Macroeconomic Uncertainty Indices Based on Nowcast and Forecast Error Distributions Online Appendix

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This Appendix contains five sections. Section 1 reports additional details on the data we used; Section 2 reports additional comparison results for our proposed measure and alternatives considered in the literature; Section 3 discusses empirical results for uncertainty indices based on forecast combinations and Section 4 provides additional results for variable-specific (inflation) uncertainty indices. Finally, Section 5 provides robustness results.

1   Data

The index we propose is based on GDP forecasts from the Survey of Professional Forecasters (SPF) obtained from the Federal Reserve Bank of Philadelphia. We focus on real as a useful proxy for the overall business cycle. We extract the cyclical component by first differencing.[1] We focus on quarterly growth rates of four-quarter-average of real GNP/GDP for the current quarter, $h = 0$, as well as four quarters ahead, $h = 4$. In doing so, we assume that the forecasters know the historical values of the series, including the last realized value, from

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[1]Alternatively, we could extract the business cycle component using filters other than first differences, such as a bandpass filter. However, one of our objectives is to compare uncertainty indices based on different models, including surveys, and the latter can only be constructed on output growth or inflation, not on bandpass filtered output growth or inflation. In addition, Stock and Watson (1999) show that first differences and bandpass filters produce similar stylized facts regarding the business cycle.

the Real-time dataset (Croushore and Stark, 2001). Since the survey is conducted after the "Advance" report of national income and product accounts (NIPA) by the Bureau of Economic Analysis, which is usually released at the end of the first month of the quarter for the previous quarter, this is a fair assumption. In fact, as the survey documentation suggests, though forecasters can provide backcasts for the previous quarter (when the realizations from the "Advance" release is in their information set), they most commonly do not move further from the realization.

The data for the SPF real GDP forecasts start in 1968:IV. We evaluate the forecasts against the real time "Advance" release of GDP since the SPF is conducted with that target variable in mind. The real-time realizations of the growth rate of the four-quarter-moving average value of real GDP are also constructed from the real-time dataset of the Philadelphia Fed and are available until 2014:I. This determines the end of our sample period.

Usually, the forecasters respond to the survey in between the second and third weeks of the month.[2] In order to make alternative measures of uncertainty comparable with our measure with respect to the information set they contain, we use the values closest to the deadline dates of the SPF. The fact that the alternative measures are available at a higher than quarterly frequency enables us to do so.

2   A Comparison with Other Measures of Uncertainty

This section compares our SPF-based macroeconomic uncertainty index associated with four-quarter-ahead GDP growth forecasts with several indices that have been proposed in the literature. The indices we use for comparison include: "VXO" as in Bloom (2009); Baker et al.'s (2013) policy index, "BBD"; Jurado et al.'s (2014) macroeconomic uncertainty index, "JLN"; and Scotti's (2013) macroeconomic surprise based uncertainty index, "Scotti." These uncertainty measures are available for different time periods and, in particular, at different frequencies. For the daily indices, such as VXO, BBD and Scotti indices, we pick the index values for the dates that are the closest to the SPF survey's deadline dates.[3] For Jurado et al.'s monthly index we select the values of the mid-month of the quarter (namely the values

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[2]The deadlines to return the surveys are available at http://www.philadelphiafed.org/research-and-data/real-time-center/survey-of-professional-forecasters/spf-release-dates.txt for the period starting from 1990 onwards.

[3]The Scotti index used in our paper is a longer one, which is somewhat different from the index used in Scotti (2013). The longer sample, provided by the author, is created by pulling together Bloomberg and MMS forecasts.

for February, May, September and November) to be the ones that are comparable to the SPF survey and focus on their twelve-month-ahead uncertainty index. The indices have also been standardized by demeaning and re-scaling (i.e. dividing by their standard deviation) in order to make them comparable to each other.

