

# **Uncertainty about the War in Ukraine: Measurement and Effects on the German Economy**

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# Motivation

- ▶ The Russian attack on Ukraine in February 2022 was a blow for the world economy.
- ▶ Countries in Europe, most notably Germany, have to revise their economic policies - with large economic costs.
- ▶ A key economic dimension of the war is uncertainty. Higher uncertainty
  - \* prompts firms to rethink their investment plans and wait until uncertainty is resolved.
  - \* leads risk-averse households to reduce consumption expenditure.
  - \* increases risk premia, thus making investment and consumption more expensive.
- ▶ We study the consequences of uncertainty about the war in Ukraine for the business cycle in Germany.

# Contribution

- ▶ Data set of 8 million German-speaking tweets, based on a list of keywords, i.e. "Ukraine", "Putin" etc.
- ▶ Machine learning approach to quantify the extent of uncertainty expressed in each tweet.
  - \* Provides us with a daily index of uncertainty.
- ▶ VAR model with daily variables such as stock prices, stock market volatility, the price of natural gas, economic activity and break-even inflation expectations.
- ▶ Identification based on distinction between Twitter activity at night and day.

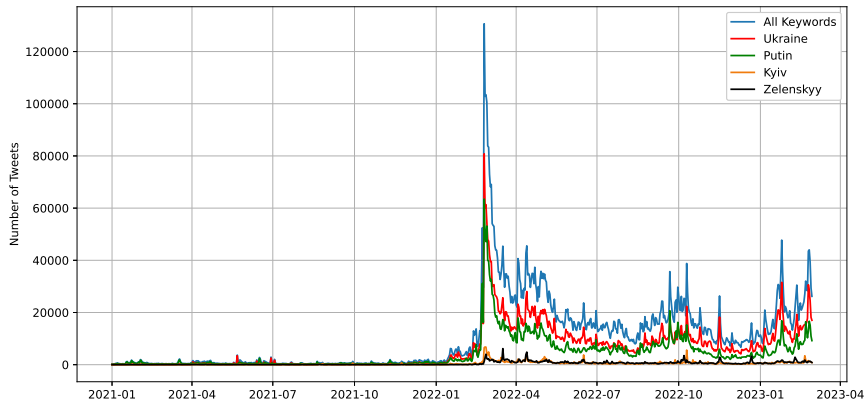
# Key results

- ▶ Strong fluctuations in uncertainty with a peak on February 24, 2022.
- ▶ An uncertainty shock has strong adverse effects: stock prices fall, stock market volatility increases, the price of natural gas increases, real economic activity falls and expected inflation rises.
- ▶ Opposite responses of activity and expected inflation suggest that the effect of uncertainty resembles the effect of an adverse supply shock.
- ▶ Effect of uncertainty much larger in the first subsample, i.e. before August 2022, compared to the second subsample.

- ▶ Dictionary-based measurement of uncertainty from large text corpora pioneered by Baker et al. (2016).
- ▶ Uncertainty shocks in recursively-identified VAR models:
  - \* Bachmann et al. (2013), Baker et al. (2016), Jurado et al. (2015), Altig et al. (2020) and Ludvigson et al. (2021), Caldara and Iacoviello (2022)
- ▶ Indicators of Geopolitical Risk based on newspaper articles and prespecified dictionaries:
  - \* Caldara and Iacoviello (2022), Caldara et al. (2022), Bondarenko et al. (2023)
- ▶ Event studies on the effects of the Ukraine war:
  - \* Federle et al. (2023), Neuenkirch et al. (2023).

- ▶ We collect German-speaking tweets containing the keywords *Zelenskyj*, *Putin*, *Ukraine*, *Kiev* and their transcriptions and transliterations from the Twitter API.
- ▶ More than 9 million tweets between January 1, 2021 and February 28, 2023 from 468,596 distinct users.
- ▶ Preprocessing:
  1. remove profile names starting with @, hashtags, hyperlinks, RT (retweet) tags, digits, special characters and line breaks.
  2. remove duplicates and empty entries.
  3. Transform time stamp to CET.
- ▶ As a result, we end up with a database of 8,457,134 unique tweets.

