Subjective Interest Rate Uncertainty and the Macroeconomy: An international panel approach*

Klodiana Istrefi
Banque de France

Sarah Mouabbi
Banque de France

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Abstract

We ask whether uncertainty about interest rates is important for economic activity. Causal effects of uncertainty on the economy are examined through the lens of a small VAR where the assumption that uncertainty and real activity cannot contemporaneously react to each other is indeed in line with the data. Our measure of uncertainty stems from professional forecasts of short- and long-term interest rates and accounts for both disagreement among forecasters and the perceived variability of future aggregate shocks. Studying a panel of ten countries we find that subjective interest rate uncertainty has large, negative and persistent effects on the economy.

JEL codes: E43, E47, E63, G12.
Keywords: interest rates, subjective uncertainty, surveys of professional forecasters, macroeconomic fluctuations, structural VAR.

*The views expressed in this paper are those of the authors and do not necessarily reflect those of the Banque de France.

1 Introduction

Recent literature advocates that time-varying uncertainty can explain macroeconomic fluctuations. However, there are two on-going challenges: i) how to measure uncertainty and ii) how to identify causal effects of uncertainty on the economy. The empirical literature has evolved along both dimensions (see Bloom (2009), Jurado et al. (2015), Ludvigson et al. (2015) among others). Drawing lessons from this literature, we attempt to account for both of these issues, focusing particularly on interest rate uncertainty.

In this paper we provide empirical evidence on the economic effects of interest rate uncertainty for an international panel consisting of the US, Japan, the UK, Germany, France, Italy, Canada, Spain, Sweden and Switzerland. To build our measure of interest rate uncertainty, forecasts of short- and long-term interest rates stemming from Consensus Economics' surveys (CE) are used. Our measure accounts for both disagreement among forecasters and the perceived variability of future aggregate shocks, in line with Lahiri and Sheng (2010), thus representing a subjective, *ex ante* interest rate uncertainty. In addition to the multi-country setup, our study adds two more dimensions to the investigation. In this respect, we explore variations across two different maturities of yields (3-month and 10-year Government yields) and two forecasting horizons (3 months and 12 months ahead). Focusing on the period between January 1993 and August 2015, we observe time-varying interest rate uncertainty. Unsurprisingly, this measure spikes during the recent financial crisis for most countries, predominantly on short-term yield uncertainty. Nonetheless, we observe substantial individual variation throughout the sample related to other important domestic events. Around these events, interest rate uncertainty increases considerably, often exhibiting the highest magnitudes in our sample.

The effect of interest rate uncertainty in the economy is studied through the lens of a structural VAR, where the timing of surveys is exploited for appropriate identification. Our subjective measure of uncertainty is constructed based on an information set that does not contain contemporaneous realizations of macro variables. In a structural VAR setup, this means that a recursive identification scheme where uncertainty and real activity cannot contemporaneously react to each other is indeed in line with the data. Specifically, the design of CE surveys is such that at the time the forecast is made (generally within the first 10 days of the month), contemporaneous monthly data on economic activity are not known. Therefore, by construction, the forecasters' information set includes only past realizations of macroeconomic data (i.e., industrial production, CPI inflation and unemployment rate) when surveys are filled out. This feature allows us to use a recursive identification strategy where interest rate uncertainty responds contemporaneously only to its own innovations and can have an immediate impact on macro variables. The use of the timing of surveys for identification is inspired by Leduc and Sill (2013), who assess the role of shocks to expected future economic activity on economic fluctuations.

We find that shocks to interest rate uncertainty have large and persistent negative effects on industrial production and unemployment. There is substantial heterogeneity across countries and uncertainty measures, with the drop in production varying from 0.5 to 3 percent within the year the shock hits. In response to this uncertainty, unemployment worsens with rates increasing by 0.2 to 1 percentage points. Furthermore, the recovery of the economy to its initial levels is slow, taking about 3 to 5 years. In addition, prices display an acyclic behavior in response to interest rate uncertainty shocks; their effect varies across countries and, within a country, it varies across the measures of uncertainty. Considering uncertainty on the short versus long yield, the differences on the economic effects mostly appear on the quantitative side. Short yield uncertainty is found to explain a large fraction (up to 50 percent) of variation of industrial production and unemployment.

Our paper contributes to the empirical literature on uncertainty (e.g., Leduc and Liu (2012), Mumtaz and Zanetti (2013), Baker et al. (2015), Fernandez-Villaverde et al. (2015), Jurado et al. (2015), Ludvigson et al. (2015)), by re-examining the way in which uncertainty is measured, focusing on subjective *ex ante* measures, and by investigating their causal effects on the economy through novel, credible exclusion restrictions for identification. Moreover, our paper relates to the literature that uses survey-based measures as a proxy for uncertainty (e.g., Lahiri and Sheng (2010), Bachmann et al. (2013)). We follow Lahiri and Sheng (2010) and construct a measure of interest rate uncertainty encompassing both disagreement among forecasters and the perceived variability of future aggregate shocks (in our paper the latter being estimated through a stochastic volatility model).

Our paper is closely related to Creal and Wu (2014), who investigate the relationship between uncertainty about interest rate and economic fluctuations, for the US. Their interest rate uncertainty is extracted from the volatility factors of a term structure model with macro variables. The effect of this type of uncertainty on selected macro variables (inflation and unemployment) is then investigated through a VAR model with stochastic volatility. Our paper complements on answering similar questions with subjective measures of interest rate uncertainty, where causality from uncertainty to the economy is defended via the design of surveys. We provide this analysis for a number of countries with different economic structures and monetary policies, allowing for interesting comparisons. Furthermore, while Creal and Wu (2014) focus on long yield uncertainty we also study the effects of subjective short yield uncertainty and find that it has stronger quantitative effects than uncertainty about the long yield.

The paper is structured as follows. In Section 2 we introduce subjective uncertainty measures of interest rates and stylized facts. In Section 3 the VAR modeling framework, identification strategy and results are presented. Finally, we conclude in Section 4.

2 Subjective interest rate uncertainty

The following section provides a summary of the survey-based uncertainty measures available in the literature. Subsequently, we present the measure we opt for in order to build our interest rate uncertainty.