Figure A1 depicts the indices. The time period for which each index is available can be inferred from the figure. We show the correlation ("corr") across various indices in Table 1. In the common sample (Panel B), our overall uncertainty index, U_{t+h}^*, is more closely correlated with VXO than the other measures (corr = 0.29). However, when we split the overall uncertainty measure to account for upside and downside uncertainty, U_{t+h}^+ and U_{t+h}^- respectively, we see that the downside measure is more correlated with the "JLN" index (corr = 0.37), while the upside measure is correlated with the "VXO" (corr = 0.19) and closely linked, yet negatively correlated, with "JLN" (corr = -0.23). Interestingly, while being similar to "Scotti" index in spirit in that both measures rely on forecast errors obtained from (different) surveys, it seems only marginally correlated with it. The correlations do not change noticeably when comparing the indices over the samples with all available data. In fact, the correlations pertaining to the overall as well as the downside uncertainty index are practically unchanged. The upside uncertainty index is still similarly correlated with VXO, though the negative correlation with "JLN" weakens: it becomes stronger with "BBD".

Table 1: Correlations								
	A: Sample with available data				*B. Sub-sample with common data*			
	VXO	BBD	JLN	Scotti	VXO	BBD	JLN	Scotti
BBD	0.4332				0.4999			
JLN	0.3676	0.3238			0.5117	0.3238		
Scotti	0.2943	0.1291	0.4535		0.3158	0.1514	0.4535	
U_{t+h}^*	0.2138	-0.0791	0.3010	-0.1034	0.2896	-0.0523	0.1264	-0.1034
U_{t+h}^-	0.0294	0.1040	0.3723	-0.0571	0.0676	0.1137	0.3713	-0.0571
U_{t+h}^+	0.1610	-0.1649	-0.1024	-0.0414	0.1912	-0.1496	-0.2290	-0.0414

3   Macroeconomic Uncertainty with Pooled Forecasts

An alternative way to construct a macroeconomic uncertainty index is by using parametric models. We focus on simple averages of forecasts from linear, autoregressive distributed lag (ADL) models where the predictors are indicators of real economic activity, asset prices, wages, prices and money. We focus on the latter model because it provides competitive point

forecasts as well as properly calibrated densities, even under the assumption of gaussianity, as shown in Rossi and Sekhposyan (2014); therefore, such an index could address the misspecification concerns discussed in Jurado et al. (2014). The data sources are the same as in Rossi and Sekhposyan (2014), to which we refer for details on the data and methodology on how to construct the forecasts. We obtain forecasts errors, construct their unconditional distribution and report our ex-post uncertainty measure. The sample we consider has quarterly final revised data for the series from 1959:I-2014:I. The data has been downloaded on July 2, 2014. The estimation is performed using a rolling window of 40 quarters.

Figure A2 reports the index. The figure shows that the index captures uncertainty episodes similar to the ones identified by the SPF index. Moreover, downside uncertainty episodes are again highly correlated with recessions. However, it seems that relative to the SPF-based uncertainty measure, downside uncertainty is identified more precisely during the latest financial crisis leading to the Great Recession perhaps due to the use of finally revised data. Indices based on short-horizon forecasts are noisier than the ones resulting from one-year ahead forecasts, a result similar to the one we found using SPF data.

4   Variable-specific Uncertainty Indices

An alternative to constructing macroeconomic uncertainty indices based on indicators of the state of the business cycle is to consider indicators based on specific macroeconomic variables. In Figure A3 we consider an inflation uncertainty index based on SPF inflation nowcasts and four-quarter-ahead forecasts. Again, uncertainty spikes up during recessions. The difference between the inflation index and the index that measures macroeconomic uncertainty by the state of the business cycle is that most of the upside and downside uncertainty episodes seem to be clustered: downside uncertainty occurs predominantly in the two decades between 1980 and 2000. On the other hand, the 1970s, as well as the last two decades, are dominated by upside uncertainty.[4]

We also consider inflation uncertainty measures based on a pooled forecast from several autoregressive distributed lag models. Figure A4 suggests that, in this case, the inflation uncertainty index is more noisy than the one based on the SPF.