**Figure** Number of tweets



**Notes:** The figure shows the total number of unique tweets according to the respective keywords, i.e. All keywords ( $n=8,457,134$ ), Ukraine ( $n=4,948,399$ ), Putin ( $n=3,441,673$ ), Kyiv ( $n=346,305$ ) and Zelenskyj ( $n=364,049$ ). Note that the category Kyiv (Zelenskyj) also includes alternative transliterations, i.e. Kiew, Kyjiw, and Kiev (Selenskyj and Selenski).

# Uncertainty index

- ▶ Zero-shot classification with German BERT.
- ▶ The model is pre-trained on more than 160 GB of German text data.
  - \* e.g. Wikipedia articles, parliament speeches, books and, among others, German court decisions.
- ▶ For each tweet, we obtain a probability  $p$  of belonging to the "uncertainty" category.

## Example tweet with $p = 0.92$

Olaf Scholz (@Bundestkanzler) on May 05 2022

***Tweet:*** Es ist wieder Krieg in Europa – unser ganzer Kontinent lebt gerade in einer Ausnahmesituation. Es gibt kein Drehbuch für das, was vor uns liegt. Meine Aufgabe ist es, unser Land sicher durch diese Zeit zu steuern. Und das tue ich.

***Translation:*** There is war again in Europe - our entire continent is currently living in an exceptional situation. There is no script for what lies ahead of us. My task is to safely navigate our country through this time. And that's what I'm doing.

## Example tweet with $p = 0.01$

Annalena Baerbock (@ABaerbock) on May 10 2022

***Tweet:*** Ich bin unfassbar froh, hier im freien #Kiew zu sein. Der dafür notwendige Mut der Ukrainer\*innen ist ergreifend. Meine Botschaft ist klar: Die #Ukraine kann sich auf unsere Unterstützung verlassen - nicht nur militärisch, nicht nur heute.

***Translation:*** I am incredibly happy to be here in free #Kyiv. The courage of the Ukrainian people is moving. My message is clear: Ukraine can rely on our support - not only military, not only today.

- ▶ We calculate the daily average of uncertainty probabilities.
- ▶ To account for the varying number of tweets, we assign each day a weight

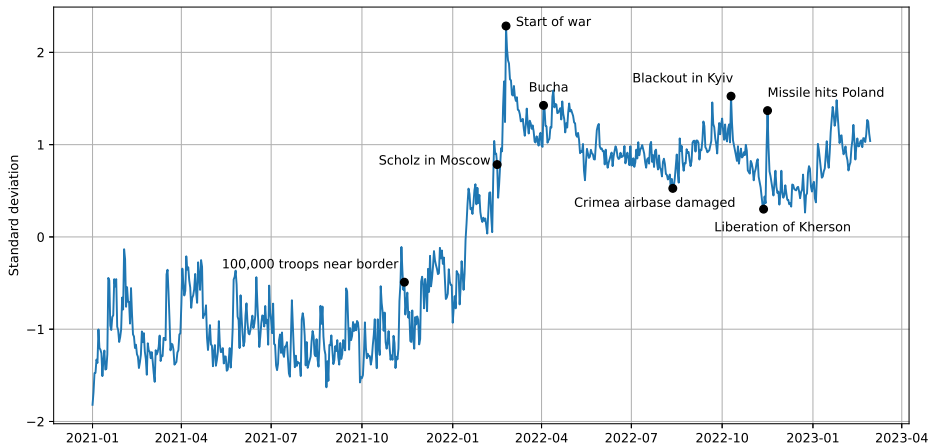
$$w_t = \frac{\log(\#tweets_t + 1)}{\sum_{t=1}^T \log(\#tweets_t + 1)},$$

where  $\#tweets_t$  is the number of tweets included on day  $t$ .

