licensed Banks (%), Average Interest Rate on New Loans & Discounts of Domestic licensed Banks (NSA, %), Average Interest Rate on New short-term Loans & Discounts (%), 10-Year Benchmark Government Bond Yield (AVG, % p.a.),Nikkei Stock Average (EOP, Yen).

South Korea: Coincident Composite Index (SA, 2015=100), Merchandise Exports (SA, Bil.Won), Merchandise Imports (SA, Bil.Won), All industries Shipments (SA, 2015=100), All Industries inventories (SA, 2015=100), Retail Sales Volume Index (SA, 2015=100), Registered Motor Vehicles: Passenger Cars (EOP, NSA, Units),Unemployment (SA, Thous), All Industry Production including Construction (SA, 2015=100) Manufacturing Industrial Production (NSA, 2015=100),Bank of Korea Base Rate (% per annum), Interest Rates on to Corporations (% per annum),Interest Rates on New Loans to Households (% per annum), Basic US$ Rate (Avg, Won/$),Reserve Money (Avg, SA, Bil.Won), Stock Price Index Korea Composite [KOSPI] (Jan-04-80=100), MSCI Share Price Index (US$,AVG, Dec-87=100).

Mexico: Economic Activity Indicator (SWDA, 2013=100), Industrial Production (SA, 2013=100), Industrial Production of Primary Metal Manufacturing (SA, 2013=100),Industrial Production of Utilities (SA, 2013=100), Industiral Production of Electric Power Generation, Transmiss & Distribution, Retail Sales Volume, Exports, fob (SA, Mil.USD), Imports, fob (SA, Mil.USD), Nonpetroleum Exports (SA, Mil.USD), Worker's Remittanances (NSA, Mil.USD), JPMorgan Real Broad Effective Exchange Rate Index, PPI Based (2010=100), Exchange Rate (NewPeso/US), Stock Price Index IPC, 91-Day Treasury Certificates [CETES] (%), 364-Day Treasury Certificates [CETES] (%), Coincident Index IMSS Insured Workers (NSA, LT Avg=100), Consumer Price Index (NSA, Jul 16-31 2018=100), Consumer Price Index (NSA, Jul 16-31, 2018=100), CPI of Food, Beverages & Tobacco (NSA, Jul 16-31 2018=100), Final Goods Domestic Demand (NSA, Jul-19=100), Monetary Aggregates M1 (EOP, SA, Mil.Pesos).

Poland: Manufacturing Index of Overall Economic Climate (SA, % Bal), Retail Sales in Constant Prices (SA, 2015=100), Industrial Production excluding Construction (NSA, 2015=100), Industrial Production in Manufacturing (NSA, 2015=100), Construction & Assembly Production (SA, 2015=100), Housing Dwellings Completed (SA, Units), JP-Morgan Real Broad Effective Exchange Rate Index PPI Based (2010=100), Money Supply Narrow Money M1 (EOP, SA, Mil.Zloty), Money Supply Broad Money M2 (EOP, SA, Mil.Zloty), Money Supply M3 (EOP, SA, Mil.Zloti), Average Paid Employment Enterprise Sector (SA, 2010=100), Total Exports fob (SA, Mil.Zloty), Total Imports, cif (SA, Mil.Zloty).

