Uncertainty and Economic Activity: A Global Perspective

Ambrogio Cesa-Bianchi\textsuperscript{1} M. Hashem Pesaran\textsuperscript{2}
Alessandro Rebucci\textsuperscript{3}

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\textsuperscript{1}Bank of England and CfM. The views expressed in this paper are solely those of the authors and should not be taken to represent those of the Bank of England.
\textsuperscript{2}University of Southern California and Trinity College, Cambridge
\textsuperscript{3}Johns Hopkins University Carey Business School
Strong correlation between “uncertainty” and economic activity

During the crisis increase in uncertainty/volatility and contraction in activity

After the crisis, low volatility and a recovery of economic activity
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- After the crisis, low volatility and a recovery of economic activity
In this paper

- **What do we do?** Quantify the relation between uncertainty and economic activity using a novel multi-country approach

- **How do we do it?**
  - Compute quarterly country-specific realized volatility measures (as a proxy for economic uncertainty) using daily returns of 109 asset prices worldwide
  - Set up a factor model for volatility and the business cycle in which both are driven by the same set of global common factors
  - Exploit the different cross-country correlation structure of volatility and GDP growth to identify the factors and the shocks

- **What do we find?** Show that conditional on global factors there is little correlation left between volatility and economic activity
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Outline

1. A simple factor model of volatility and macro dynamics
2. Results
A standard model of volatility and economic activity

- Model used in the literature (abstracting from dynamics) to interpret correlation between $v_t$ and $\Delta y_t$

\[
v_t = \alpha \Delta y_t + \varepsilon_t \\
\Delta y_t = \beta v_t + u_t
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A standard model of volatility and economic activity

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    v_t &= \alpha \Delta y_t + \varepsilon_t \\
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$$

- Since the covariance matrix $Cov(v_t, \Delta y_t)$ provides only three moments, the system is not identified

- Identification of structural parameters and shocks is typically achieved with an exclusion restriction (ie $\alpha = 0$ or $\beta = 0$)
An alternative model based on common factors

- Assume that a small set of *unobserved* global factors characterize the evolution of the world economy.
An alternative model based on common factors

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- Global factor $n_t$ affects both $v_t$ and $\Delta y_t$

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\begin{align*}
v_t &= \lambda n_t + \varepsilon_t \\
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  $$

- Again, identification of structural parameters and shocks cannot be achieved unless we impose an exclusion restriction, i.e., by assuming $\lambda = 0$ (or $\gamma = 0$)
An alternative model based on common factors: multi-country perspective

Replace model above with the following disaggregated system of equations:

\[ v_{it} = \lambda_i n_t + \varepsilon_{it} \quad \text{for } i = 1, 2, \ldots, N \]
\[ \Delta y_{it} = \gamma_i n_t + u_{it} \quad \text{for } i = 1, 2, \ldots, N \]

Global volatility \((v_t)\) and world GDP growth \((\Delta y_t)\) are aggregates over a large number of countries:

\[ v_t = \sum_{i=1}^{N} w_i v_{it}, \quad \Delta y_t = \sum_{i=1}^{N} w_i \Delta y_{it}, \]
Identifying assumptions

- **Assumption 1** Weights $\mathbf{w} = (w_1, w_2, \ldots, w_N)'$ are of order $1/N$

  $\|\mathbf{w}\| = O_p(N^{-\frac{1}{2}})$, \[ \frac{w_i}{\|\mathbf{w}\|} = O_p(N^{-\frac{1}{2}}) \] \quad \forall i,$

  - Ensures that the weights are not dominated by a few of the cross-section units
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- **Assumption 2**  The volatility innovations ($\varepsilon_{it}$) are strongly correlated across countries, whilst the output innovations ($u_{it}$) are weakly cross-correlated across countries.

  $$\lambda_{\text{max}}(\Sigma_{\varepsilon}) = O_p(N) \quad \text{and} \quad \lambda_{\text{max}}(\Sigma_{u}) = O_p(1)$$

  - One cross-sectional unit plays dominant role in global financial markets but not in world activity
Identifying assumptions

- **Assumption 1** Weights $w = (w_1, w_2, ..., w_N)'$ are of order $1/N$

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||w|| = O_p(N^{-\frac{1}{2}}), \quad \frac{w_i}{||w||} = O_p(N^{-\frac{1}{2}}) \quad \forall i,
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- One cross-sectional unit plays dominant role in global financial markets but not in world activity

- These assumptions are not contradicted by the time series evidence
Identification of the factor by aggregation

Consider the cross-country weighted averages of the disaggregated system

\[ v_t = \lambda n_t + \bar{\varepsilon}_t \]
\[ \Delta y_t = \gamma n_t + \bar{u}_t \]

where \( \bar{\varepsilon}_t = \hat{w}' \varepsilon_t \) and \( \bar{u}_t = w' u_t \)

For sufficiently large \( N \), \( n_t \) can be identified from macro equation

\[ n_t = \gamma - 1 \Delta y_t + \bar{u}_t \]

However, since the volatility shocks (\( \varepsilon_{it} \)) are strongly correlated across countries, \( n_t \) cannot be approximated by \( v_t \).
Identification of the factor by aggregation

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n_t = \gamma^{-1} \Delta y_t + \bar{u}_t + O_p\left( N^{-1/2} \right)
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\[ n_t = \gamma^{-1} \Delta y_t + \bar{u}_t + O_p\left(N^{-1/2}\right) \]