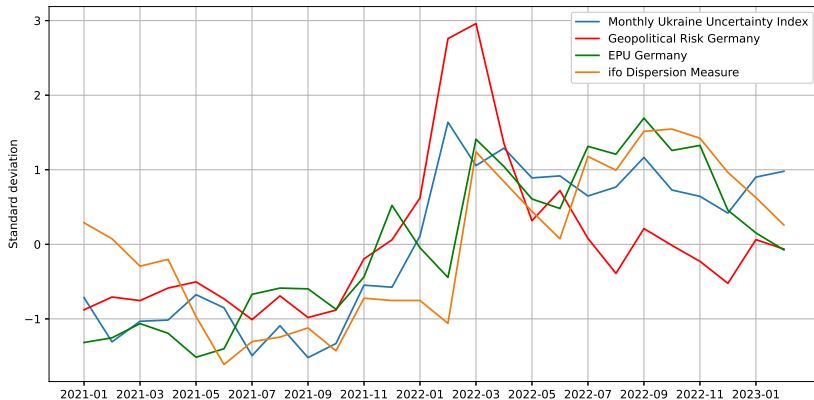
- ▶ Data available at

[www.ukraine-uncertainty.de](http://www.ukraine-uncertainty.de).

**Figure** The Ukraine Uncertainty Index



**Figure** Comparing our index with alternative indices



**Notes:** The figure shows the monthly Ukraine Uncertainty Index derived from German tweets, the Geopolitical Risk Index for Germany, the EPU index for Germany and the ifo Dispersion Measure. Each index is standardized.

# Identification & VAR model

- ▶ Key idea: Twitter is active 24/7 while trading on financial markets and (most) economic activity takes place during trading hours only.
- ▶ Twitter activity at night is exogenous with respect to financial markets and real activity the next day.
- ▶ This lends itself to a straightforward recursive ordering:

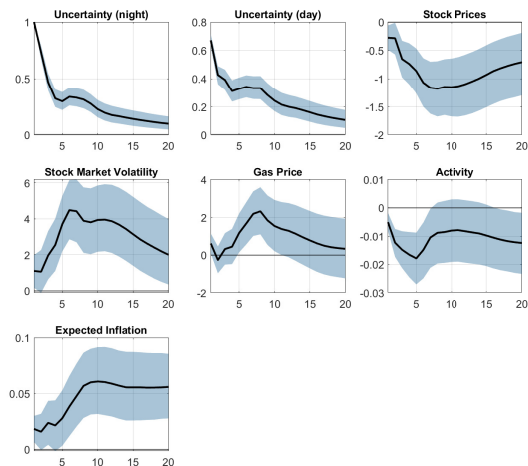
$$y'_t = \begin{bmatrix} unc_{t,j}^{night} & unc_{t,j}^{day} & stockp_t & stockv_t & gasp_t & activity_t & infl_t^e \end{bmatrix}$$

- ▶ Sample period January 3, 2022 - February 28, 2023.
- ▶ Bayesian estimation with a Normal-Wishart prior.

# Data series in the baseline model

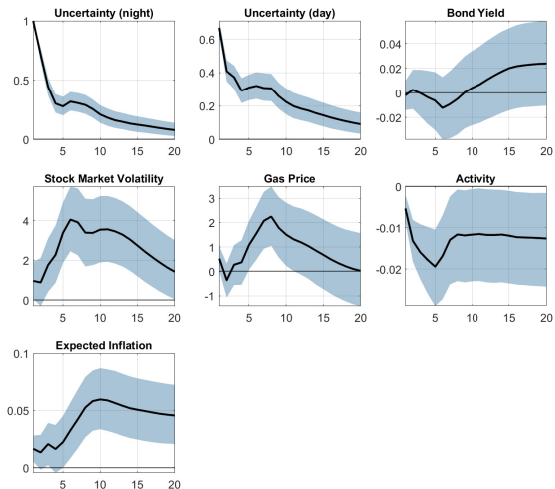
1.  $unc_{t,j}^{night}$ : uncertainty of type  $j$  at night between 05:30pm on day  $t - 1$  and 08:59:59am on day  $t$
2.  $unc_{t,j}^{day}$ : uncertainty of type  $j$  at day between 09:00am and 05:29:59pm on day  $t$
3.  $stockp_t$ : German stock market index (logs  $\times 100$ )
4.  $stockv_t$ : volatility index (VDAX) of the German stock market (logs  $\times 100$ )
5.  $gasp_t$ : natural gas price (Dutch TTF), (logs  $\times 100$ )
6.  $activity_t$ : Bundesbank weekly activity index interpolated to daily frequency using the Chow-Lin procedure with the truck toll mileage index as a reference series
7.  $infl_t^e$ : 5y break-even inflation from the bond market

**Figure** The response to an uncertainty shock (baseline model)



*Notes:* The shaded areas reflect 68% probability bands.