Sweden: Retail Trade Volume Excl Fuel (SA, 2015=100), New Car Registrations (NSA, Units), Merchandise Exports (TC, Mil.Kronor), Merchandise Imports (TC, Mil.Kronor), PMI in Manufacturing (SA, 50+=Expansion), Manufacturing Production (SA, 50+=Expansion), PMI Manufacturing New Orders (SA, 50+=Expansion), PMI Manufacturing Export Orders (SA, 50+=Expansion), Economic Tendency Indicator (NSA, Mean Value=100), Confidence Indicator of Total Industry (SA, 100=Mean), Consumer Confidence Indicator (SA, 100=Mean), Harmonized Consumer Price Index (NSA, 2015=100), Producer Price Index (NSA, 2015=100), Total Agriculture and Industry Less Construction exports(NSA, 2015=100), Total Agriculture and Industry Less Construction imports (NSA, 2015=100), Money Supply M1, Money Supply M3 (EOP, Mil.Kronor), MFI Loans to Households (EOP, % per annum), Outstanding MFI Loans to Non Financial Corporations (% per annum), Outstanding Bank Deposit Rates for Households (% per annum), Outstanding Bank Deposit Rates for Non Financial Corporations (% pa), Stock Price Index Stockholm Affarsvarlden (AVG, Dec-29-95=100), Government Bond Yield: 10-year (% p.a.),JP Morgan Nominal Broad Effective Exchange rate (2010=100).

United Kingdom: Industrial Production (SA, 2018=100), Industrial Production in Manufacturing (SA, 2018=100), Index of Services Total Service Industries (SA, 2018=100) Exports Goods (SA, Mil.Pounds), Imports Goods (SA, Mil.Pounds), Retail Sales Volume Retailing including Auto Fuel(SA,2018=100), Unemployment Claimant Count Rate (SA, %), Employment (SA, Thous), Unemployment Rate Aged 16 and Over (SA, %), CBI Industrial Trends Current Total Order Book(% Balance), Mortgage Loans Approved for House Purchase (SA, Number), Consumer Credit Net Change (SA, Mil.GBP), London Interbank Offered Rate [LIBOR], Sterling 3 Month (AVG, %), Government Securities Real Forward Yields, 10-Year (AVG, %), Exchange Rate (US$/GBP), FTSE All Share Price Index (Avg, Apr-10-62=100), Money Supply M1 Amount Outstanding (EOP, SA, Mil.GBP), Money Supply M2 Amount Outstanding (EOP, SA, Mil.GBP), Money Supply M3 (EOP, SA, Mil.GBP), Money Supply M4 Amount Outstanding (EOP, SA, Mil.GBP), MFI Net Lending to non financial corporation (EOP, NSA, Mil.GBP), Government Bonds, 10-Year Zero Coupon Nominal Yields (Average, %), London Interbank Offered Rate [LIBOR] Sterling (AVG, %), PMI Manufacturing Output (SA, 50+=Expansion), PMI Services Business Activity (SA, 50+=Expansion, PMI Construction (SA, 50+=Expansion).

United States: Industrial Production Index (SA, 2012=100),Manufacturing New Order of Nondefense Capital Goods ex Aircraft (SA, Mil.$), PMI Composite Index (SA, 50+ = Econ Expand), Services PMI Composite Index (SA, 50+=Increasing), Retail Sales & Food Services (SA, Mil.$), Light Weight Vehicle Sales (SAAR, Mil.Units), University of Michigan Consumer Sentiment (NSA, Q1-66=100), S&P CoreLogic Case-Shiller Home Price Index (NSA, Jan-00=100), Housing Starts (SAAR, Thous.Units), Civilian Unemployment Rate (SA, %), All Employees Total Nonfarm (SA, Thous), Exports FAS Value (SA, Mil.Chn.2012$), Imports Customs Value (SA, Mil.Chn.2012$), CPI All Items (NSA, 1982-84=100), CPI All Items Less Food and Energy (NSA, 1982-84=100) PCE Chain Price Index (SA, 2012=100), NAR Total Existing Home Sales, United States (SAAR, Thous), FHFA House Price Index (SA, Jan-91=100), New Orders of All Manufacturing Industries (SA, Mil.$), Conference Board Consumer Confidence (SA, 1985=100), Real Personal Income (SAAR, Bil.Chn.2012$), Real Personal Consumption Expenditures (SAAR, Bil.Chn.2012$), Federal Funds effective Rate (% p.a.), 3-Month Nonfinancial Commercial Paper (% per annum), Bank Prime Loan Rate (% p.a.), 10-Year Treasury Note Yield at Constant Maturity (% p.a.), Money Stock M1 (SA, Bil.$), Contract Rates on Commitments: Conventional 30-Yr Mortgages (%), Dow Jones 30 Industrial Stocks Average Price Close (AVG, May-26-1896=40.94),Standard & Poor's 500 Composite (1941-43=10), ACM Fitted Yield 10 Year (AVG, %), Commercial Paper Outstanding (EOP, SA, Bil.$), Break-Adjusted Consumer Credit Outstanding (EOP, SA, Bil.$), All Commercial Banks Loan to Deposit Ratio (%), Home Builders Housing Market Index (SA, All Good = 100), NFIB Small Business Optimism Index (SA, 1986=100).

