Generalizing the *Max Share* Identification to multiple shocks identification: an Application to Uncertainty

Andrea Carriero (Queen Mary and University of Bologna) and Alessio Volpicella (University of Surrey)

EEA-ESEM Conference
Bocconi University
August 24, 2022

Motivation

- *Max Share Identification* is a popular device to identify structural shocks in SVARs.
- Optimizing the Forecast Error Variance (FEV) of a target variable, e.g. tech shock maximizes the FEV of labour productivity in the long run.
- *Max Share Identification* typically identifies shocks individually . . . single shock identification is common, but problematic.
- E.g. individually identified shocks tend to be correlated to each other, sequential identification of shocks implies some ordering restrictions.

This Paper

- We generalize the *Max Share Identification* to simultaneous identification of multiplicity of shocks.
- In our application, we disentangle macro uncertainty vs financial uncertainty vs pure financial (credit supply) shocks.

Empirical Exercise: Motivation

- This empirical application is motivated by three challenges in the uncertainty literature.
- First, most empirical works employ SVARs and assume that uncertainty is (contemporaneously) exogenous: it does not respond contemporaneously to economic variables, whereas economic variables react contemporaneously to uncertainty.
- However, according to economic theory both directions of causality are feasible: Van Nieuwerburgh & Veldkamp (06, *JME*), Bachmann & Moscarini (11), Fajgelbaum et al. (17, *QJ Econ*), Brunnermeier & Sannikov (14, *AER*).

- Second, a separate challenge is about the origins of uncertainty.
- Standard theories claim that uncertainty originates from macroeconomic fundamentals, e.g., productivity (macro or real uncertainty).
- However, uncertainty can be also specific to financial markets (financial uncertainty).
- With some exceptions, the current literature does not disentangle/identify the contributions of real versus financial uncertainty to business cycle fluctuations, nor it allows feedback between macro and financial uncertainty.
- In other words, researchers usually assume source of uncertainty is homogeneous: in a typical SVAR one would find a proxy for -say- macroeconomic uncertainty, but not for financial uncertainty (and viceversa).

- Third, it is hard to distinguish between uncertainty and credit supply shocks as there is a high degree of comovement between indicators of financial distress and uncertainty proxies and they have the same qualitative effects on macro variables.

Main Contributions

- Generalizing the *the Max Share Identification* to multiple shocks identifications. In the application, this (i) allows for uncertainty endogeneity, (ii) disentangles macro vs financial uncertainty, and (iii) separates uncertainty from pure financial shock.
- Methodological contribution: identification consists of solving a quadratic optimisation problem on the columns of the rotation matrix transforming reduced-form shocks into structural disturbances $\rightarrow$ we establish general results for existence and uniqueness of the solution that can be applied to any empirical application.

- Empirical findings: uncertainty is *partially endogenous*; omitting heterogeneous sources of uncertainty biases the estimation.
- Ignoring the endogenous role of uncertainty leads to under-estimating (downward bias) the effects of credit shocks on the economy.

Today's Presentation

- Literature
- Identification
- Estimation and Inference
- Monte-Carlo Simulation
- Empirical Application

The Econometric Framework

- SVAR(p):

$$\boldsymbol{A}_0 \boldsymbol{y}_t = \boldsymbol{a} + \sum_{j=1}^{p} \boldsymbol{A}_j \boldsymbol{y}_{t-j} + \boldsymbol{\epsilon}_t, \;\; \boldsymbol{\epsilon}_t | (\boldsymbol{y}_{t-1}, \dots) \sim \mathcal{N}(\boldsymbol{0}, \boldsymbol{I}_n), \qquad (1)$$

  where $\theta = (\boldsymbol{A}_0, \boldsymbol{a}, \boldsymbol{A}_1, \dots, \boldsymbol{A}_p)$ collects the structural parameters and n is the number of variables.

- Reduced-form VAR(p):

$$\boldsymbol{y}_t = \boldsymbol{b} + \sum_{j=1}^{p} \boldsymbol{B}_j \boldsymbol{y}_{t-j} + \boldsymbol{u}_t, \;\; \boldsymbol{u}_t | (\boldsymbol{y}_{t-1}, \dots) \sim \mathcal{N}(\boldsymbol{0}, \boldsymbol{\Sigma}), \qquad (2)$$

  where $\boldsymbol{\phi} = (\boldsymbol{b}, \boldsymbol{B}_1, \dots, \boldsymbol{B}_p, \boldsymbol{\Sigma})$ collects the reduced-form parameters.