2.1 Measuring survey-based uncertainty

In the literature, several proxies for uncertainty have been used. These include stock market volatility (both implied and realized), conditional volatility of series, keyword counts in newspapers, cross-sectional dispersions and survey-based measures. However, as noted by Jurado et al. (2015), in order to obtain a valid measure of uncertainty of a particular series x_t, one is advised to remove the forecastable component $E[x_{t+h}|I_t]$ before computing the conditional volatility. Omission to do so tends to overestimate uncertainty by inappropriately embedding predictable variations within uncertainty. When using survey forecasts we are not prone to this critique.[1]

Subjective measures are typically obtained via survey forecasts of professionals and/or households. The information provided varies substantially from one survey to another and includes a range of the following: consensus information, individual point estimates, and individual probability distributions. Based on this information, three subjective measures of uncertainty have been predominantly represented in the literature: i) the disagreement among forecasters, ii) the average individual forecast error variance and iii) the variance of the surveys' aggregate probability distribution (scarcely available). From the aforementioned list, the last measure is the most informative on uncertainty. This measure assigns probabilities to the given forecasts, thus converging towards the notion of Knightian uncertainty, in which even

[1] In survey-based measures, the conditional forecast of x_{t+h} is observed, thus not necessitating the estimation of $E[x_{t+h}|I_t]$.

probabilities cannot be pinned down. However, few surveys report these individual histograms. For that reason, measures of uncertainty have been constructed based on a more limited information set.

One of the most common survey-based uncertainty proxies in the literature is the disagreement of forecasters (e.g. Mankiw et al. (2004), Boero et al. (2008), Capistrán and Timmermann (2009), Rich and Tracy (2010), Dovern et al. (2012)). The literature starts from the premise that disagreement is positively correlated with uncertainty (see Zarnowitz and Lambros (1987) and Giordani and Soderlind (2003)). However, there are several known caveats associated with disagreement as a proxy for uncertainty. Differences in opinion, rather than uncertainty, may be more likely reflected in the disagreement of survey forecasts (e.g. Diether et al. (2002), Mankiw et al. (2004)). Lahiri and Sheng (2010) show that, even if forecasts are unbiased, the disagreement in forecasters' point estimates does not equal forecast error uncertainty unless the variance of accumulated aggregate shocks over the forecast horizon is zero. They further show, that the reliability of disagreement as a proxy for uncertainty is contingent on the stability of the forecasting environment and the length of the forecast horizon. D'Amico and Orphanides (2014) also find disagreement to be a poor proxy for forecast uncertainty, thus reinforcing arguments for the exploitation of uncertainty measures similar to those proposed by Lahiri and Sheng (2010) and Clements (2012).[2]

In the following we present the *ex ante* measure of uncertainty as proposed by Lahiri and Sheng (2010). Let us denote by N the number of forecasters, T the target year and H the forecast horizons. Let F_{ith} be the h-month ahead forecast of the variable of interest made by agent i, for the target year t. In a nutshell, their measure of forecast uncertainty is the sum of the observed disagreement from the survey, d_{th}, and the variance of aggregate shocks, $\hat{\sigma}^2_{a|th}$, expressed as:

$$\hat{U}_{th} = (1 - \frac{1}{N})d_{th} + \hat{\sigma}^2_{a|th}. \tag{1}$$

Uncertainty as measured in Eq. 1 stems from the error components embedded in private (idiosyncratic) information, d_{th}, and the information common to all forecasters, $\sigma^2_{a|th}$. Disagreement in this case reflects the imprecision in forecasters' idiosyncratic information and the diversity in their forecasting models. The observed disagreement (d_{th}) among forecasters is the variance of their point forecasts which

[2]These papers target predominantly inflation and output uncertainty.

can be expressed as:

$$d_{th} = \frac{1}{N-1}\sum_{i=1}^{N}(F_{ith} - F_{.th})^2, \tag{2}$$

where $F_{.th}$ is the mean forecast.

Furthermore, $\sigma^2_{a|th}$, represents the conditional variance of mean forecast errors. Denoting by A_t the actual value of the variable, the individual forecast error, e_{ith}, is defined as:

$$e_{ith} = A_t - F_{ith}. \tag{3}$$

Lahiri and Sheng (2010) suggest that in order to construct a robust *ex ante* measure of uncertainty, the econometrician should use information available to the forecaster in real time. That is, the forecast error used to extract the variance of aggregate shocks at time t, should not include the $t+h$ realizations of the forecast. This necessitates the estimation of $\sigma^2_{a|th}$ conditional on past information. Lahiri and Sheng (2010), estimate $\sigma^2_{a|th}$ using GARCH-type models with various distributional assumptions on the filtered mean forecast errors, e_{th}.

However, with GARCH-type models the evolution of $\sigma^2_{a|th}$ is deterministic. To our purpose, we would like to study the effects of shocks to uncertainty therefore it is important for $\sigma^2_{a|th}$ to be time-varying and stochastic. To this purpose we propose a stochastic volatility model on the mean forecast errors that allows for a shock to the second moment that is independent of the first moment, consistent with theoretical models of uncertainty. We estimate $\sigma^2_{a|th}$ using a standard stochastic volatility model (e.g. Taylor (1993), Harvey et al. (1994)), as follows. Denoting by e_{th} the forecasting error which has been filtered for possible autocorrelation, we have:

$$e_{th} = \epsilon_t \exp\left(\frac{1}{2}s_{th}\right) \tag{4}$$

$$\log e^2_{th} = s_{th} + \log(\epsilon^2_{th}) \tag{5}$$

$$s_{th} = \gamma_0 + \gamma_1 s_{t-1,h} + \eta_{th}, \tag{6}$$

where s_{th} is the counterpart of $\sigma^2_{a|th}$ (subject to a transformation) in a stochastic volatility framework, $\epsilon_{th} \sim \mathcal{N}(0, \sigma^2_\epsilon)$ and $\eta_{th} \sim \mathcal{N}(0, \sigma^2_\eta)$. Thus, the latter term represents a contemporaneous innovation to the conditional variance of forecast errors, allowing the process of e_{th} to display stochastic volatility.[3] Consequently,

[3] We opted for a parsimonious specification of our stochastic volatility model.

our *ex ante* measure of uncertainty is built as follows:

$$\hat{U}_{th} = (1 - \frac{1}{N})d_{th} + \exp\left(\frac{1}{2}\hat{s}_{th}\right). \tag{7}$$

This measure accounts for two extreme cases: i) the case in which point estimate disagreement is low and uncertainty is high (this happens when forecasters observe high macroeconomic uncertainty) and ii) the case in which point estimate disagreement is high and the variance around their forecast is low (this typically occurs when forecasters disagree on their point estimates but are all confident about their point estimate prediction).

2.2 Interest rate uncertainty and its dynamics

We use global macroeconomic survey data provided by Consensus Economics, which polls both public and private economic institutions. These surveys are published on a monthly basis. Consensus Economics reports the point estimates of individual forecasters for several macroeconomic variables. To our interest, we exploit short- and long-term interest rate forecasts. In the survey, responders are asked to provide their forecast on the 3-month and 10-year government bonds interest rates.[4] These estimates are available at two forecast horizons, 3-months and 12-months ahead. We will exploit this variation, thus constructing four measures of interest rate uncertainty, two being across yield maturities and the remaining, across forecast horizons.