We could also potentially use our framework to construct indices that describe a joint measure of uncertainty associated with a group variables. For instance, we could quantify

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[4]We note that, in the case of inflation, we treat inflation above expectations as downside uncertainty, and vice-versa. This works under the assumption that the higher the value of inflation, the more costly it is.

uncertainty in the labor market by the joint forecast error density of labor market variables. This could be useful for the recent monetary policy of the Federal Reserve, whose unconventional monetary policy measures focus extensively on labor market indicators.
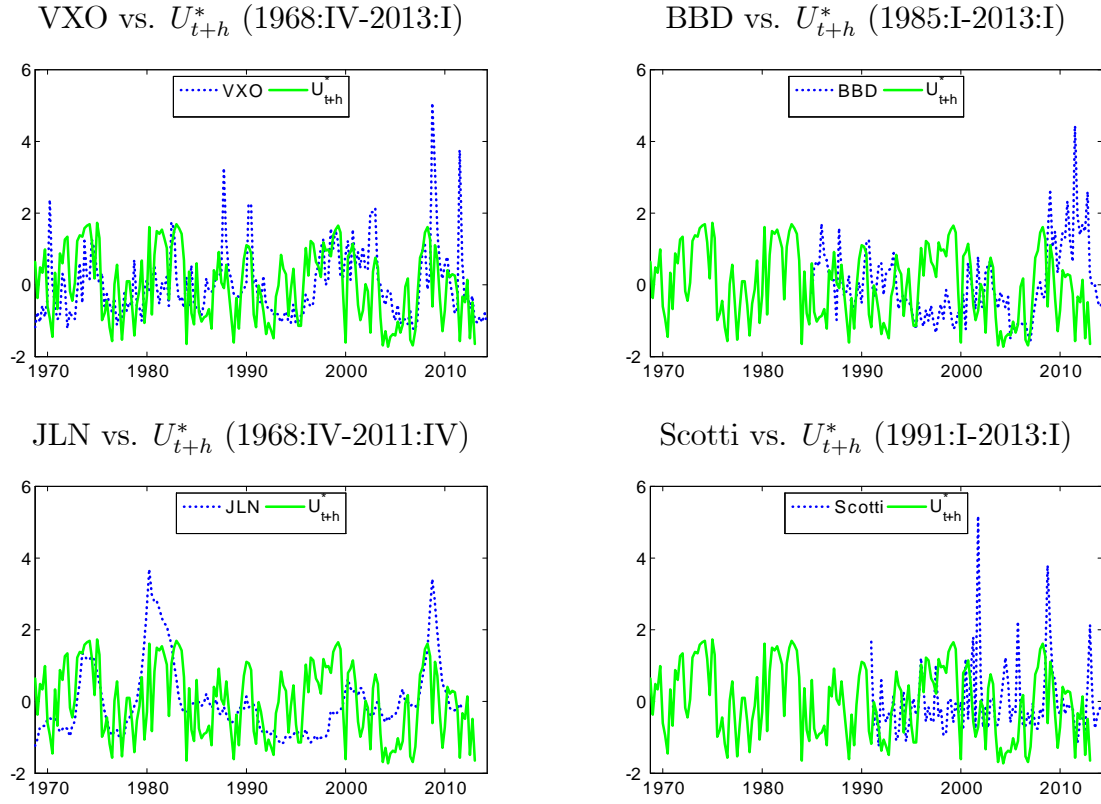
5   Additional Robustness Checks for VARs

First, we consider using industrial production instead of GDP. Figures A5 and A6 report the effects of uncertainty measures on employment and real activity when in the VAR we use the industrial production index as opposed to GDP. The figures demonstrate that the empirical results for the uncertainty effects on industrial production are quantitatively similar to those we report for GDP. Second, Figure A6 shows that our VAR results (where output is measured by industrial production) are robust to using the ordering in Baker et al. (2013).

