Disentangling the geopolitical risk and its effects on commodities. Evidence from a panel of G8 countries

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GeoPolitical Risk (GPR)

Tuathail (1998a,b): GPR refers to the impact of political, economic, and social factors on the global and/or regional landscape.

GPR stems from international relations, trade disputes, and unforeseen events. It causes:

- disruptions in supply chains → increase in prices;
- currency fluctuations → speculation opportunities.

Monitoring GPR is important for policymakers and investors to reach the economic and financial stability.

Literature

- The GPR influences financial markets behavior (Gkillas et al., 2018; Elsayed and Helmi, 2021);
- Guidolin and La Ferrara (2010): the outbreak of military conflicts influenced the financial markets behavior.
- The global GPR has been found to impact on:
  - equity markets (Elsayed and Helmi, 2021);
  - bond markets (Sohag et al., 2022);
  - currency markets (Bossman et al., 2023);
  - inflation (Caldara et al., 2023).
- Major events have shaken the past two decades:
  - the Global Financial Crisis (GFC) in September 2008;
  - the “Whatever it takes” speech in July 2012;
  - the Brexit referendum in June 2016 ;
  - the Covid-19 pandemic in March 2020;
  - the Russia-Ukraine conflict in February 2022,

Motivation

Ding et al. (2021); Gong and Xu (2022): the investigation of GPR shocks across countries is missing.

The global GPR impact the commodity sectors:

- energy (Cunado et al., 2020; Chowdhury et al., 2021);
- metals (Baur and Smales, 2020; Li et al., 2021);
- food (Hasan et al., 2022; Tiwari et al., 2021).

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The aim of the paper is to:

- analyze the GPR transmission across different countries in the last two decades;
- disentangle the impact of country-specific GPR on commodity market prices.

Data

- monthly data from Jan 2001 to Oct 2022 ($T = 274$);
- GPR indexes (Caldara et al., 2023);
- G8 countries;
- 13 log differences of commodity prices (list);
- 3 commodity sectors (energy, metals, food);

Data

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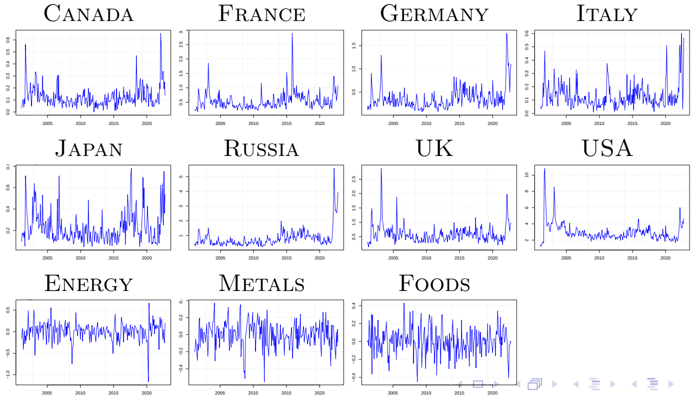

Methodology

- Time Varying Parameter VAR (TVPVAR) Koop and Korobilis (2013) and Antonakakis et al. (2020);
- Kalman filter;
- Generalized Impulse Response Functions (GIRFs);
- no window size is required;
- outlier sensitive estimated parameters;
- identification of GPR shocks over time;
- suitable model for low frequency data;
- the events that shook the last decade are accounted for.

Methodology

TVPVAR(p):

$$\boldsymbol{y}_t = \boldsymbol{A}_t \boldsymbol{x}_{t-1} + \boldsymbol{\varepsilon}_t \tag{1}$$

where $\boldsymbol{\varepsilon}_t \sim N(0, \boldsymbol{\Omega}_t)$ and

$$\underset{(n\times np)}{\boldsymbol{A}_t} = \begin{bmatrix} \boldsymbol{A}_{1t} & \boldsymbol{A}_{2t} & \dots & \boldsymbol{A}_{pt} \end{bmatrix} \quad \text{and} \quad \underset{(np\times 1)}{\boldsymbol{x}_{t-1}} = \begin{bmatrix} \boldsymbol{y}_{t-1} \\ \boldsymbol{y}_{t-2} \\ \vdots \\ \boldsymbol{y}_{t-p} \end{bmatrix}.$$

We assume:

$$\boldsymbol{a}_t = \boldsymbol{a}_{t-1} + \boldsymbol{\nu}_t, \tag{2}$$

where $\boldsymbol{\nu}_t \sim N(\boldsymbol{0}, \boldsymbol{\Sigma}_t)$ and $\boldsymbol{a}_t = \text{vec}(\boldsymbol{A_t})$.
We estimate a TVPVAR(1).