Let us denote by U^j_{th} the uncertainty measure for the h-period ahead forecast of variable j at time t. In the following, we will often refer to uncertainty measures as U^{short}_{th} and U^{long}_{th} for h=3, 12 months and where *short* and *long* refer to 3-month and 10-year Government bonds' interest rates, respectively. Starting from the individual point estimates and using Eq. 7, we build U^j_{th} for the United States, Japan, the United Kingdom, Germany, France, Italy, Spain, Canada, Sweden and Switzerland. Our first data point starts in January 1993; though data for some countries in our data set are only available later, the last country included being Switzerland in January 1998. To construct the forecast errors we use equivalent realized data on interest rates for each country, obtained from Bloomberg.

Table 1 displays summary statistics for CE forecasts at a 3-month ahead horizon, their respective realized data, disagreement D^j_{th} and our uncertainty measure U^j_{th}.[5] We observe that the forecasted yield curve is upward sloping preserving the feature of realized yields that also tend to be upward sloping on average (i.e. the average

[4]In different countries the exact term might change, for example, in the US, CE refers to Treasury Bill and Treasury Bond Rate.

[5]Disagreement being defined as the variance of forecasters' point estimates, as shown by Eq. 2.

Table 1: Descriptive statistics

	US	Japan	Ger.	France	UK	Italy	Canada	Spain	Sweden	Switz.
3 month yield										
CE mean	2.75	0.61	2.75	2.92	4.53	3.73	3.13	3.19	3.26	1.04
CE std	2.22	0.71	1.63	1.77	2.23	2.78	1.90	2.30	1.93	1.14
Realized mean	2.64	0.37	2.42	2.61	3.64	3.24	2.54	2.95	2.83	1.32
Realized std	2.22	0.63	1.81	1.97	2.42	2.71	1.66	2.29	2.08	1.21
U_{th} **mean**	0.31	0.15	0.42	0.42	0.48	0.38	0.27	0.41	0.50	0.43
D_{th} **mean**	0.04	0.01	0.03	0.04	0.05	0.04	0.06	0.03	0.05	0.03
Corr(U_{th},D_{th})	0.43	0.69	0.54	0.45	0.49	0.40	0.57	0.61	0.51	0.36
10 year yield										
CE mean	4.59	1.88	4.15	4.44	5.28	5.41	4.79	4.97	4.53	2.22
CE std	1.56	1.07	1.66	1.62	1.88	2.38	1.88	1.98	2.04	1.04
Realized mean	4.41	1.70	4.01	4.26	4.53	5.22	3.94	4.96	4.28	2.14
Realized std	1.58	1.03	1.75	1.67	1.74	2.34	1.38	2.00	2.21	1.08
U_{th} **mean**	0.50	0.20	0.47	0.48	0.50	0.63	0.52	0.58	0.53	0.38
D_{th} **mean**	0.06	0.03	0.04	0.06	0.07	0.11	0.07	0.11	0.07	0.04
Corr(U_{th},D_{th})	0.05	0.61	-0.01	0.12	0.23	0.38	0.24	0.41	0.11	0.06

10-year yields forecasts are higher than those for the 3-month yields). Furthermore, in line with actual data stylized facts, the short-end of the forecasted yield curve is more volatile than the long-end. This feature is true for all countries except for Japan and Sweden; Japan being a particular case on its own due to the fact that short yields have been constrained by the zero lower bound for almost two decades. UK, Italy, Spain and Sweden display the highest level and volatility in actual and CE forecasts at the short- and long-end of the yield curve, in our sample. In contrast, Japan and Switzerland have the lowest levels of realized interest rates within our sample, which is also reflected by having the lowest level and volatility in their CE forecasts. Among the countries with high volatility at the long-end of the yield-curve, countries that have struggled with the sustainability of their public finances, such as Italy and Spain, lead the ranks on the level and volatility across actual and CE forecasts.

With respect to interest rate uncertainty, measures on the 10-year yields are higher than on 3-month yields, with the exception of Switzerland. Looking at disagreement, similar but nonetheless milder results are found. It is important to note that disagreement remains at similar levels across countries and across the maturity of yields. Average disagreement remains between 1 and 7 basis points at all times, with the only exceptions being Italy and Spain, where disagreement on long-term yields can reach levels of 11 basis points.

Figure 1 reports graphical representations of our uncertainty measure U^j_{th} for all countries, for the 3-month and 10-year yields at a 3-month forecasting horizon.

Overall, we observe that interest rate uncertainty varies over time. Across countries, we observe common spikes (predominantly on short-term yield uncertainty) pertaining mostly to the recent financial crisis, but also substantial individual variation. For instance, the US displays the largest peak in short-term interest rate uncertainty around the September 11 attacks. In Europe, the beginning of our sample presents high uncertainty for France and Italy. This coincides with years in which many changes were occurring, such as the breakdown of the Exchange Rate Mechanism (ERM I) and its replacement with the Eurozone and ERM II. While for most countries, uncertainty on long-term yields appears to be noisy, it is well defined for Italy and Spain. These countries have been strongly affected by the European sovereign debt crisis and the pressure exerted on their long-term yields is reflected in their corresponding uncertainties. Moreover, we observe that zero lower bound environments are characterized by periods of low uncertainty, as in the case of Japan (for the early 2000s), the US and the UK (since 2009), and euro area countries (since late 2012).

3 Interest Rate Uncertainty and the Macroeconomy

In the following we investigate the dynamic responses of selected key macroeconomic variables to innovations to subjective interest rate uncertainty. To this aim we estimate individual structural VAR models for the US, Japan, the UK, Germany, France, Italy, Canada, Spain, Sweden and Switzerland. The VAR model has a standard representation as below:

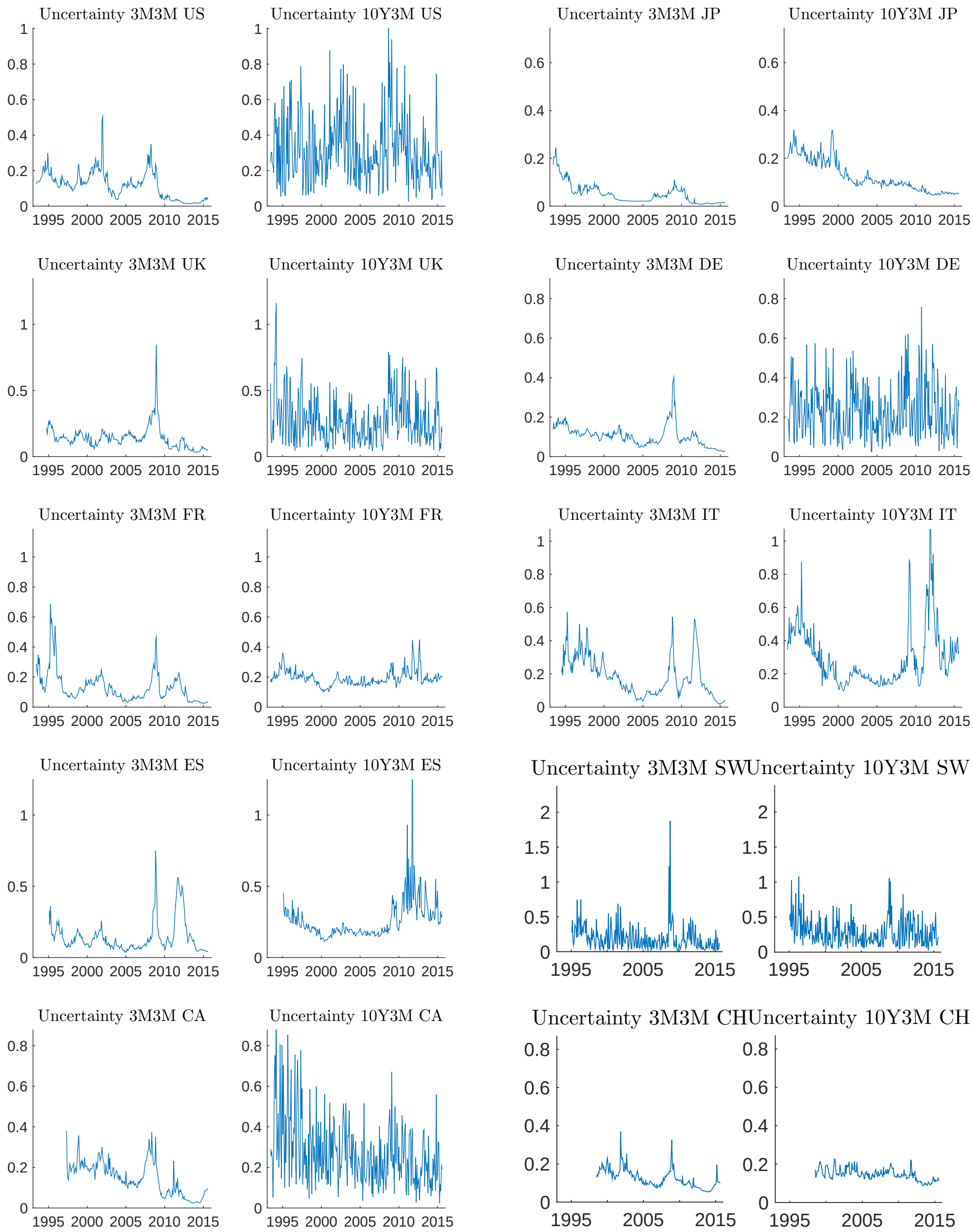
$$y_t = A_{0i} + A_1 y_{t-1} + ... + A_p y_{t-p} + B_0 z_t + u_t \tag{8}$$

for $t = 1, ..., T$, where y_t is a $n \times 1$ vector of endogenous variables, z_t is a $m \times 1$ vector of exogenous variables, and u_t represents the reduced-form errors,

$$u_t | y_{t-1} \sim iid\, N(0, \Sigma). \tag{9}$$

Our estimations include the following vector of endogenous variables: $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI inflation rate and u_t being the unemployment rate. The individual VARs also include a constant, a time trend and oil prices as an exogenous variable. We will estimate two versions of this VAR for

Figure 1: Subjective interest rate uncertainty



each country with uncertainty pertaining to either the short yield, $U_{t,3m}^{short}$, or the long yield, $U_{t,3m}^{long}$, for the 3 months ahead forecasts.

At this stage an important question arises on the identification strategy. Even though the empirical literature on uncertainty has rapidly evolved in recent years, there is still no consensus as of yet, on how to best identify shocks to uncertainty. Most of the studies have identified them using the recursive Cholesky decomposition, see Leduc and Liu (2012), Bachmann et al. (2013), Baker et al. (2015), Fernandez-Villaverde et al. (2015) and Jurado et al. (2015), among others.[6] However the question of causality remains a challenge as the ordering of the variables has been hard to defend whether based on theoretical grounds or based on the way the proxy measures are constructed. The critique is that contemporaneous changes in uncertainty can arise both due to fluctuations in the business cycle and as a response to other shocks which by construction are ruled out when using a particular recursive ordering. In a recent paper, Ludvigson et al. (2015) propose a structural VAR with external instruments to help with identification. As usual, the success of the instrumental variables' approach depends heavily on the choice of external instruments.

In our setup, working with survey-based measures of uncertainty is helpful for identification. We follow Leduc and Sill (2013) in this regard, where the timing of surveys is used in order to assess the role of shocks to expected future economic activity on economic fluctuations. Knowing the timing of the survey is crucial as one can align the data in the VAR such that when making forecasts at time t, the information set on which agents condition their forecasts will not include, by construction, the time t realizations of macro variables in the VAR. Consensus Economics is a good example. CE is conducted every month and the deadline for the forecast to be made is generally within the 10 first days of the month.[7] At the time the forecast is made, contemporaneous, monthly data on economic activity are not known (furthermore official monthly statistics are released with delay). This means that forecasters have in their information set at time t only past information on industrial production, CPI inflation and unemployment when surveys are filled out. Our measure of *ex ante* interest rate uncertainty preserves this feature of the surveys, allowing us to use a recursive identification strategy that places this measure first in the VAR ordering (i.e. exogenous innovations to uncertainty can

[6] In addition to the recursive Cholesky decomposition, Bachmann et al. (2013) have used long-term restrictions to identify uncertainty shocks.

[7] Some deadlines in 2003, 2004, 2008, 2009 and 2010 include the second week of the month as well. Also note that these dates represent the deadlines, meaning that the responses can potentially be given before the deadline but not after.

have immediate impact on the macro variables but uncertainty will respond with a lag to other innovations). The order of the remaining variables does not matter when interested on the effect of (only) shocks to interest rate uncertainty (see Christiano et al. (1999)).

Our data set spans the period 1993:1-2015:8 for the US, Japan, the UK, Germany, France, Italy and Canada, 1995:1-2015:8 for Spain and Sweden and 1998:1-2015:8 for Switzerland. The source of the macro data for each country is Datastream. We employ Bayesian techniques for estimation, following Uhlig (2005). The VAR coefficients are drawn from a normal-inverse-Wishart distribution with a flat prior.[8] The optimal lag is selected based on the BIC information criteria. We provide inference through the median response and its 68 percent posterior distribution, based on 2000 draws.