References

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Rossi, B. and T. Sekhposyan. 2014. "Evaluating Predictive Densities of U.S. Output Growth and Inflation in a Large Macroeconomic Data Set." *International Journal of Forecasting* 30(3), 662-682.

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Additional Tables and Figures

Figure A1. Comparison of Uncertainty Indices

VXO vs. U_{t+h}^* (1968:IV-2013:I)

BBD vs. U_{t+h}^* (1985:I-2013:I)

JLN vs. U_{t+h}^* (1968:IV-2011:IV)

### Scotti vs. U_{t+h}^* (1991:I-2013:I)

Notes: The figure depicts our overall uncertainty index, U_{t+h}^*, together with those based on the VXO, Baker, Bloom and Davis (2013), Jurado, Ludvigson and Ng (2014) and Scotti (2013).

Figure A2. Uncertainty Index with Pooled Forecast Error Distribution
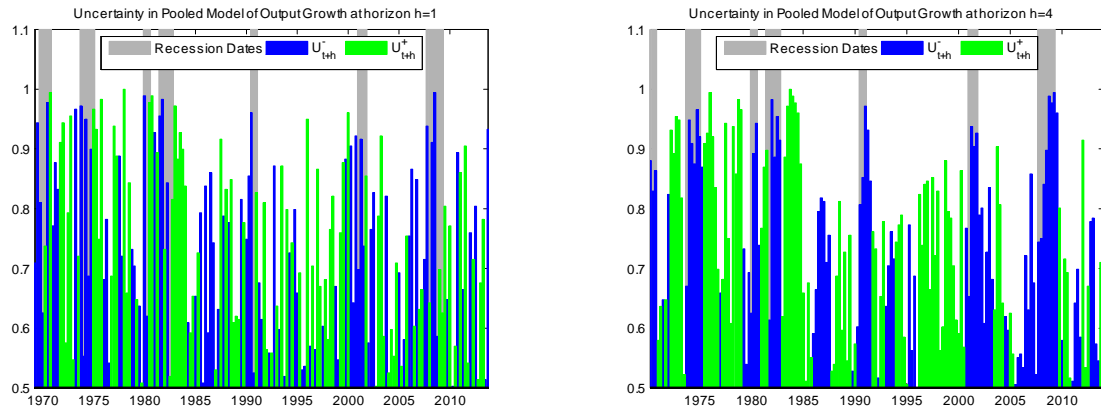
Notes: The figure depicts the uncertainty measure obtained from the pooled forecasts from ADL models that incorporate asset prices, measures of real activity, wages and prices, as well as money. Results are based on a rolling window estimation with 40 observations.

Figure A3. Inflation Uncertainty Index based on SPF Forecast Error Distribution
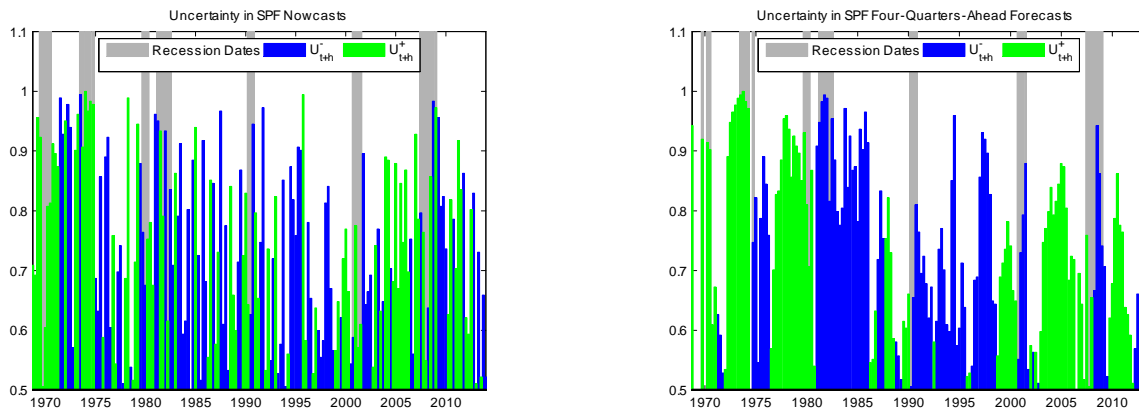
Notes: The figure depicts the uncertainty measure obtained from forecast error distributions of the SPF's inflation nowcasts and four-quarter-ahead forecasts.