Kalman filter

- training set: from January 2001 to December 2007 ($T_0 = 96$);
- test set: from January 2008 onward ($T_1 = 180$);
- $T_0 + T_1 = T = 274$;
- starting parameters $\boldsymbol{a}_0$, $\boldsymbol{A}_0$, and $\boldsymbol{\Omega}_0 = T_0^{-1}\boldsymbol{E}_0'\boldsymbol{E}_0$;
- Initial conditions:

$$
\begin{aligned}
\boldsymbol{A}_t|\boldsymbol{\mathcal{I}}_{t-1} &= \boldsymbol{A}_{t-1} \\
\boldsymbol{\varepsilon}_t|\boldsymbol{\mathcal{I}}_{t-1} &= \boldsymbol{y}_t - \boldsymbol{A}_{t-1}\boldsymbol{x}_{t-1} \\
\boldsymbol{\Omega}_t|\boldsymbol{\mathcal{I}}_{t-1} &= \kappa_2\boldsymbol{\Omega}_{t-1} + (1-\kappa_2)\left.\frac{\boldsymbol{\varepsilon}_t\boldsymbol{\varepsilon}_t'}{T_0}\right|\boldsymbol{\mathcal{I}}_{t-1} \\
\boldsymbol{\Sigma}_t^*|\boldsymbol{\mathcal{I}}_{t-1} &= k_1^{-1}\boldsymbol{\Sigma}_{t-1} = k_1^{-t}\boldsymbol{\Sigma}_0,
\end{aligned}
$$

where κ_1, κ_2 are decay factors (Koop and Korobilis, 2014).

Kalman filter

The multivariate Kalman filter proceeds via the following steps

$$\boldsymbol{\Omega}_t = \boldsymbol{X}'_{t-1}(\boldsymbol{\Sigma}^*_t|\boldsymbol{\mathcal{I}}_{t-1})\boldsymbol{X}_{t-1} + \kappa_2\boldsymbol{\Omega}_{t-1} + (1-\kappa_2)\frac{\boldsymbol{\varepsilon}_t\boldsymbol{\varepsilon}'_t}{T_{t-1}}, \quad (3)$$

$$\boldsymbol{K}_t = (\boldsymbol{\Sigma}^*_t|\boldsymbol{\mathcal{I}}_{t-1})\boldsymbol{X}_{t-1}\boldsymbol{\Omega}_t^{-1}, \quad (4)$$

$$\boldsymbol{a}_t = \boldsymbol{a}_{t-1} + \boldsymbol{K}_t(\boldsymbol{\varepsilon}_t|\boldsymbol{\mathcal{I}}_{t-1}), \quad (5)$$

$$\boldsymbol{\varepsilon}_t = \boldsymbol{y}_t - \boldsymbol{A}_t\boldsymbol{x}_{t-1}, \quad (6)$$

$$\boldsymbol{\Sigma}_t = (\boldsymbol{I}_{n^2p} - \boldsymbol{C}_t)\boldsymbol{\Sigma}^*_t|\boldsymbol{\mathcal{I}}_{t-1}, \quad (7)$$

where $\boldsymbol{C}_t = \boldsymbol{K}_t\boldsymbol{X}'_{t-1}$, $\boldsymbol{X}_{t-1} = \boldsymbol{x}_{t-1} \otimes \boldsymbol{I}_n$, $\boldsymbol{I}_n$ is the n-dimensional identity matrix.

(Gretl code)

Results

We provide:

- 80 GIRFs:

  56 GPR shock transmission across countries;
  24 GPR shock impact to commodity prices;

- 13 step-ahead horizons;
- country GPR shares on sectors commodity prices;

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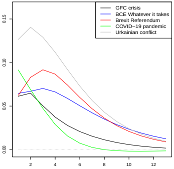
- 80 GIRFs:

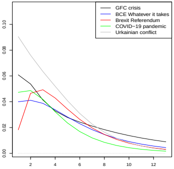
  56 GPR shock transmission across countries;
  24 GPR shock impact to commodity prices;
- 13 step-ahead horizons;
- country GPR shares on sectors commodity prices;
- **black** line: Global Financial Crisis, September 2008;
- **blue** line: "Whatever it takes", July 2012;
- **red** line: Brexit, June 2016;
- **green** line: Covid-19, March 2020;
- **gray** line: Russia-Ukraine war, February 2022.