- However, since the volatility shocks \( (\varepsilon_{it}) \) are strongly correlated across countries, \( n_t \) cannot be approximated by \( v_t \)
Implications: volatility equation

- Substitute $n_t$ into the volatility equation to get

\[ v_{it} = \lambda_i \gamma^{-1} \Delta y_t + \bar{u}_t + \varepsilon_{it} = \]

\[ = (\lambda_i \gamma^{-1}) \Delta y_t + \varepsilon_{it} + O_p \left( N^{-1/2} \right) \]

- **Result** OLS consistently estimate the impact of contemporaneous changes in global activity on country-specific volatility

- **Result** We can identify the volatility innovation $\varepsilon_{it}$
1. A simple factor model of volatility and macro dynamics

2. Results
Volatility equation estimation

- Realized volatility of equity prices $v_{eq}^{it}$ (robustness with other asset classes)
Volatility equation estimation

- Realized volatility of equity prices $v_{it}^{eq}$ (robustness with other asset classes)

- Model country-specific volatilities ($v_{it}$) allowing for dynamics

$$v_{it}^{eq} = \sum_{k=1}^{r} \Theta_{ik} v_{i,t-k}^{eq} + \sum_{k=0}^{s} \Psi_{ik} \Delta y_{t-k} + \varepsilon_{it}^{eq}$$
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- Get volatility innovations $\hat{\varepsilon}_{it}^{eq}$

- Check validity of identifying assumption: strong cross-sectional dependence of volatility innovations $\hat{\varepsilon}_{it}^{eq}$
Pairwise correlation of volatility innovations: strong cross-sectional dependence

Table: Pairwise Correlation Of The Volatility Innovations

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Macro equation estimation

Model country-specific GDP growth ($\Delta y_{it}$) as:

$$\Delta y_{it} = \sum_{k=1}^{p} \Phi_{ik} \Delta y_{i,t-k} + \sum_{k=0}^{q} \Lambda_{ik} \Delta y_{t-k} + u_{it}$$
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- Get macro innovations $\widehat{u}_{it}$
Macro equation estimation

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Pairwise correlation of GDP innovations: weak cross-sectional dependence

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Note. Lag length determined with Akaike criterion with a max of 4 lags.
The impact of volatility innovations on economic activity

Is there any relation left (after controlling for the global factor) between volatility and economic activity?

\[ \hat{u}_{it} = b_i \hat{\epsilon}_{eqit} + \eta_{it} \] for \( i = 0, 1, \ldots, N \)
The impact of volatility innovations on economic activity

▶ Is there any relation left (after controlling for the global factor) between volatility and economic activity?

▶ If yes, we should observe a (negative) correlation between $\hat{u}_{it}$ and $\hat{\varepsilon}_{it}^{eq}$

▶ Estimate the following country-specific equations

$$\hat{u}_{it} = b_i \hat{\varepsilon}_{it}^{eq} + \eta_{it} \quad \text{for } i = 0, 1, ..., N$$
The impact of volatility innovations on economic activity

Table: The Relation Between GDP Innovations And Volatility Innovations

|       | ARG  | AUSTLIA | AUSTRIA | BEL   | BRA   | CAN   | CHINA  | CHL   | FIN   | FRANCE | GERM   | INDIA | INDNS | ITALY | JAPAN | KOR   | MAL   | MEX   | NETH  | NOR   | NZLD  | PER   |
|-------|------|---------|---------|-------|-------|-------|--------|-------|-------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| beta  | -0.04| 0.00    | -0.01   | -0.02 | -0.02 | 0.00  | -0.01  | 0.01  | 0.00  | 0.01   | 0.01   | -0.01 | -0.02 | 0.00  | -0.04 | -0.01 | 0.02  | 0.00  | -0.02 | -0.04 | 0.03  |
| t-stat| -2.79| -0.22   | -0.46   | -1.09 | -2.01 | -0.12 | -0.35  | 0.24  | 0.22  | 0.88   | 0.58   | -0.61 | -1.27 | 0.20  | -2.05 | -0.61 | -2.83 | 0.19  | -1.06 | -1.75 | 0.74  |
| R2    | 0.08 | 0.00    | 0.00    | 0.01  | 0.04  | 0.00  | -0.03  | 0.00  | 0.00  | 0.01   | 0.00   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.01  | 0.00  |
|       |      |         |         |       |       |       |        |       |       |        |        |       |       |       |       |       |       |       |       |       |       |
|       | PHLP | SAFRC   | SARBIA  | SING  | SPAIN | SWE   | SWITZ  | THAI  | TURK  | UK     | US     |       |       |       |       |       |       |       |       |       |       |       |
| beta  | -0.02| -0.01   | -0.02   | 0.02  | 0.00  | -0.02 | -0.01  | -0.01 | 0.02  | -0.01  | -0.02  |       |       |       |       |       |       |       |       |       |       |
| t-stat| -0.93| -0.77   | -0.66   | 0.68  | 0.41  | -1.06 | -0.81  | -0.44 | 0.59  | -0.57  | -1.67  |       |       |       |       |       |       |       |       |       |       |
| R2    | 0.01 | 0.00    | 0.00    | 0.00  | 0.00  | 0.01  | 0.00   | 0.00  | 0.00  | 0.00   | 0.02   |       |       |       |       |       |       |       |       |       |       |       |

Results 17/18
Conclusions

- Quantify the relation between uncertainty and economic activity using a novel multi-country approach.

- Exploit the different cross-country correlation structure of volatility and GDP growth to establish the direction of causation.

- Much of the reduced form correlation between volatility and economic is driven by common (first moment) factors.