Figure A4. Inflation Uncertainty Index with Pooled Forecast Error Distribution
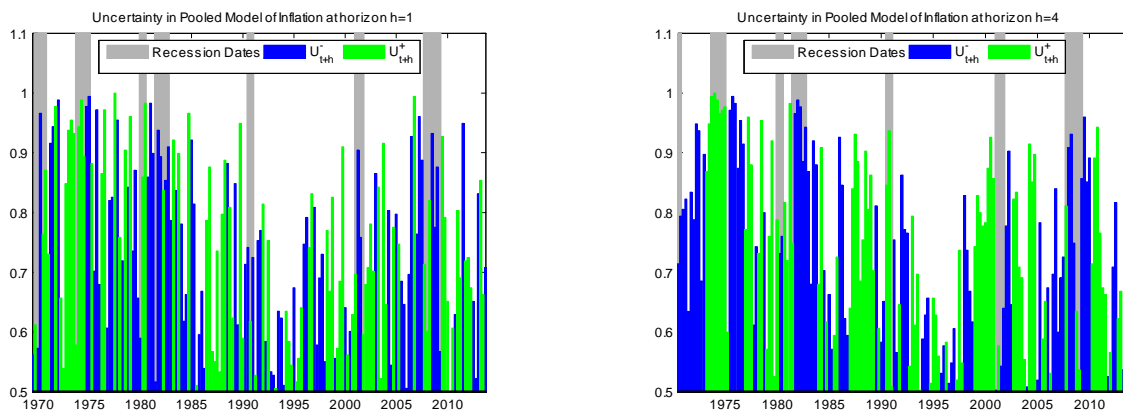
Notes: The figure depicts the uncertainty measure obtained from the pooled forecasts from ADL models that incorporate asset prices, measures of real activity, wages and prices, as well as money. Results are based on a rolling window estimation with 40 observations.
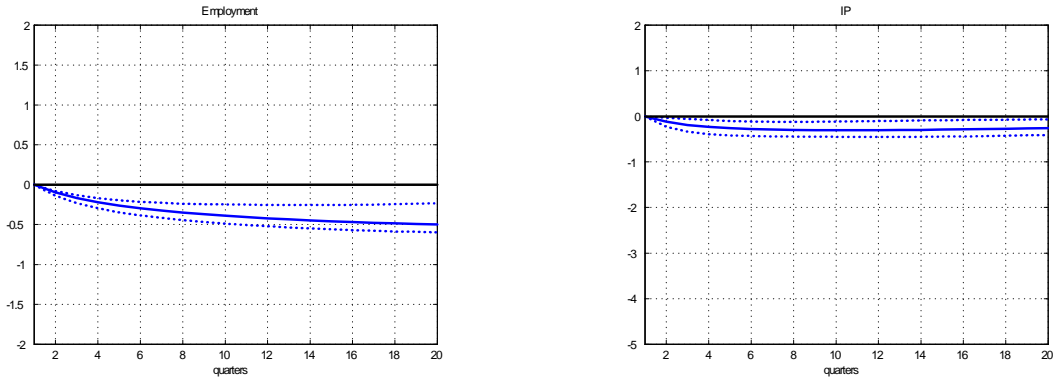
Figure A5. Macroeconomic Impact of Uncertainty

Panel A. SPF-based Uncertainty (U^*_{t+h})