Russia: Exports of Goods fob (SA, Mil.US$),Imports of Goods, fob (SA, Mil.US$), Retail Trade Volume Index (SA, 2000=100),Unemployment Rate, ILO Concept (SA, %),MOEX Russia Index Closing Value (AVG, Sep-22-97=100), Money Supply M2 (EOP, SA, Bil.RUB),Central Bank of Russia Policy Rate (EOP,%),Government Bond Zero Coupon Yield Curve 10-Year (AVG, % p.a.),Private Sector Credit (EOP, NSA, Mil.RUB), PMI Manufacturing (SA, 50+=Expansion),EMBI Plus Sovereign Spread (bp).

Turkey: Imports volumes (SA, 2010=100), CPI Based Real Effective Exchange Rate (2003=100), Industrial Production (SWDA, 2015=100), Total Vehicle Production (NSA, Units), Exports volumes (SA, 2010=100), Financial Account Excluding Reserve Assets (NSA, Mil.US$), Money Supply M3, (EOP, SA, Mil.TL), Reserve Money (EOP, SA, Thous.TL), BIST 100 Composite Stock Price Index (AVG, Jan-01-86=.01), EMBI Plus Sovereign Spread (bp).

Global: Global PMI Composite Output (SA, 50+=Expansion),Global PMI Composite New Orders (SA, 50+=Expansion),Euro Area PMI Manufacturing New Orders (SA, 50+=Expansion),Federal Funds Effective Rate (% p.a.), World Industrial Production ex Construction (SWDA,2010=100),Dow Jones Global Index World (Avg, Dec-31-91=100), European Brent Spot Price FOB ($/Barrel),Emerging Markets Share Price Index (EOP, Dec-31=100),OECD Total Consumer Price Index (NSA, 2015=100),OECD Total Retail Sales Volume (SA, 2015=100),Average Spot Price: Crude Oil Brent (US$/Barrel),Average Price Natural Gas Europe (US$/Mil.BTU),World Bank Comm Price Index for Emerging Countries of Agriculture (2010=100),World Bank Comm Price Index for Emerging

Countries of Energy (2010=100),EU27 Industrial Production in Manufacturing (SWDA, 2015=100), CBOE Market Volatility Index (Index),ISM Composite Index (SA, ¿50=Increasing),Industrial Production Index (SA, 2012=100),Retail Sales & Food Services (SA, Mil.$),All Employees Total Nonfarm (SA, Thous),Housing Starts (SAAR, Thous.Units),ISM Manufacturing PMI Composite Index (SA, 50+=Increasing).

B Appendix

B.1 Estimation of Factor Model

The factor model is Section 2:

$$u_{j,i,t} = \lambda'_{j,i} f_t^{global} + \gamma'_{j,i} f_t^{country} + \xi_{j,i,t} \tag{B.1}$$

is used to estimate our baseline measure of global uncertainty. In equation B.1, f_t^{global} represent the vector of global factors and $\lambda'_{j,i}$ the respective loadings. Global factors are assumed to load on all $u_{j,i,t}$. Conversely, $f_t^{country}$ and $\gamma'_{j,i}$ are country-specific factors and the respective loadings which load on country i only. Finally, $\xi_{j,i,t}$ represents an idiosyncratic or variable-specific component.