- $\theta = \boldsymbol{Q} f(\boldsymbol{\phi})$.

The Identification Strategy

- Consider a SVAR with macro and financial variables, including macro uncertainty proxy, financial uncertainty proxy and credit spreads (measure of financial distress).
- Our identification scheme identifies a subset of $k = 3$ shocks, i.e., macro uncertainty, financial uncertainty, and credit supply disturbances.

- The identifying assumption is that in the short-run (i) the three shocks must maximize a function of the total variation of the three variables, subject to (ii) constraints that each shock of interest -say, macro uncertainty shock- needs to explain the variation of the corresponding target variable -say, some macro uncertainty proxy- more than the other target variables -say, financial uncertainty proxy and credit spread-.

$$\boldsymbol{Q}^{*}_{1:k} = \arg\max_{\boldsymbol{Q}_{1:k}} \sum_{i=1}^{k} \boldsymbol{q}_i' \boldsymbol{\Upsilon}^{\boldsymbol{i}}_{\tilde{\boldsymbol{h}}}(\boldsymbol{\phi}) \boldsymbol{q}_i \tag{3}$$

subject to

$$\boldsymbol{q}_j' \boldsymbol{\Upsilon}^{\boldsymbol{j}}_{\tilde{\boldsymbol{h}}}(\boldsymbol{\phi}) \boldsymbol{q}_j \geq \boldsymbol{q}_j' \boldsymbol{\Upsilon}^{\boldsymbol{i}}_{\tilde{\boldsymbol{h}}}(\boldsymbol{\phi}) \boldsymbol{q}_j \text{ for } j = 1, \ldots, k, \quad \forall i = 1, \ldots, k \text{ and } i \neq j, \tag{4}$$

and

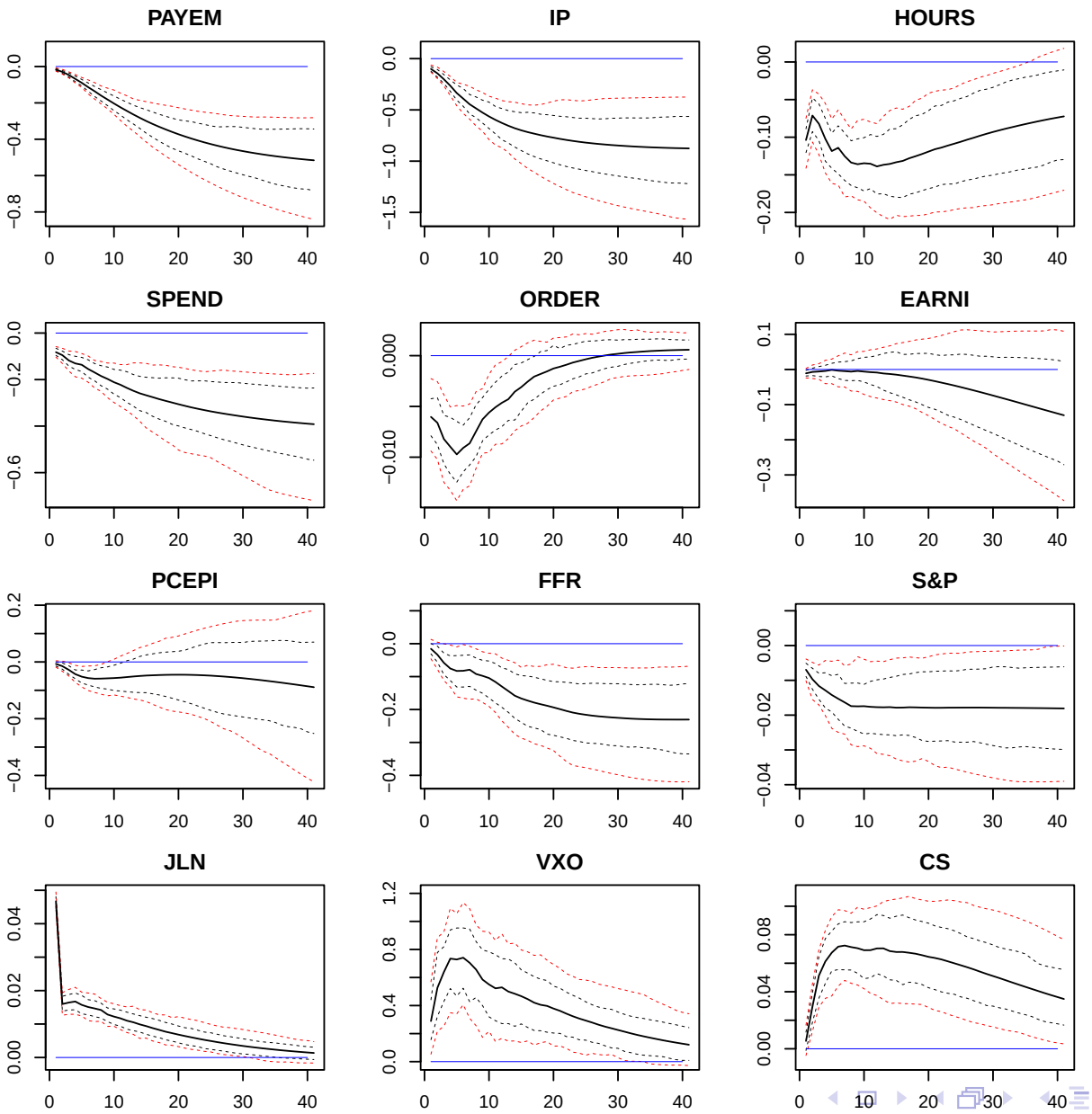
$$\boldsymbol{Q}_{1:k}' \boldsymbol{Q}_{1:k} = \boldsymbol{I}_n. \tag{5}$$