In the following we present the results from the estimation of the individual country-BVARs. In all figures, the black solid line denotes the point-wise posterior median impulse response and the shaded area represents the corresponding 68 percent posterior distribution. For each country the impulse responses to innovations to short and long yield uncertainty are displayed in the first and second row, respectively. Following the literature (see Bloom (2009) and Jurado et al. (2015), among others) we show responses to big uncertainty shocks, corresponding to four standard deviations.[9]

A general observation from Figure 2 to 4 is that shocks to interest rate uncertainty are recessionary; they reduce production and increase unemployment. The magnitudes and the persistence of responses of both macro variables are considerable. Overall, there is substantial heterogeneity across countries and uncertainty measures, with the drop in production varying from 0.5 to 3 percent within the year the shock hits. In addition, we do not observe any signs of overshooting or a rebound on economic activity in response to this type of uncertainty for any of the countries under study. Instead, the recovery of output to initial levels is slow, taking about 3 to 5 years. The unemployment worsens in response to interest rate uncertainty, with rates increasing between 0.2 and 1 percentage points. For most of the countries this increase is quite persistent and the reversion to initial levels takes longer than for output.

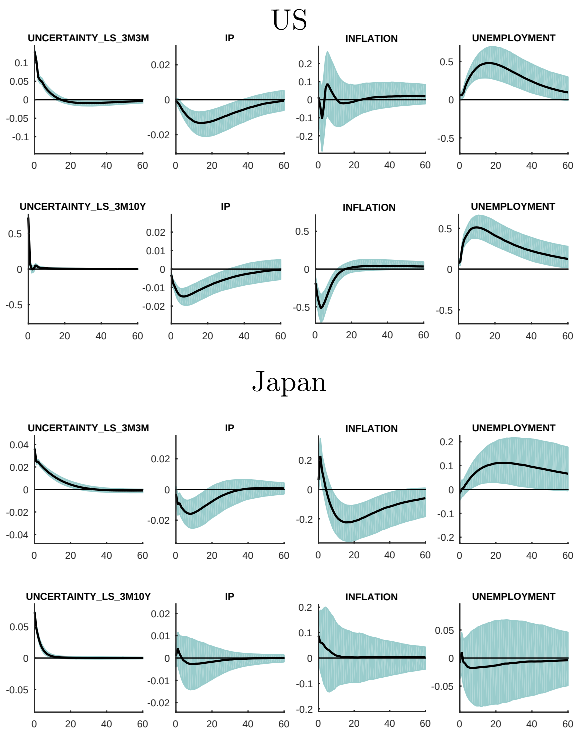
On the other hand, we do not observe a common, unique pattern of CPI inflation

[8] A flat prior allows us to use the benefits of the Bayesian techniques while allowing our results to be more data-driven.

[9] In our sample, this shock size is in general below the level we observe for both measures of interest rate uncertainty in all countries under our study. Especially for Spain, Sweden and France (for the 10 year yield uncertainty only), four standard deviations is only about half of what we observe.

responses to interest rate uncertainty shocks. The effect on prices varies across countries and, within a country, it varies across the measures of uncertainty. Figures 2 to 4 show that innovations to interest rate uncertainty induce a sharp fall in prices in the UK, Germany, Sweden and Switzerland. For Canada, Japan and France we observe immediate but short-lasting jumps in prices followed by sharp and long-lasting price contractions. On the other hand, for the US, Spain and Italy the sign of the response differs across the measure of uncertainty (and even here we do not see a general pattern).

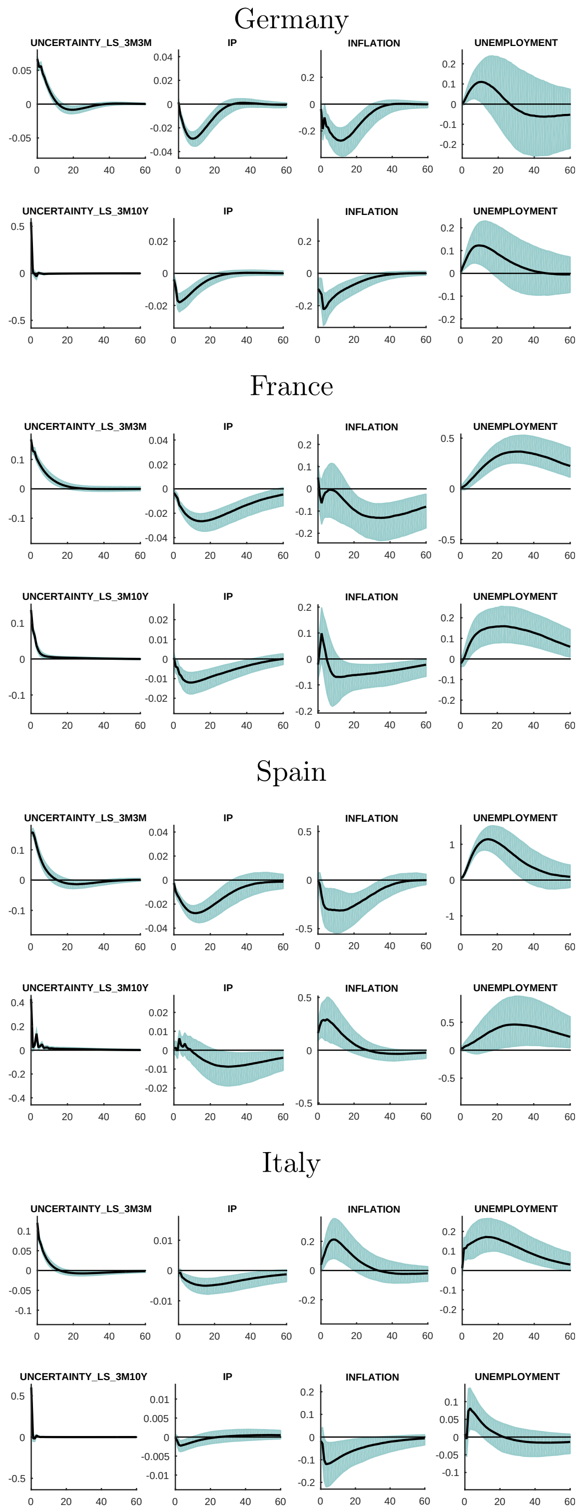
Figure 2: IRFs to interest uncertainty shock



Notes: The solid line in black denotes median impulse response from the estimated Bayesian SVARs with $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI year-on-year inflation rate and u_t being the unemployment rate. VARs include an exogenous variable, oil prices, a constant and a time trend. The shaded area corresponds to the 68 percent error band. Horizontal axis is in months.

The variation across the two measures of interest rate uncertainty appears mostly on the quantitative side (and occasionally on the qualitative side for inflation). First, the response of these measures to their own innovations is different. The response of short yield uncertainty is small in magnitude but very persistent compared to the response of the long yield uncertainty. In fact, the latter does not exhibit any persistence especially for the US, the UK, Germany, Spain, Italy and Switzerland. Nonetheless, the lack of persistence appears to be reflected only in responses of lower magnitude.