The model is estimated by sequential-principal components, as explained in Breitung and Eickmeier (2014). As explained in Bonciani and Ricci (2020), the approach can be summarised in the following sequential steps:

1. obtain an initial estimate of the global factor, $f_t^{global(0)}$;
2. purge all variables from the global factor by running regressions on the estimated global factor and taking residuals;
3. from the residuals, extract the first principal component for each country i;
4. regress the data for country i on their respective country factor and back out the residuals;
5. re-estimate by principal components the global factors on the data which are now purged of the country-specific factors;
6. repeat the above steps until convergence.

This procedure assumes that the regional factors are orthogonal to the global factor.

B.2 Data and BVAR Model

Table 2 lists the variables used in our baseline Proxy SVAR, their description and source.

Table 2: Variables Used in the Baseline Model

Variable	Description	Source
Global Uncertainty	Own Estimate	Authors' calculation
Δ log(euro area stock prices)	EURO STOXX Index	ECB
Δ log(industrial production)	Industry excl. construction	Eurostat
Δ log(CPI)	Harm. Index of Consumer Prices	Eurostat
Policy rate	Wu-Xia Shadow ECB Rate	Wu and Xia (2016)
Δ log(Unemployment)	EA19 Unemployment (SA)	Eurostat

Notes: The Global measure of uncertatiny used in our baseline specification is the one obtained using equation 6 in Section 2.2.

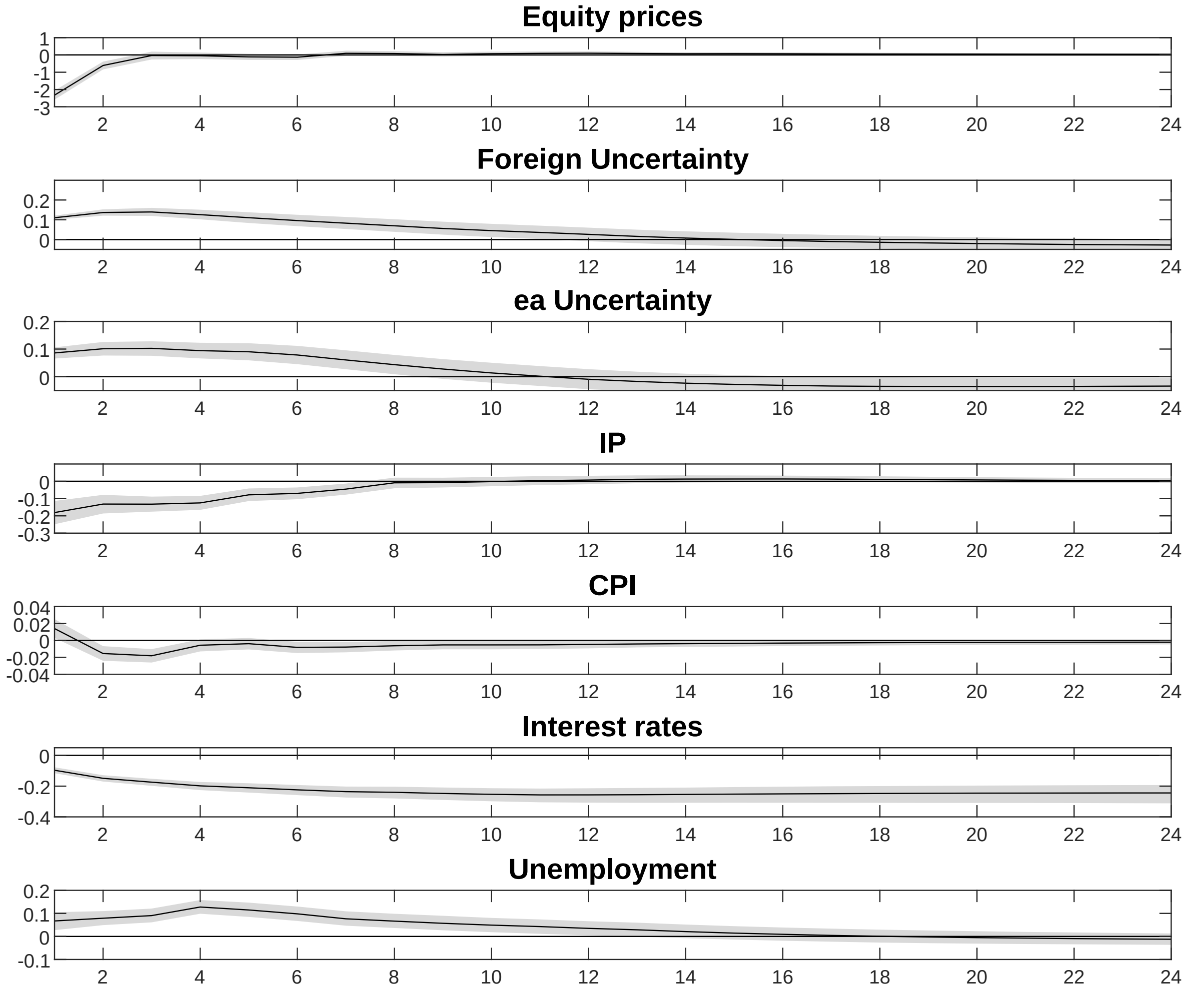
The model is estimated wit the help of the Toolbox developed by Canova and Ferroni (2020) using standard Bayesian techniques as well as standard priors. Hyper-parameters were chosen to maximize the marginal likelihood, yielding 2.8 for the overall tightness, 1.5 for the prior tightness on the lags, 3.3 for the sum-of-coefficients prior, 3.7 for the co-persistence prior and 3 for the prior on the covariance matrix. For more information on the methodology and routines employed, please refer to the Toolbox documentation. The BVAR has been estimated using 12 lags. The lag length does not affect substantially our results; impulse responses with different lags are available upon request.