- This is a quadratic optimisation problem on the columns of the rotation matrix transforming reduced-form shocks into structural disturbances.
- Under mild conditions, we prove that solution to the optimisation problem *exists* and is *unique*.
- Simulations show that our identification is supported by structural models.

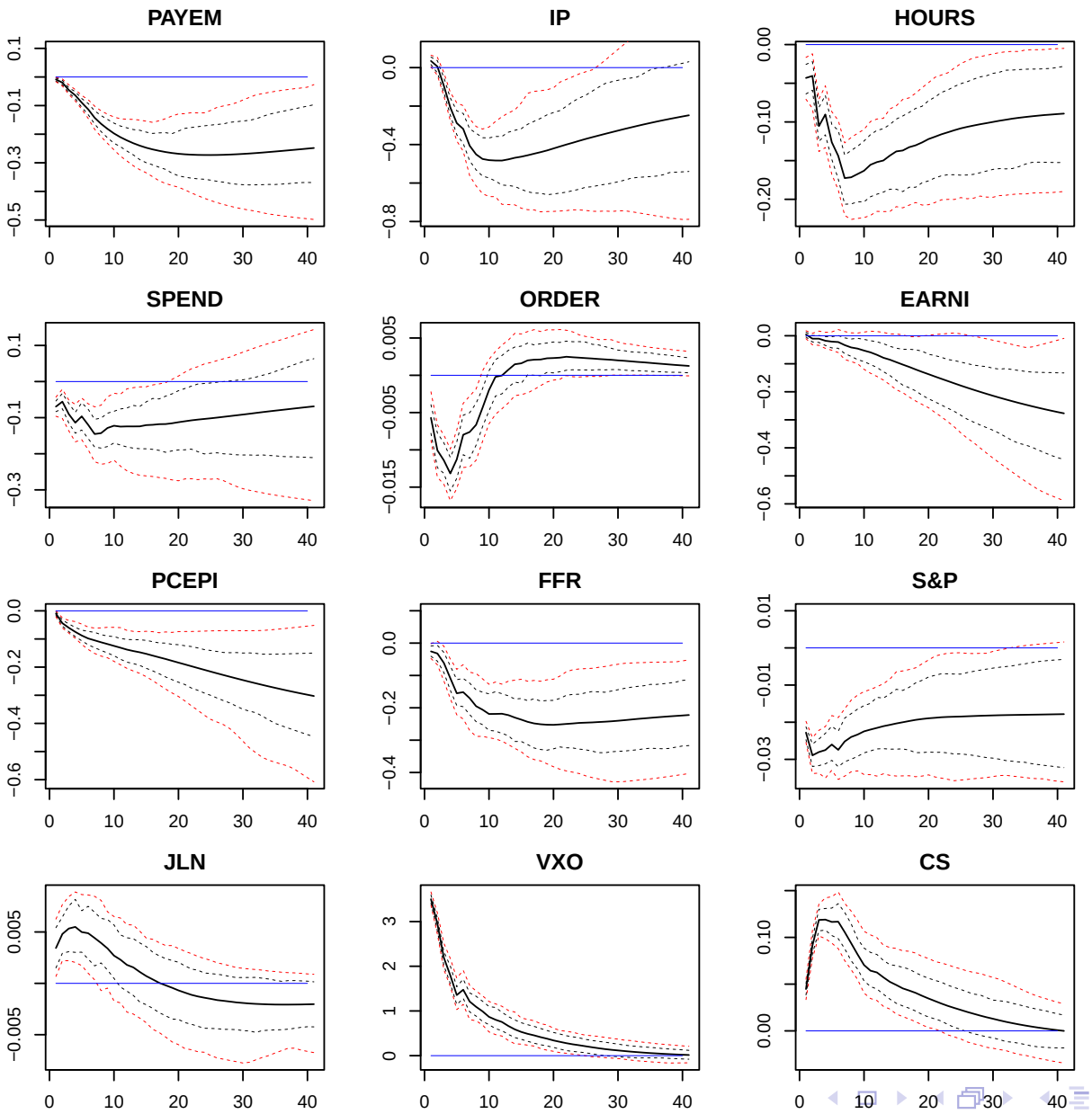
SVAR with US data

- US data, 1962m7-2016m12.
- As proxy of financial uncertainty, we use the VXO.
- For macro uncertainty, we employ the measure of Jurado et al. (15, *AER*).
- SVAR(7) with 12 variables: macro uncertainty proxy (JLN), financial uncertainty proxy (VXO), credit spreads (CS), number of non-farm workers (PAYEM), industrial production (IP), weekly hours per worker (HOURS), real consumer spending (SPEND), real manufacturers' new orders (ORDER), real average earnings (EARNI), PCE price index (PCEPI), variation of federal funds rate (FFR), S&P 500 (S&P).
- Results are robust to alternative proxies of macro and financial uncertainty.
- Bayesian estimation with a flat prior.