## Figure The response to an uncertainty shock (with bond yields)



Notes: The shaded areas reflect 68% probability bands.

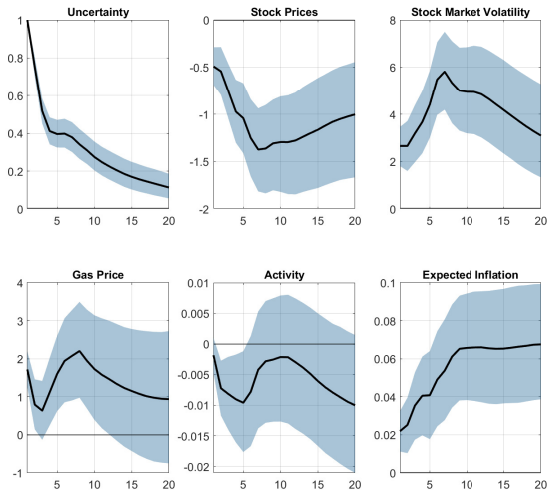
# Alternative identifications

- ▶ Alternative I: Recursive ordering with daily uncertainty ordered first.
- ▶ Alternative II: "hybrid" approach of Romer and Romer (2004), Coibion (2012) and Caldara and Herbst (2019).
  - \* Select a number of dates with important news about the Ukraine and calculate the change of uncertainty on these dates.
  - \* Put the cumulative sum of the changes of uncertainty as the first variable into the VAR model.
  - \* The vector of endogenous variables is

$$y'_t = [\Delta^{cum}unc_t \quad unc_t \quad stockp_t \quad stockv_t \quad gasp_t \quad activity_t \quad infl_t^e]$$

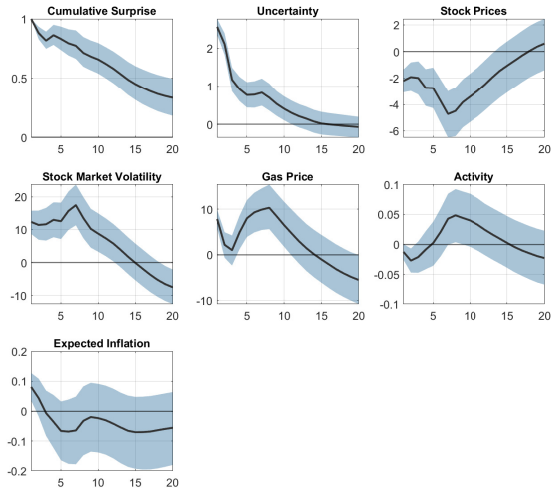
where  $\Delta^{cum}unc_t$  is the cumulative change of uncertainty on selected dates.

**Figure** The response to an uncertainty shock (alternative identification I)



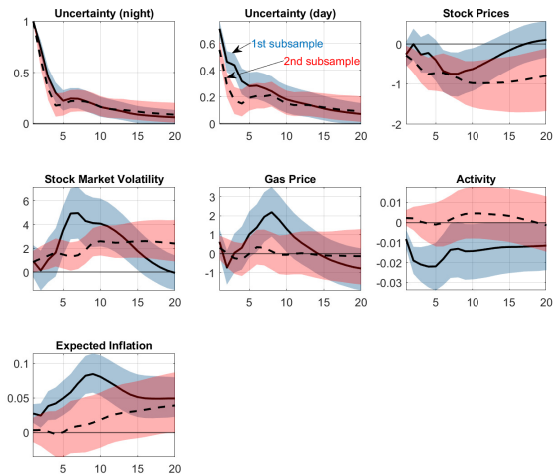
Notes: The shaded areas reflect 68% probability bands.