B.3 The Transmission of Uncertainty Shocks to the Euro Area

In order to shed light on the transmission of global uncertainty shocks to the euro area, we slightly modify our baseline model. Specifically, we introduce a euro area-specific measure of uncertainty and instead of our baseline global uncertainty measure we use a global uncertainty measure weighted by euro area foreign demand trade weights.[10] This alternative global measure of uncertainty can be understood as euro area foreign uncertainty as the the weight assigned to the uncertainty indicator for the euro area is zero. Figure 10 shows that the impulse responses of all variables entering our model are unchanged compared to our baseline specification. In fact, euro area uncertainty increases in parallel with euro area foreign uncertainty, tentatively suggesting that global uncertainty shocks transmit to the euro area by raising local uncertainty rather than directly affecting the economy via real channels.

[10]Using our baseline uncertainty measure would not alter the results neither qualitatively nor quantitatively.

Figure 10: The Impact of Global Uncertainty Shocks on the euro-area: transmission

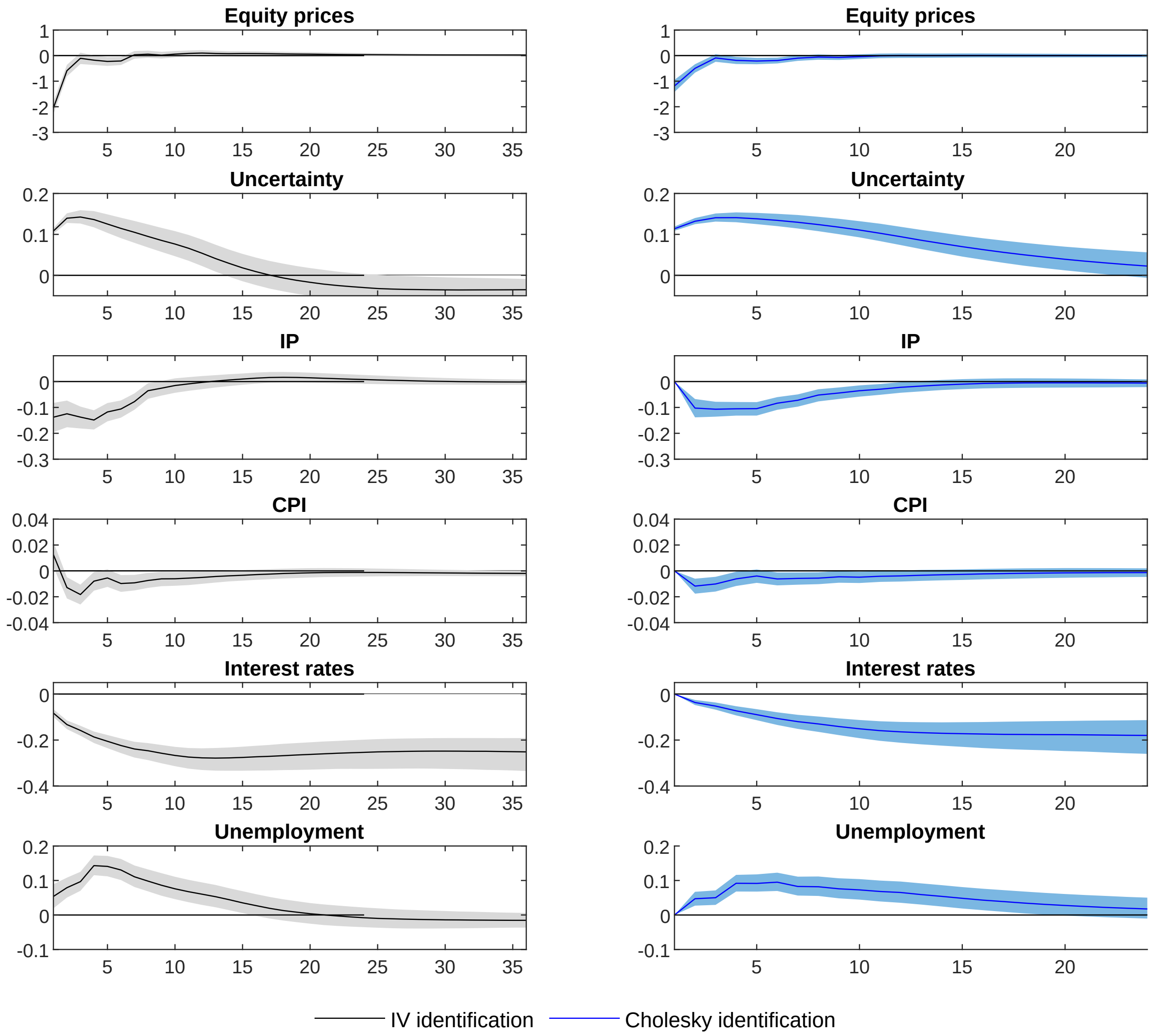


Note: Impulse responses to a one standard deviation increase in the identified shock to global uncertainty. The shaded areas show 68% credibility intervals.