Macro Uncertainty Shock

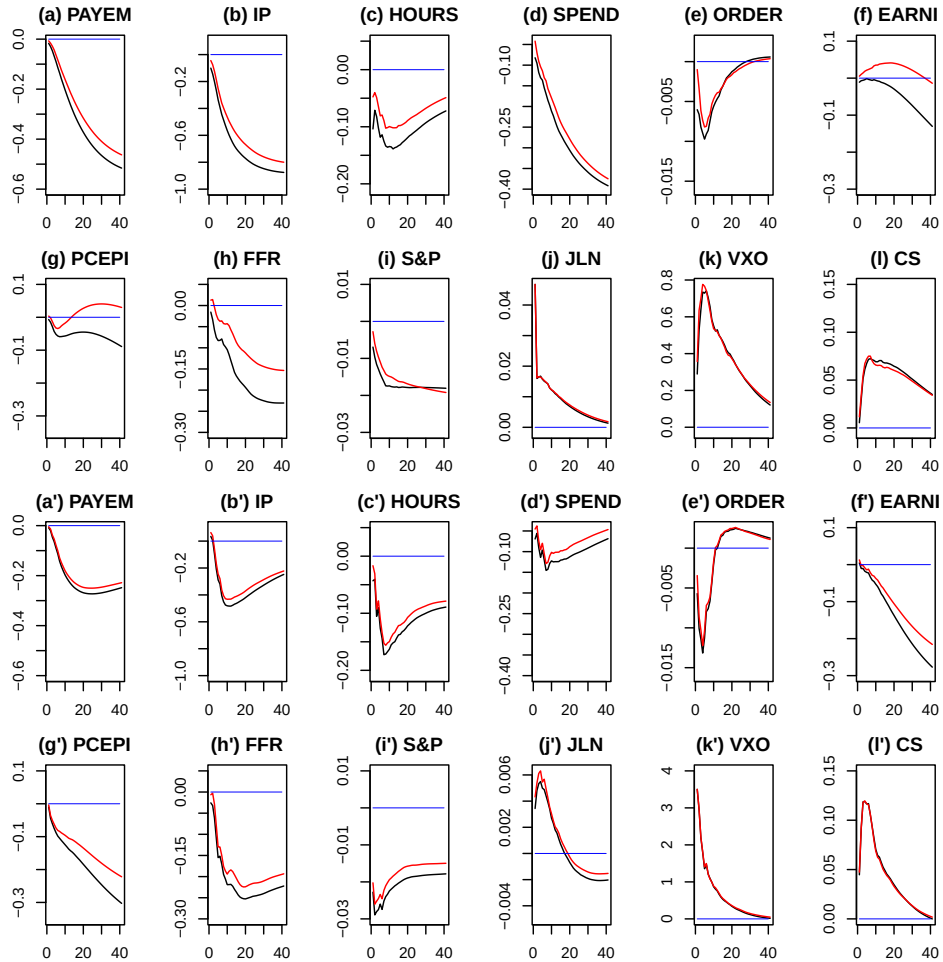


Financial Uncertainty Shock



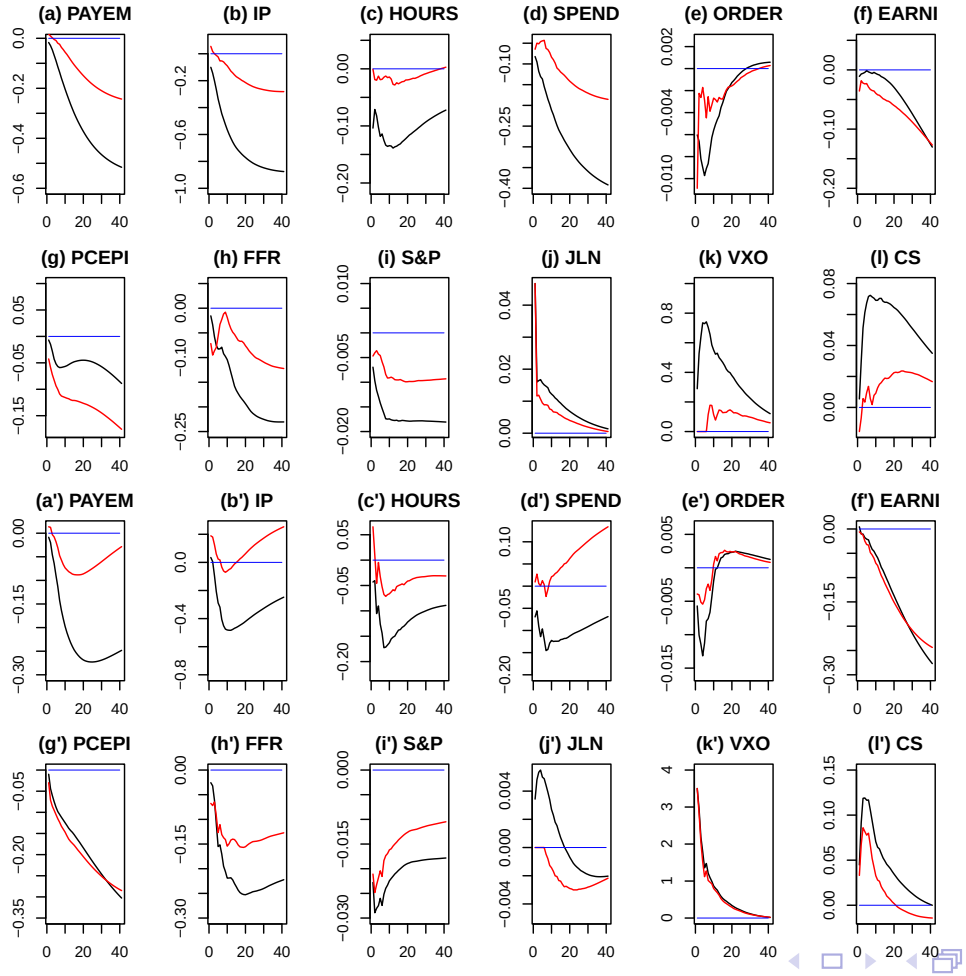
Baseline Scenario (Black) vs Exogenous Uncertainty (Red)

Panels a-l: responses to macro uncertainty shock.
Panels a′-l′: responses to financial uncertainty shock.



Baseline Scenario (Black) vs Shutting Down one Typology of Uncertainty (Red)

Panels a-l: responses to macro uncertainty shock.
Panels a′-l′: responses to financial uncertainty shock.



Empirical Findings

- Uncertainty shock acting as a demand shock.
  - consistent with NK models with Rotemberg-type price rigidities (Basu & Bundick, 17 *Ecta*; Oh, 20 *IER*) and/or real frictions in the labour market (Leduc & Liu, 16 *JME*);
  - inconsistent with frameworks with flexible prices (Fernandez-Villaverde & Guerron-Quintana, 20 *RED*) and with Calvo-type price rigidities (Oh, 20 *IER*).
- Macro uncertainty is endogenous; financial uncertainty is mostly exogenous.
- Omitting heterogeneous sources of uncertainty biases the effects of uncertainty on the economy.

Conclusion

- Generalize the Max Share Identification to simultaneous identification of multiple shocks.
- Application: uncertainty acts as a demand shock and presents some endogenous features; omitting heterogeneous sources of uncertainty biases the estimation. *Not* shown in the presentation: neglecting the role of uncertainty biases the effects of credit supply shocks.