## Figure The response to an uncertainty shock (alternative identification II)



Notes: The shaded areas reflect 68% probability bands.

## Figure The response to an uncertainty shock (subsamples)



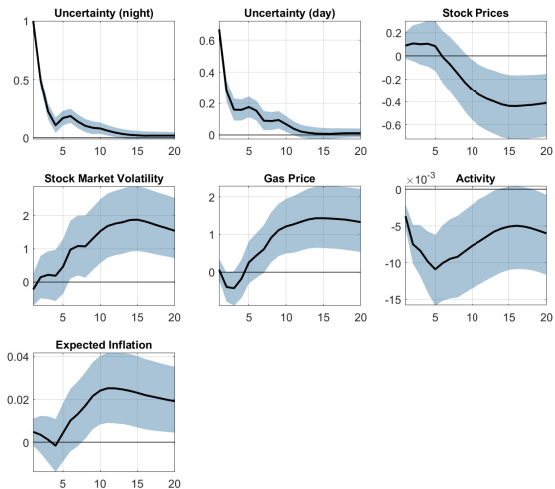
Notes: The model is estimated for January 2022 to August 2022 (first subsample, blue) and September 2022 to February 2023 (second subsample, red).

# Conclusions

- ▶ We construct an indicator of uncertainty about the war in Ukraine based on more than eight million German tweets.
- ▶ Uncertainty has strong and persistent effects on real and financial variables as well as expected inflation.
- ▶ Main take-aways:
  1. Twitter is a useful source of information in order to learn about the evolution of uncertainty.
  2. Uncertainty about the war in Ukraine does not only cause military and political upheaval, but also leads to macroeconomic adjustments that resemble those after adverse supply shocks.
  3. Geopolitical risks in general are an important source of economic fluctuations.

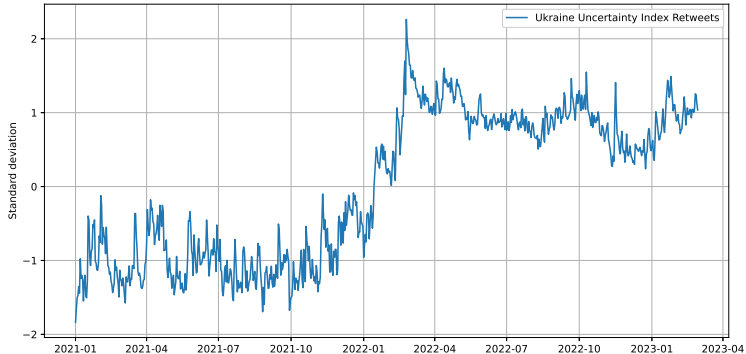
## Additional slides

**Figure** The response to an uncertainty shock (unweighted tweets)



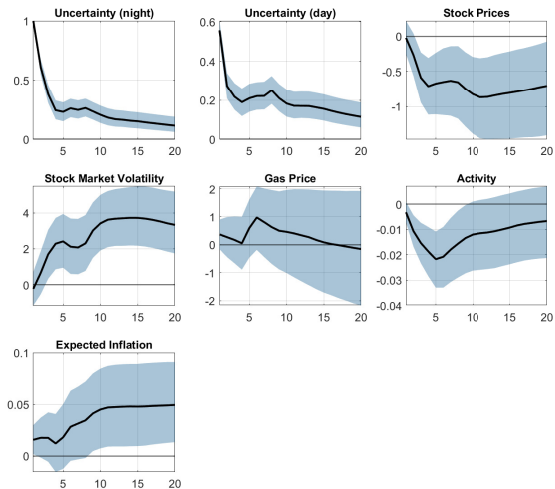
Notes: The shaded areas reflect 68% probability bands.