Russian GIRFs: highest magnitude in the **Russia-Ukraine conflict** case, in both directions.

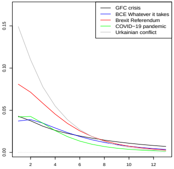
RUS → CAN



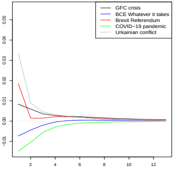
RUS → FRA



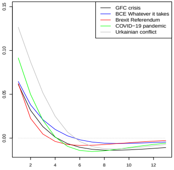
RUS → GER



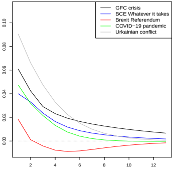
RUS → ITA



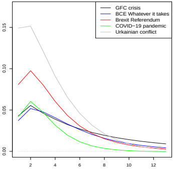
CAN → RUS



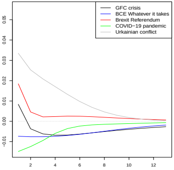
FRA → RUS



GER → RUS

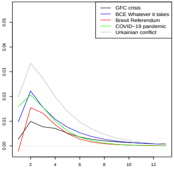


ITA → RUS

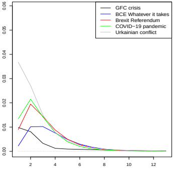


A sudden GPR shock in Germany increase the GPR in other countries: leading role in Europe.

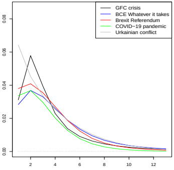
GER → FRA



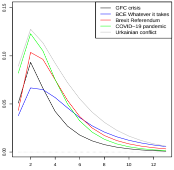
GER → ITA



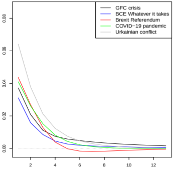
GER → UK



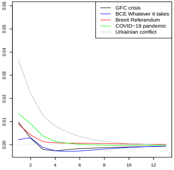
GER → US



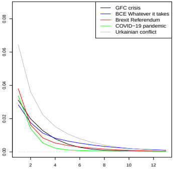
FRA → GER



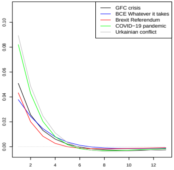
ITA → GER



UK → GER

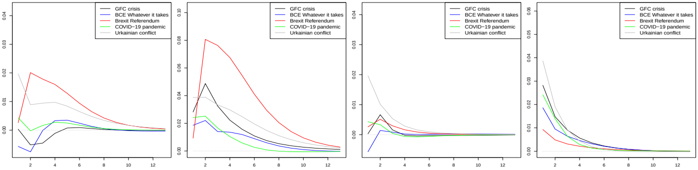


US → GER



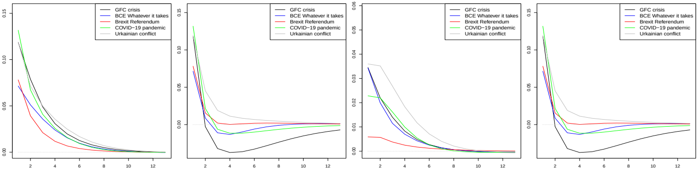
- The Canadian GPR shock significantly increases the UK and US GPR after two months (**Brexit period**): significant devaluation of the British pound (Nasir and Morgan, 2018).
- Shocks from other countries to Canada are quickly absorbed, meaning a low influences in the Canadian domestic situation (same behavior of Japanese GPR).

CAN → UK CAN → USA UK → CAN USA → CAN



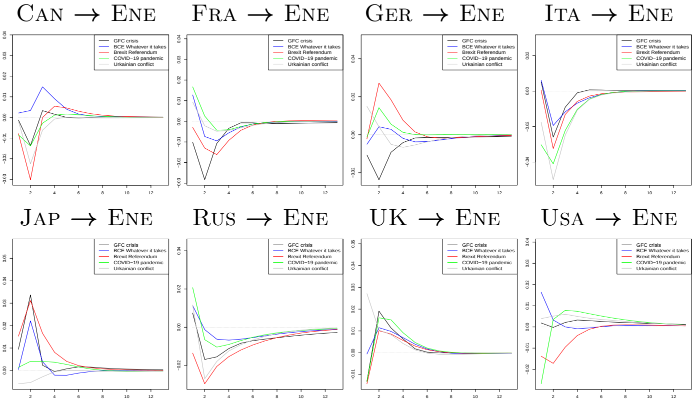
- The backlash in the UK and US GPRs is the more pronounced, especially for the **pandemic** and the **war**;
- The USA and Japan are considered relatively stable and safe economies, in comparison to the UK, therefore the domestic perceived GPR decrease.