Figure 3: IRFs to interest uncertainty shock



Notes: The solid line in black denotes median impulse response from the estimated Bayesian SVARs with $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI year-on-year inflation rate and u_t being the unemployment rate. VARs include an exogenous variable, oil prices, a constant and a time trend. The shaded area corresponds to the 68 percent error band. Horizontal axis is in months.

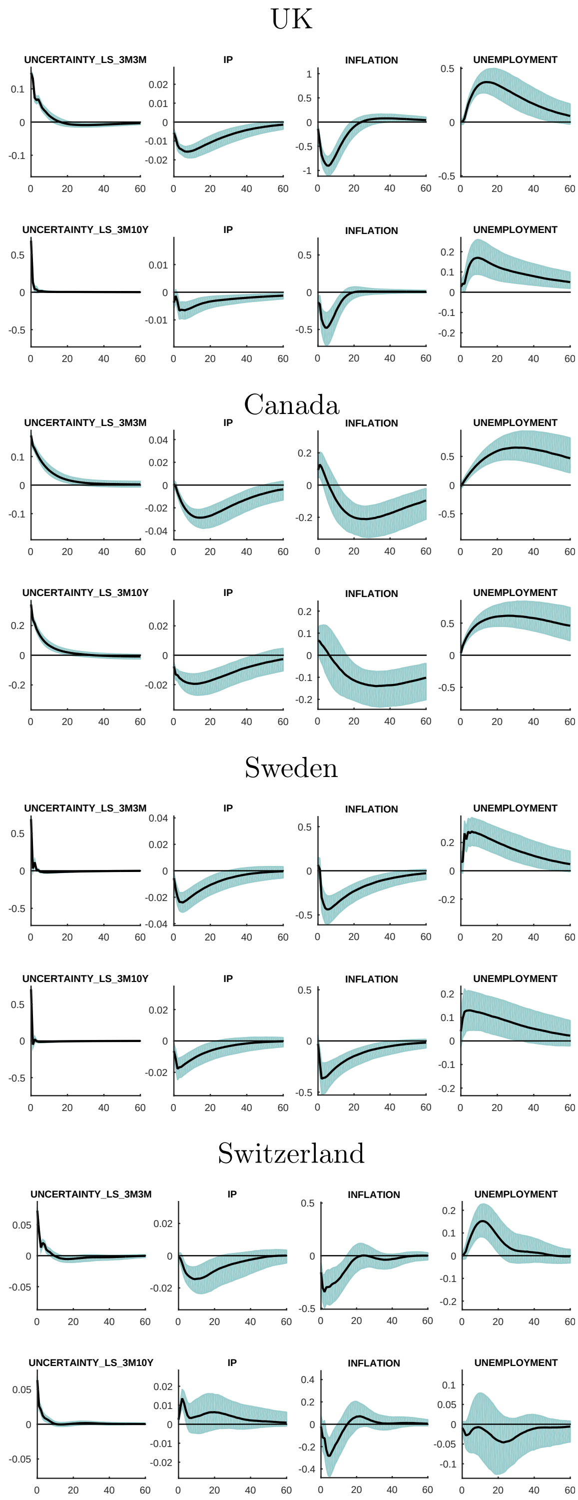
The heterogeneity across countries also appears mainly on the quantitative side. Considering euro area countries, the contraction of output in Germany is the fastest but also the most short-lived. The trough in output is observed within 10 months and the reversion occurs within two years. Interestingly, the effect on unemployment is not as sharply estimated as for the other countries (similar only to the case of Japan). France shows similar magnitudes as German data but much more persistent responses which revert back to initial levels only after five years. For Italy on the other hand, we observe muted responses for output and unemployment. However, unlike other countries, the effect on unemployment is immediate; a rise of 0.2 percentage points. The effect on unemployment is the highest for Spain, about 1 percentage point.

When considering inflation targeting countries (Canada, the UK and Sweden), output contraction is high and similar in magnitudes for Canada and Sweden (around 2 to 3 percent) and low in the UK (0.5 to 1.8 percent). Inflation falls in response to both uncertainty shocks. Results for Canada show high persistence of responses (due to a higher persistence of the measure itself to its own shocks). Sweden displays the opposite case, with the least persistence of both uncertainty measures to own shocks. Nevertheless, their magnitudes are quite large, leading to well-estimated responses and relatively long-lasting effects on macro variables.

Interestingly for the US, although the response of the two measures to their own shocks is different (with the short one being persistent and the other not), the effects on output and unemployment are of the same magnitude, about 1.5 percent and 0.5 percentage points, respectively. The effect of short yield uncertainty on CPI inflation is not different from zero. Conversely, prices decrease by 0.5 percentage points to shocks to the long yield uncertainty. Regarding Japan, despite the fact that the country has been in a zero lower bound environment for nearly two decades, shocks to short yield uncertainty do have significant effects on the dynamics of our selected macro variables. Nevertheless, the magnitude of the uncertainty shock itself is the smallest in our sample.

So far we show that interest rate uncertainty shocks have significant effects on the dynamics of industrial production, CPI inflation and unemployment. In the following, we focus our attention on the quantitative importance of these shocks along two dimensions, the maturity of the yield and across countries. To this aim, Table 2 reports the forecast error variance decomposition (FEVD), and more precisely, the maximum fraction of the posterior median of the FEVD, over a forecasting horizon of 60 months. Several observations are worth mentioning. Overall we see that uncertainty on the short yield is quantitatively far more important than uncertainty on

Figure 4: IRFs to interest uncertainty shock



Notes: The solid line in black denotes median impulse response from the estimated Bayesian SVARs with $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI year-on-year inflation rate and u_t being the unemployment rate. VARs include an exogenous variable, oil prices, a constant and a time trend. The shaded area corresponds to the 68 percent error band. Horizontal axis is in months.

Table 2: FEVD (posterior median) in production, CPI inflation and unemployment

	US	**Japan**	**Ger.**	**France**	**UK**	**Italy**	**Canada**	**Spain**	**Sweden**	**Switz.**
$U^{short}_{t,3m}$										
IP	13.47	5.27	42.50	48.86	50.43	13.44	37.82	34.00	12.38	9.87
CPI inflation	3.09	7.36	20.09	9.57	33.02	7.02	18.23	10.35	12.77	11.23
Unemployment	23.12	5.92	4.07	39.56	31.56	16.47	38.91	31.12	11.41	13.06
$U^{long}_{t,3m}$										
IP	14.77	1.46	11.97	10.01	6.61	1.68	20.10	3.66	6.27	8.36
CPI inflation	11.08	1.78	7.57	3.70	7.02	1.61	10.46	4.75	7.71	6.56
Unemployment	23.87	1.40	2.74	9.01	6.42	1.56	41.24	4.11	3.02	4.20

Notes: Posterior median of FEVD from the individual VARs with following order of variables: v($U^{j}_{th}, ip_t, \pi_t, u_t$). Results above from two VARs, where interest rate uncertainty is either on the short or the long yield, $U^{short}_{t,3m}$ and $U^{long}_{t,3m}$, respectively. We report the max fraction of variance (from the posterior median) in each variable.

the long yield. The case of the US is an exception where the latter is slightly more important. In terms of variables, interest rate uncertainty contributes substantially on the variations of industrial production and unemployment and less so on the variation of prices.