**Figure** The Ukraine Uncertainty Index (weighted by retweets)



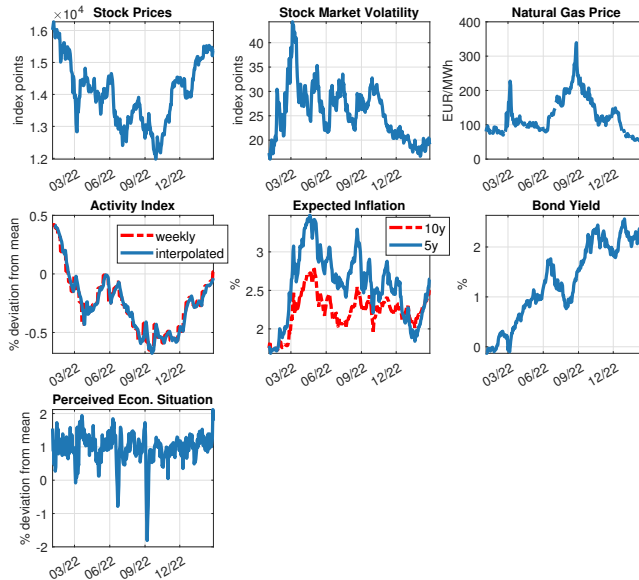
*Notes:* The figure shows the standardized daily Ukraine Uncertainty Index (Retweets) derived from German tweets.

**Figure** The response to an uncertainty shock (sample begins in March 2022)



Notes: The shaded areas reflect 68% probability bands

**Figure** Data series for the VAR model

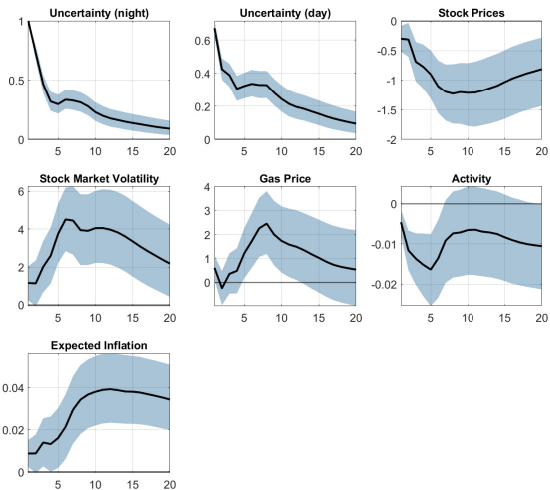


**Figure** Structural uncertainty shock



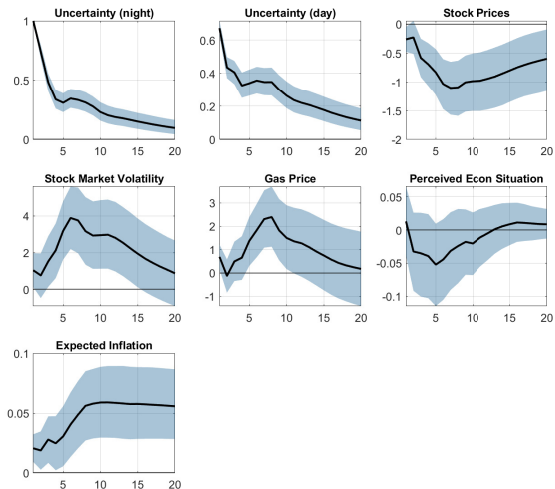
*Notes:* The figure shows the series of estimated structural uncertainty shocks (in standard deviations).

## Figure The response to an uncertainty shock (with ten-year expected inflation)



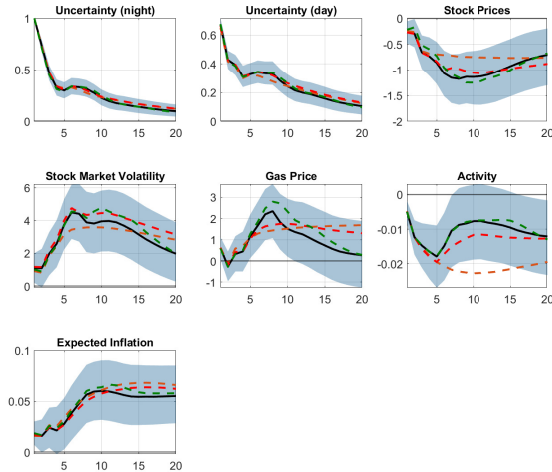
Notes: The shaded areas reflect 68% probability bands.