USA → UK   UK → USA   USA → JAP   UK → JAP



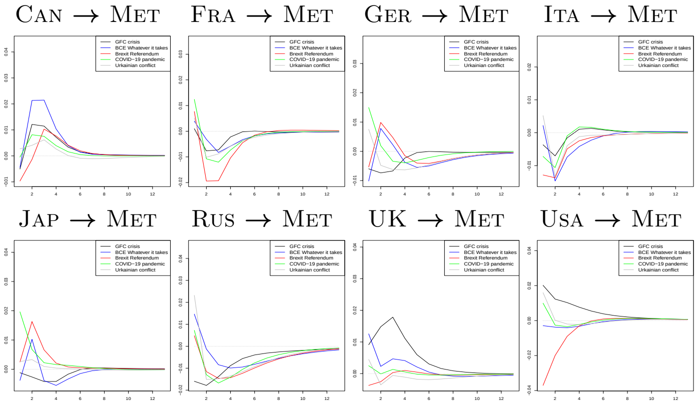
GPR and energy sector

- 8 months to absorb shocks. Min/max around the 2 month;

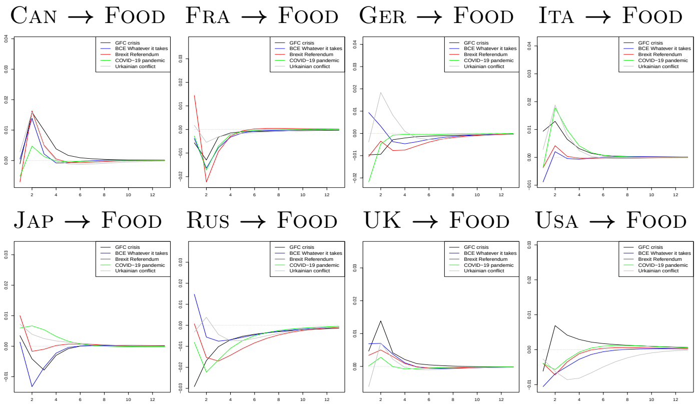


GPR and metals sector

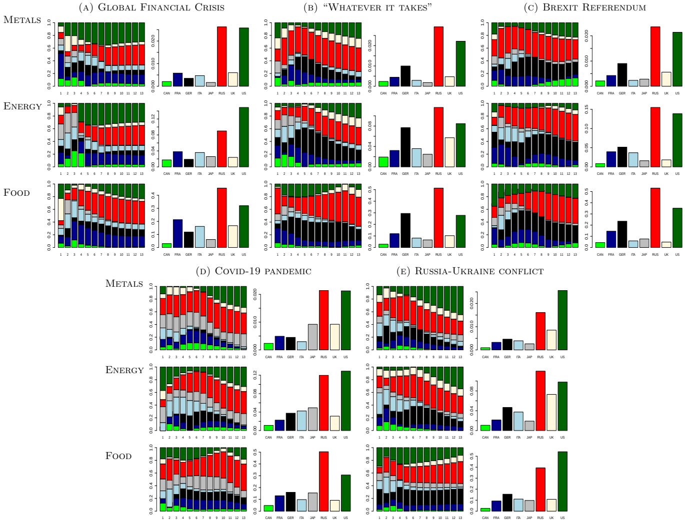
GIRF magnitudes are generally lower than those of the energy sector. US, Russia, and Germany have the most relevant effects.



GPR and food sector



Shares over time and aggregates



Economic Implications I

Concluding remarks:

- ongoing globalization of world markets;
- GPR transmission between G8 countries and that on commodity markets tends to be uneven;
- geographic proximity (North America and Europe) generally amplifies the mutual influence of GPR shocks;
- shocks from the Russian GPR have a more pronounced impact on European countries and the US (not viceversa);
- other factors, such as:
  - globalization (Sweidan and Elbargathi, 2022);
  - trade relationships (Gupta et al., 2019);
  - political and financial instability (Shahzad et al., 2023)

  can contribute to transmitting GPR to commodity markets.