Emphasizing on cross-country results, short yield uncertainty explains between 42 to 50 percent of variation of industrial production in the UK, France and Germany. This shock is less important in Japan, Switzerland and Sweden, with FEVD reaching up to 12 percent. Regarding unemployment, the contribution is substantial in France and Canada (up to 40 percent) and the UK (up to 32 percent). With respect to prices, the FEVD ranges from 3 to 33 percent, with the extremes pertaining to the US and the UK, respectively. In Canada both short and long yield uncertainty have considerable effects, especially on unemployment (up to 40 percent).

3.1 One Year Ahead Uncertainty

When considering one year uncertainty, $U^{short}_{t,12m}$, all stylized facts observed for the 3-month ahead horizon forecasts persist. One exception is disagreement which appears to be higher for 3-month yield forecasts in comparison to 10-year yield forecasts, on average (see Table 3 in the Appendix).

Regarding the effects on the economy, the qualitative results as discussed so far remain the same for the US, the UK, Germany, France, Spain and Canada (see Figures 5 to 7 in the Appendix). However, compared to previous findings, one year ahead interest rate uncertainty induces a stronger persistence in the responses. This horizon seems particularly important for the US and Spain. In the former, the effects on the economy are the strongest to shocks to long yield uncertainty (around

2 percent for output and 0.5 percentage points for unemployment). For Spain, we observe a sharper reduction of output and an increase of unemployment to the two types of uncertainty (around 2.5 percent for output and 1.2 percentage points for unemployment).

4 Conclusion

In this paper we seek to answer whether uncertainty about interest rates is important for economic activity. Using the timing of surveys from which we construct our uncertainty measure we can explore if exogenous variations in this type of uncertainty cause declines in the economy. Supported by the CE survey design, our subjective measure of interest rate uncertainty is constructed based on an information set that does not contain contemporaneous realizations of the macro variables. In a structural VAR setup, this means that our recursive identification scheme where uncertainty and real activity cannot contemporaneously react to each other is indeed in line with the data.

We observe time-varying interest rate uncertainty. Most countries display common spikes (predominantly on short-term yield uncertainty) pertaining mainly to the recent financial crisis. Nonetheless, there is also substantial individual variation related to important domestic events. In relation to the economy, we find that shocks to interest rate uncertainty have large negative effects on industrial production and unemployment. The magnitudes and the persistence of responses of both macro variables are considerable. Overall, there is substantial heterogeneity across countries and uncertainty measures, with the drop in production varying from 0.5 to 3 percent within the year the shock hits. The negative effects are persistent and the recovery of the economy to initial levels is slow, taking about 3 to 5 years. Furthermore, the effect on prices varies across countries and, within a country, it varies across the measures of uncertainty. Prices display an acyclic behavior in response to interest rate uncertainty shocks. The variation across the different measures of interest rate uncertainty and across countries appears mostly on the quantitative side. Moreover, short yield uncertainty is found to explain a large fraction of variation of industrial production and unemployment.

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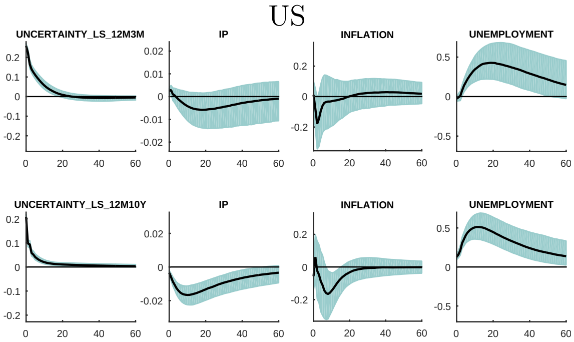
A One year ahead uncertainty

Table 3: Summary statistics - 12 months ahead uncertainty -

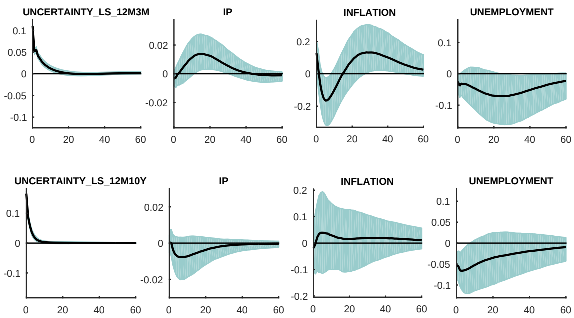
	US	**Japan**	**Ger.**	**France**	**UK**	**Italy**	**Canada**	**Spain**	**Sweden**	**Switz.**
3 month yield										
CE mean	3.09	0.74	2.91	2.97	4.71	3.75	3.48	3.36	3.61	1.32
CE std	2.12	0.81	1.55	1.63	2.20	2.55	1.79	2.31	1.93	1.17
Realized mean	2.64	0.37	2.42	2.61	3.64	3.24	2.54	2.95	2.83	1.32
Realized std	2.22	0.63	1.81	1.97	2.42	2.71	1.66	2.29	2.08	1.21
U_{th} **mean**	0.29	0.09	0.20	0.21	0.34	0.28	0.34	0.24	0.33	0.21
D_{th} **mean**	0.19	0.04	0.10	0.12	0.25	0.13	0.23	0.11	0.15	0.10
Corr(U_{th},D_{th})	0.94	0.95	0.95	0.95	0.97	0.88	0.92	0.81	0.60	0.93
10 year yield										
CE mean	4.91	2.11	4.43	4.61	5.44	5.45	5.01	5.12	4.81	2.53
CE std	1.42	1.16	1.63	1.52	1.84	2.17	1.70	1.92	1.94	1.03
Realized mean	4.41	1.70	4.01	4.26	4.53	5.22	3.94	4.96	4.28	2.14
Realized std	1.58	1.03	1.75	1.67	1.74	2.34	1.38	2.00	2.21	1.08
U_{th} **mean**	0.34	0.17	0.27	0.27	0.31	0.33	0.38	0.39	0.37	0.23
D_{th} **mean**	0.18	0.08	0.10	0.12	0.17	0.17	0.17	0.18	0.15	0.08
Corr(U_{th},D_{th})	0.99	0.94	0.31	0.71	0.92	0.95	0.62	0.56	0.64	0.35