## Figure The response to an uncertainty shock (with perceived economic situation)



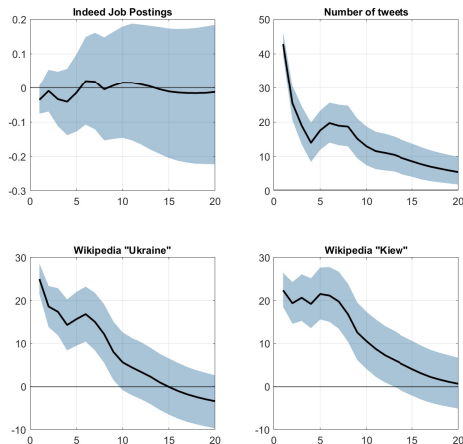
Notes: The shaded areas reflect 68% probability bands.

**Figure** The response to an uncertainty shock (alternative lag orders)



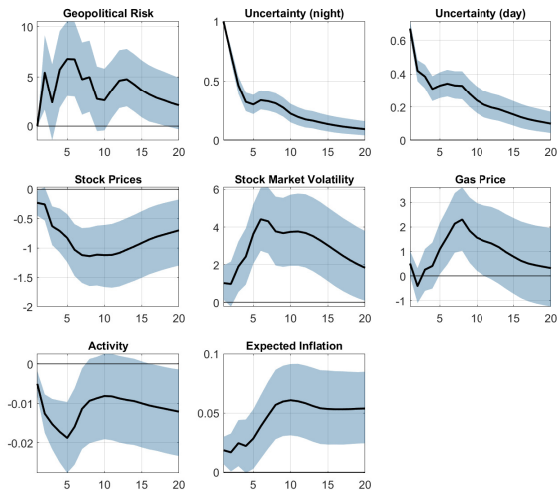
**Notes:** The figure shows the responses for the model with eight lags (black line) and alternative models with ten (green), six (red) and four (orange) lags.

**Figure** The response to an uncertainty shock (additional variables)



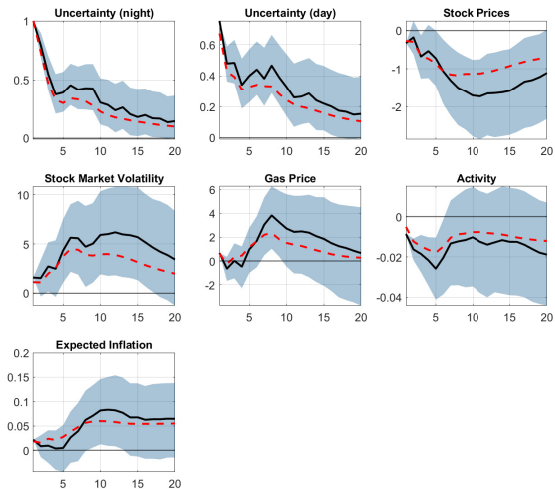
*Notes:* The figure shows the responses of the additional variables, each used as the alternative seventh variable replacing expected inflation, to an uncertainty shock.

**Figure** The response to an uncertainty shock (geopolitical risk ordered first)



Notes: The shaded areas reflect 68% probability bands

**Figure** The response to an uncertainty shock (OLS-VAR)



*Notes:* The shaded areas reflect 90% probability bands. The red dashed line is the response in the baseline model.

# Dates used in alternative identification II

## ► 2022

February 11, 2022 (White House warns Russian invasion of Ukraine may be imminent); February 15, 2022 (Chancellor Scholz in Moscow); February 21, 2022 (Russia sends troops into Eastern Ukraine); February 24, 2022 (Russian invasion begins); March 24, 2022 (fighting near Zaporizhzhia nuclear power plant); April 4, 2022 (news about Bucha massacre emerge); April 28, 2022 (Bundestag decides to send heavy weapons); July 22, 2022 (Black Sea grain deal); August 19, 2022 (Gazprom announces pipeline maintenance); September 21, 2022 (Russia declares partial mobilization); November 15, 2022 (misguided Ukrainian missile hits Poland)

## ► 2023

January 25, 2023 (German government decides to send Leopard tanks to Ukraine); February 20, 2023 (President Biden in Kyiv)

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