Employment

IP
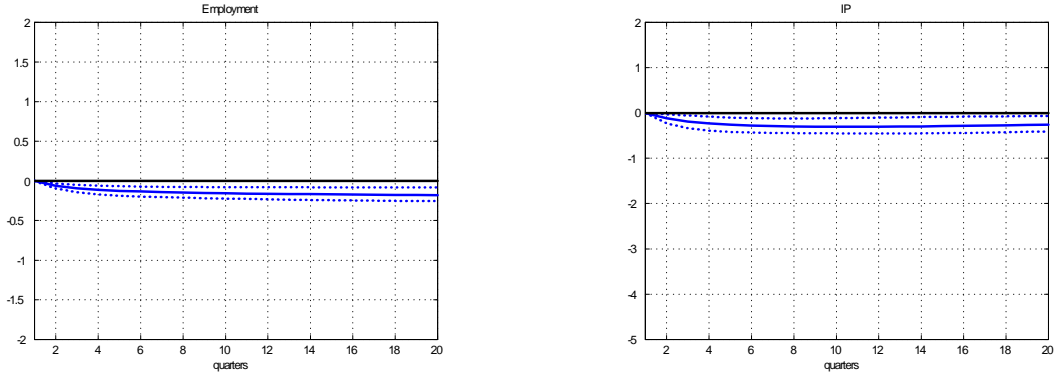
Panel B. SPF-based Upside Uncertainty (U^+_{t+h})

Employment

IP
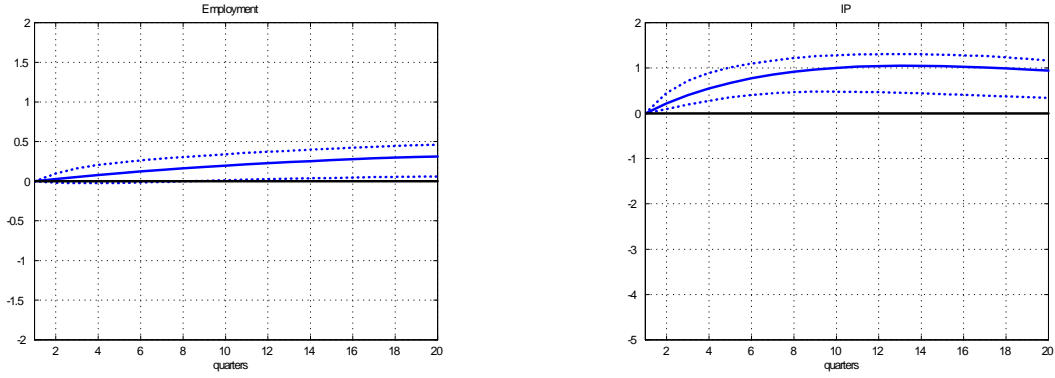
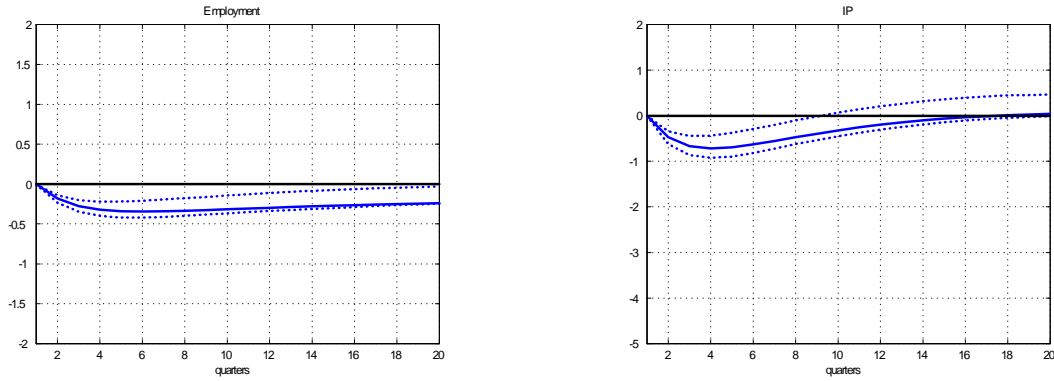## Panel C. SPF-based Downside Uncertainty (U^-_{t+h})