Economic Implications II

- the GPR increase generally reduce the energy prices. This result is attributable to the general contraction in demand (Assaf et al., 2021; Bossman et al., 2023);
- GPR shocks in Germany and Japan lead to higher energy prices: market speculation and commodities as safe-haven assets (Triki and Maatoug, 2021);
- our results could help policymakers and investors.

Thank you!

Any questions and/or suggestions?

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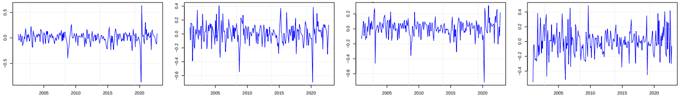
Log Differences of Commodity prices

Figure: Log differences of commodity prices Back to Dataset slide

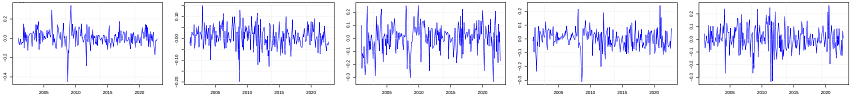
Energy

Crude oil | Gasoline | Heating oil | Natural gas



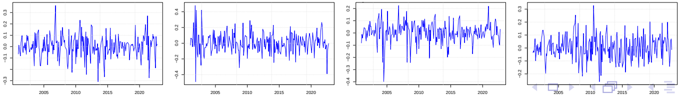
Metals

Copper | Gold | Palladium | Platinum | Silver



Foods

Corn | Oats | Soybeans | Wheat



Gretl code: initialization

```
matrices A_t_mean = array(t)
matrices Omega_t = array(t)
matrices Sigma_t = array(t)
matrices Kalman_t = array(t)
matrices C_t = array(t)
matrix A_pred = zeros(n^2,t)
matrix A_update = zeros(n^2,t)
matrix Varepsilon_t = zeros(n,n)
matrix A_col = zeros(n^2*p,1)
matrix y = zeros(n,1)

loop for i = 1 .. t #Inizialization of arrays
    A_t_mean[i] = zeros(n,n*p)
    Omega_t[i] = zeros(n,n*p)
    Sigma_t[i] = zeros(n^2*p,n^2*p)
    C_t[i] = zeros(n^2*p,n^2*p)
    Kalman_t[i] = zeros(n^2*p, n)
endloop

# Inizialization of the variables. It means the starting point of the Kalman filter where t=1
Omega_t[1] = Omega_0
Sigma_t[1] = beta_0_var
A_pred[,1] = beta_0_mean

matrix yy = x[(p+1):t,]
matrix xx = x[1:(t-p-1),]
```

Back to Methodology slide

Gretl code: main loop

```
loop for i = 2 .. (t-1)
    if i <= (p+1)
        A_pred[,i] = A_pred[,(i-1)]
        A_update[,i] = A_pred[,i]
        Sigma_t[i] = Sigma_t[(i-1)]
        Varepsilon_t = x[i,]'x[i,]
        Omega_t[i] = l_2*Omega_t[(i-1)] + (1-l_2)*Varepsilon_t
    elif i>(p+1)
        Varepsilon_t = yy[(i-p),] - xx[(i-p),]*A_t_mean[(i-1)]
        SSR = Varepsilon_t*Varepsilon_t'
        Kron = x[i,] ** I(n)
        Sigma_t[i] = (1/l_4)*Sigma_t[(i-1)]
        Omega_t[i] = Kron*Sigma_t[i]*Kron' + l_2*Omega_t[(i-1)] + (1-l_2)*SSR
        Kalman_t[i] = Sigma_t[i]*(Kron'*inv(Omega_t[i]))
        e_hat = yy[(i-p),] - xx[(i-p),]*A_t_mean[i]
        A_update[,i] = A_pred[,i] + Kalman_t[i]*e_hat'
        C_t[i] = Kalman_t[i]*Kron
        Sigma_t[i] = (I(n^2*p) - C_t[i])*Sigma_t[i]
        Omega_t[i] = l_2*Omega_t[i] + (1-l_2)*e_hat*e_hat'
    endif
    A_col = decay_factor*A_update[,(i-1)]
    print
    A_t_mean[i] = mshape(A_col, n, n*p)
    print i | x[i,]*A_t_mean[i]
endloop
```

Back to Methodology slide