B.4 Additional Robustness Tests

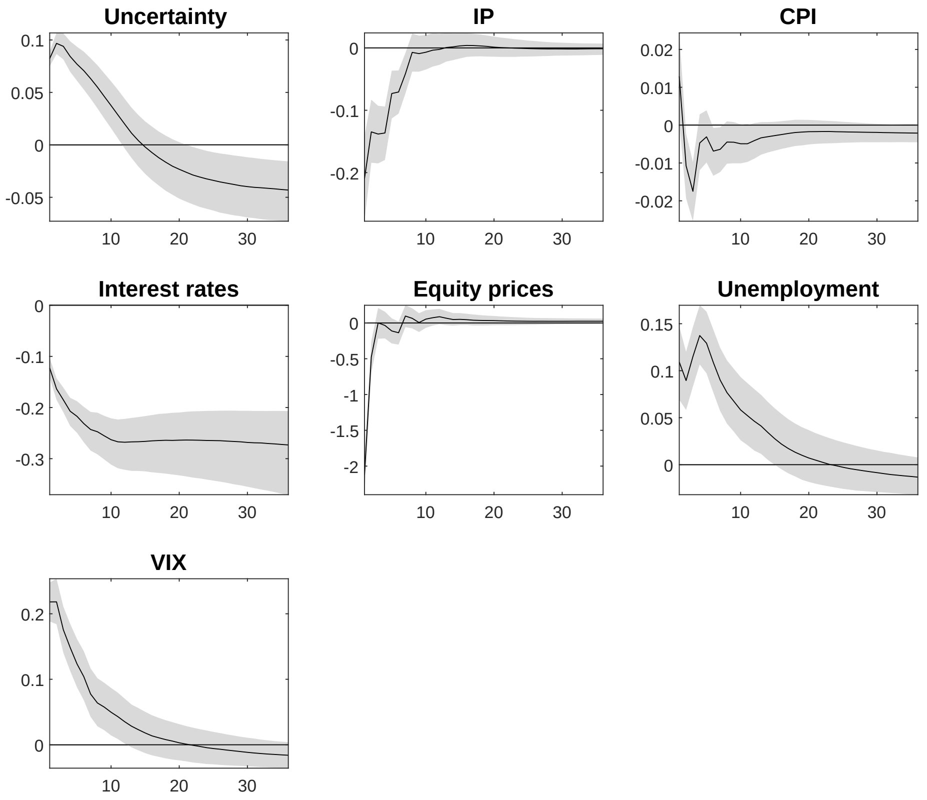
This section contains additional robustness checks and material that do not form part of the main sections of the paper.

Figure 11: Instrument Variable and Cholesky Decomposition, Alternative Ordering



Note: Impulse responses to a one standard deviation increase in the identified shock to global uncertainty. The shaded areas show 68% credibility intervals. Uncertainty is ordered second to last, before equity prices.

Figure 12: Incorporation of the VIX into the Baseline Model



Note: Impulse responses to a one standard deviation increase in the identified shock to global uncertainty. The shaded areas show 68% credibility intervals.

C Appendix: List of Events Employed to Construct the Proxy

List of events employed to construct the proxy in chronological order:

11 Sep 2001: 9/11 attack

02 Dec 2001: Enron bankruptcy

21 Jul 2002: Worldcom bankruptcy

11 Mar 2004: Madrid train bombings

14 Mar 2008: Approval of takeover of Bear Stearns by JP Morgan

15 Sep 2008: Lehman Brothers failure and AIG rescue

10 May 2010: Adoption of the European Financial Stability Facility (EFSF)

09 Nov 2011: Resignation of the Italian government

12 Sep 2012: Approval of the European Stability Mechanism (ESM) by the German Constitutional Court

05 Jul 2015: Greek referendum in support of Greek Prime Minister Tsipras

20 Jan 2016: Financial market stress over fears of a Chinese economic slowdown

17 Jul 2017: Release of UK election results

31 Jul 2018: US announcement of higher tariffs on $200 USD bn of Chinese imports

24 Dec 2018: Fears about a trade war trigger a financial market correction

Acknowledgements

The authors would like to thank seminar participants at the ECB and an anonymous referee for their useful comments and suggestions.

Alina Bobasu
European Central Bank, Frankfurt am Main, Germany; email: alina.bobasu@ecb.europa.eu

André Geis
International Monetary Fund, Washington, D.C., United States; email: ageis@imf.org

Lucia Quaglietti
World Bank, Washington, D.C., United States; email: lquaglietti@worldbank.org

Martino Ricci
European Central Bank, Frankfurt am Main, Germany; email: martino.ricci@ecb.europa.eu

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

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PDF ISBN 978-92-899-4541-7 ISSN 1725-2806 doi:10.2866/621710 QB-AR-21-032-EN-N