Employment

IP

Notes: The figure depicts impulse responses of employment and industrial production ("IP") to several uncertainty index shocks based on:
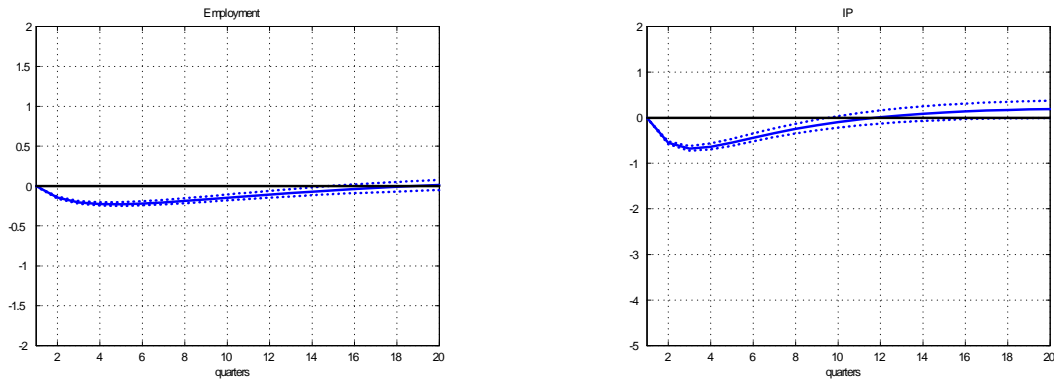U^*_{t+h}, U^+_{t+h}, and U^-_{t+h}.
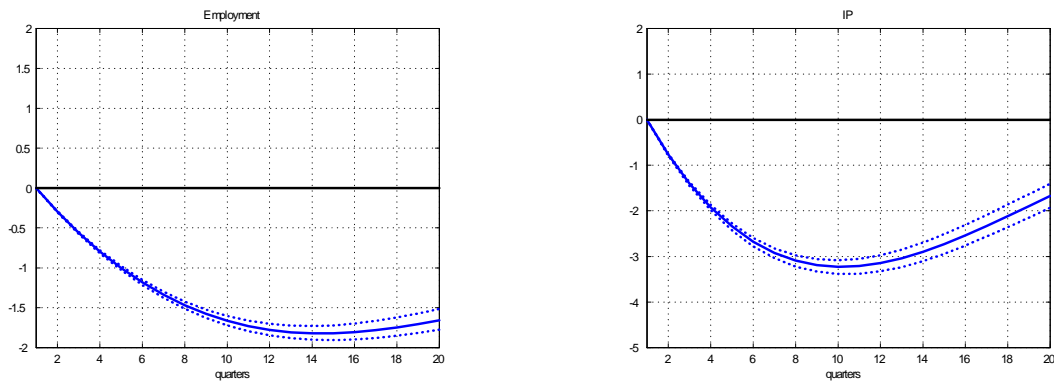
Figure A6. Macroeconomic Impact of Uncertainty
Panel A. VXO

Employment

IP

Panel B. Baker, Bloom and Davis (2013)

Employment

IP

Panel C. Jurado, Ludvigson, Ng (2014)

Employment

IP

Panel D. Scotti (2013)