Figure 5: IRFs to interest uncertainty shock - 12 months ahead uncertainty -

US

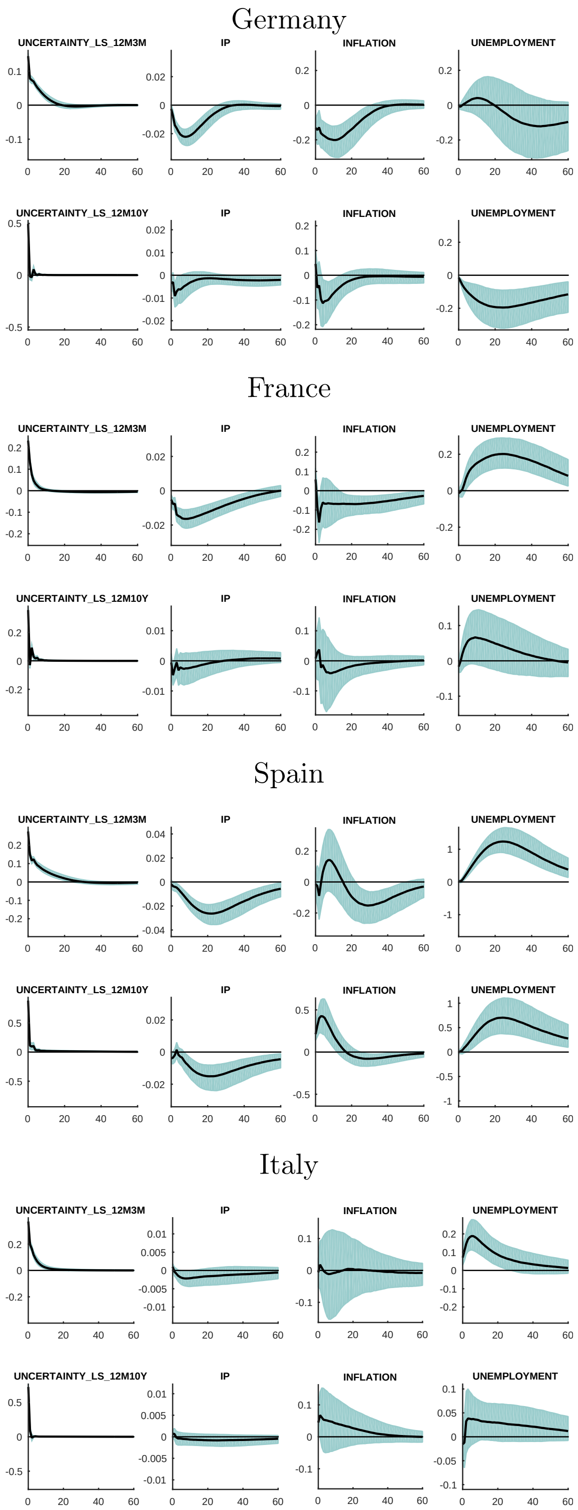


Japan



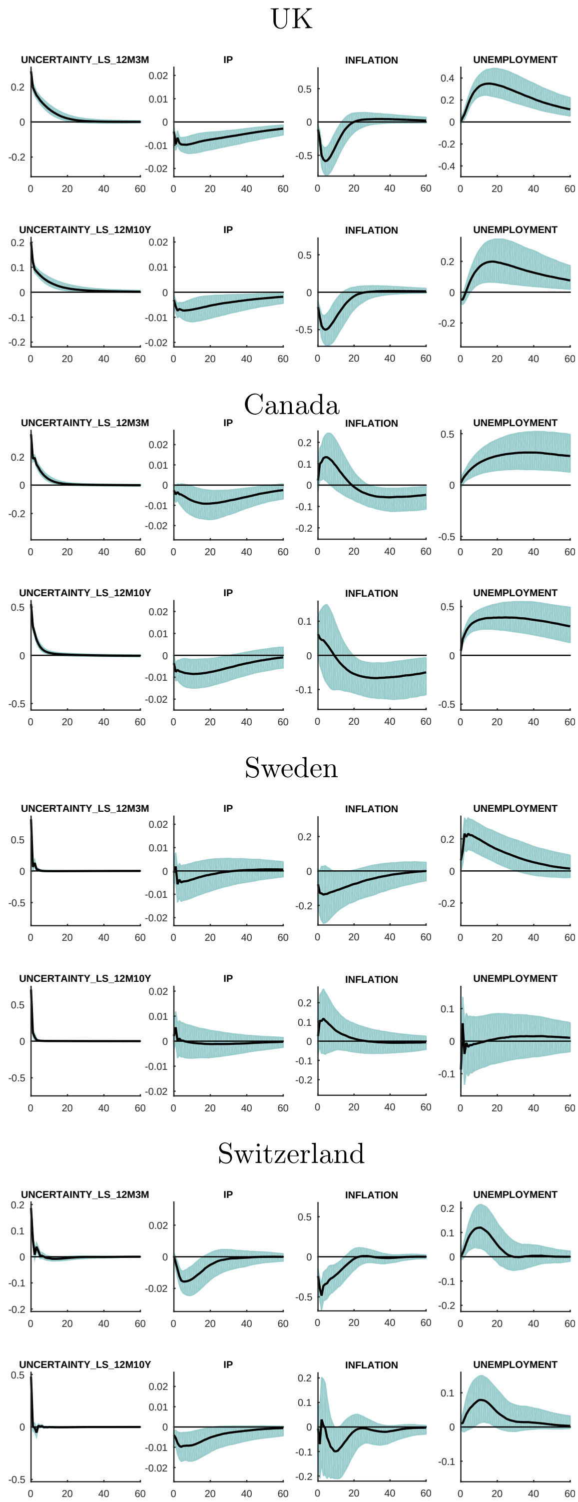
Notes: The solid line in black denotes median impulse response from the estimated Bayesian SVARs with $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI year-on-year inflation rate and u_t being the unemployment rate. VARs include an exogenous variable, oil prices, a constant and a time trend. The shaded area corresponds to the 68 percent error band. Horizontal axis is in months.

Figure 6: IRFs to interest uncertainty shock - 12 months ahead uncertainty -



Notes: The solid line in black denotes median impulse response from the estimated Bayesian SVARs with $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI year-on-year inflation rate and u_t being the unemployment rate. VARs include an exogenous variable, oil prices, a constant and a time trend. The shaded area corresponds to the 68 percent error band. Horizontal axis is in months.

Figure 7: IRFs to interest uncertainty shock - 12 months ahead uncertainty -



Notes: The solid line in black denotes median impulse response from the estimated Bayesian SVARs with $y_t = (U^j_{th}, ip_t, \pi_t, u_t)$, with U^j_{th} being the interest rate uncertainty measure, ip_t the (log) of the industrial production index, π_t the CPI year-on-year inflation rate and u_t being the unemployment rate. VARs include an exogenous variable, oil prices, a constant and a time trend. The shaded area corresponds to the 68 percent error band. Horizontal axis is in months.