Employment

IP

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Notes: The figure depicts impulse responses of employment and industrial production ("IP") to several uncertainty index shocks based on:
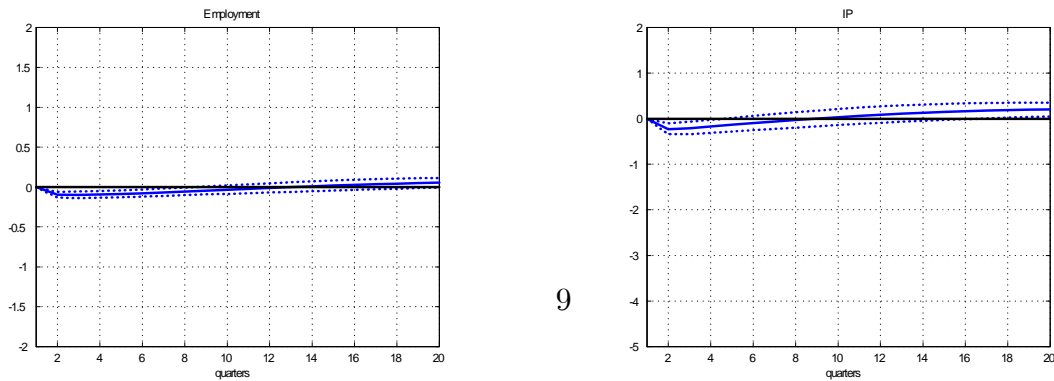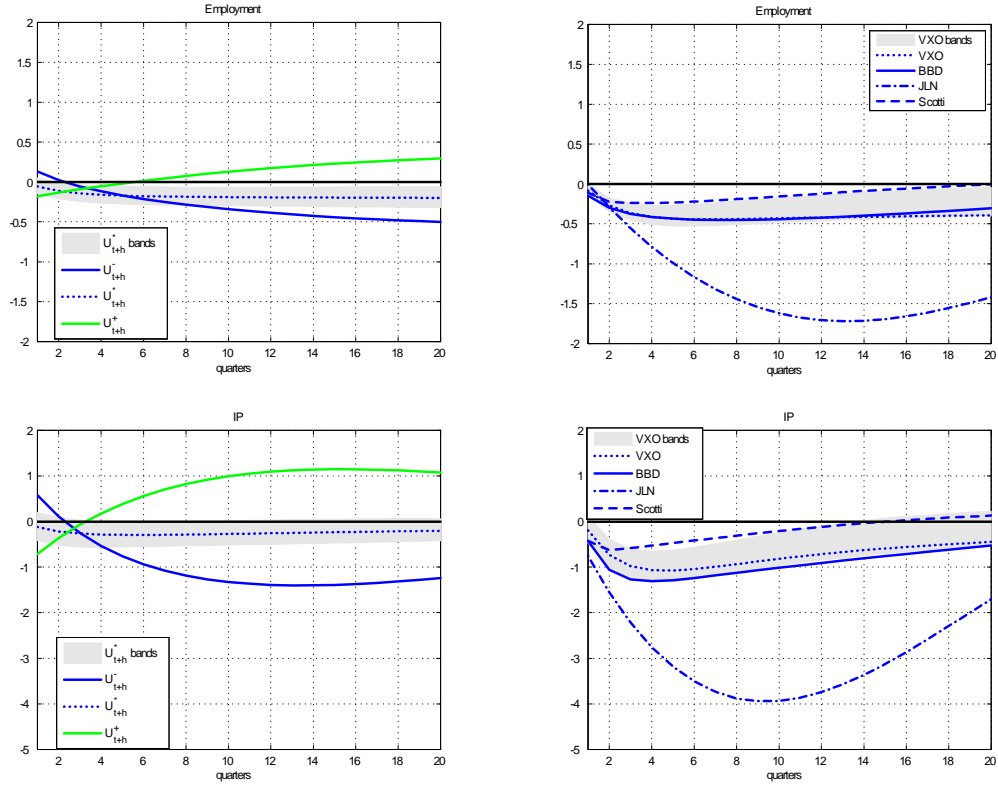
Figure A7. Robustness to Ordering

Note. The figure depicts impulse responses of employment and industrial production ("IP") to several uncertainty index shocks: our uncertainty index shocks, U_{t+h}^*, U_{t+h}^+, and U_{t+h}^- on left panel; VXO, Baker, Bloom and Davis (2013), Jurado, Ludvigson and Ng (2014) and Scotti (2013) on right panel. The gray shaded region is the 90% coverage area for VXO on the right panel and U_{t+h}^* on the left panel.