New news-based measure of geopolitical risk. Macroeconomic effects and the role of sentiment

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Outline

Introduction I

- Geopolitical risk (GPR) as a manifestation of uncertainty has been widely studied in recent years
- Caldara and Iacoviello (2022, CI) introduced an influential GPR index that is based on the occurrence of certain keywords in newspaper articles
  - Captures threats, realization of wars, terrorism, and tensions between countries
  - Covers six english-language newspapers starting 1985
- Empirical studies using the CI GPR index highlight how GPR events may influence the economy:
  - Direct channel: GPR event constitutes a supply or demand shock (e.g., disrupting trade)
  - Higher GPR leads to increased volatility and portfolio shifts
  - Higher GPR reduced consumer and business confidence, lowering spending and investment

Introduction II

- We construct a similar index using daily, dictionary based cross-country data on media coverage for 182 countries from MarketPsych to analyze how the CI GPR index would change to:
  1. Broader country coverage
  2. Extended search terms
  3. A distinction between different news dimensions
- We distinguish between a narrow and a broad index and compare the economic effects with the benchmark CI GPR index
- Specifically, we look at three economic outcomes:
  1. The crude oil market
  2. GDP growth rate
  3. GDP growth distribution
- Furthermore, we explore the link between GPR and media-based sentiment

Literature Review: Uncertainty I

- Textual sentiment indicators based on media coverage have strong effects on both the real economy and financial markets (see e.g. van Binsbergen et al., 2024; Benhabib et al., 2016; Fraiberger et al., 2021) - Algaba et al. (2020) provide a comprehensive overview
- Castelnuovo (2023) reviewed recent literature on measurement and effects of uncertainty, highlighting that interest in the effects of uncertainty has increased as a result of the Covid-19 pandemic
- Main findings of literature on uncertainty:
  - Identifying uncertainty shocks is complicated (e.g. Leduc and Liu, 2016; Ma and Samaniego, 2019)
  - Uncertainty is detrimental for trade (e.g. Baley et al., 2020)
  - Effects of uncertainty shocks are state-dependent (e.g. Caggiano et al., 2014, 2017; Ricco et al., 2016)

Literature Review: Uncertainty II

  - Macroeconomic policies are weaker during periods of uncertainty (e.g. Bachmann and Sims, 2012; Bekaert et al., 2013), but they can also induce uncertainty themselves (e.g. Born and Pfeifer, 2014; Husted et al., 2020; Jasova et al., 2021)
  - Apart from these country-level findings, studies like Carrière-Swallow and Céspedes (2013); Bhattarai et al. (2020) find that uncertainty also has effects on the global level
- We add to these studies by distinguishing between a global and a domestic component of GPR and media sentiment, and allowing for an interaction between both
- Furthermore, we broaden the scope of GPR by using different definitions of geopolitical risk, adding to literature on uncertainty measures

GPR and media sentiment indices I

- Data for GPR and media sentiment indices is taken from MarketPsych, which provides a detailed documentation and is available for different frequencies, news contents, and a broad range of countries
- MarketPsych uses AI-based machine learning algorithms for natural language processing to process textual data
  - Explores global news in real time and consolidates them into a series of scores describing activity metrics (i.e. *buzz*, sentiment metrics, and emotional indicators)
  - Covers both newspapers (Reuters and internet news from Lexis-Nexis) and social media (2,000 selected sources like Twitter, Reddit, Investing.com) in separate time series dating back to (in part) 1998
  - Until Feb. 2020 it covered only English-language text, since then 12 major languages were added

GPR and media sentiment indices II

- For the GPR index, we use both narrow and broad definitions:
  - Narrow definition: uses the terms *war* and *terrorism*
  - Broad definition: adds dimensions of political stability by including the terms *violent crime*, *regime change*, and *social unrest*
  - Both measures are constructed as percentages of total references (rescaled to a range of 0 to 1)
  - We create GPR indices based on newspapers (NSP) and social media (SOC) and a total (TOT) by weighting NSP and SOC by *buzz*
  - Global GPR is calculated as a weighted average of the country indices (N=182)
- This extents the benchmark CI GPR index in three ways:
  1. Wider coverage of newspapers
  2. Adding social media news
  3. Allowing for the possibility that political stability reflects GPR

GPR and media sentiment indices III

- We construct two additional news dimensions from the MarketPsych data:
  - Media sentiment towards an economy: positive and negative news coverage about the economy (difference between the two scaled to -1 to 1)
  - Intensity of news coverage: the *buzz*, which reflects the sum of news coverage
- Comparing our GPR indeces to the benchmark from CI (see figures 2 and 3)
  - Narrow GPR indices are highly correlated with the CI GPR index, but broad GPR indices are not
  - Country coverage: we cover 182 economies, while CI only cover 44
  - Therefore, the broad GPR indices offer a complementary perspective compared to the benchmark

Figures: GPR I

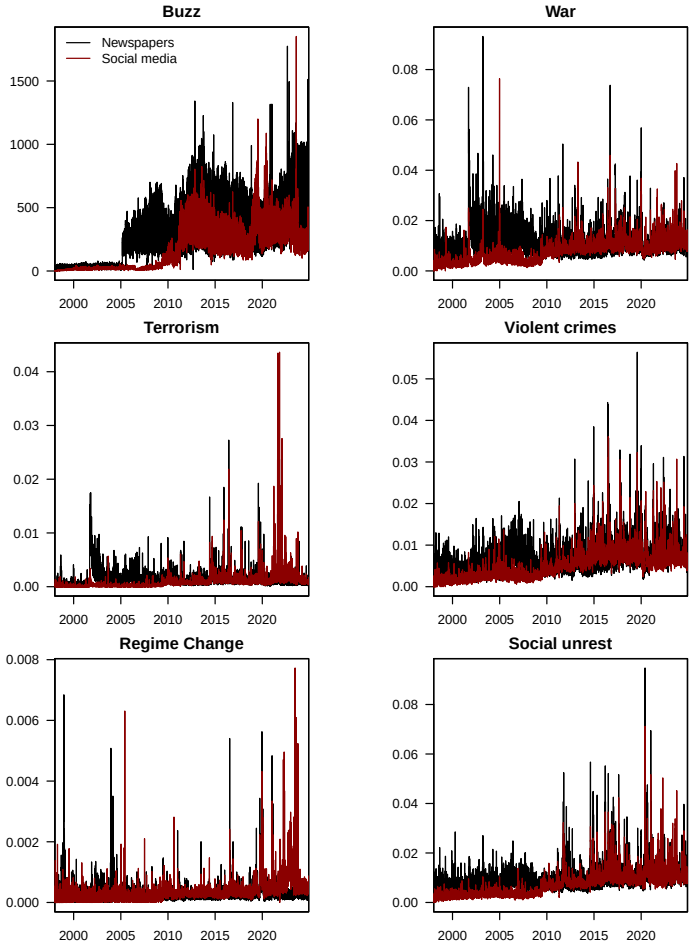

Figure 1: Daily data on buzz geopolitical risk subcomponents for the U.S.

Figures: GPR II

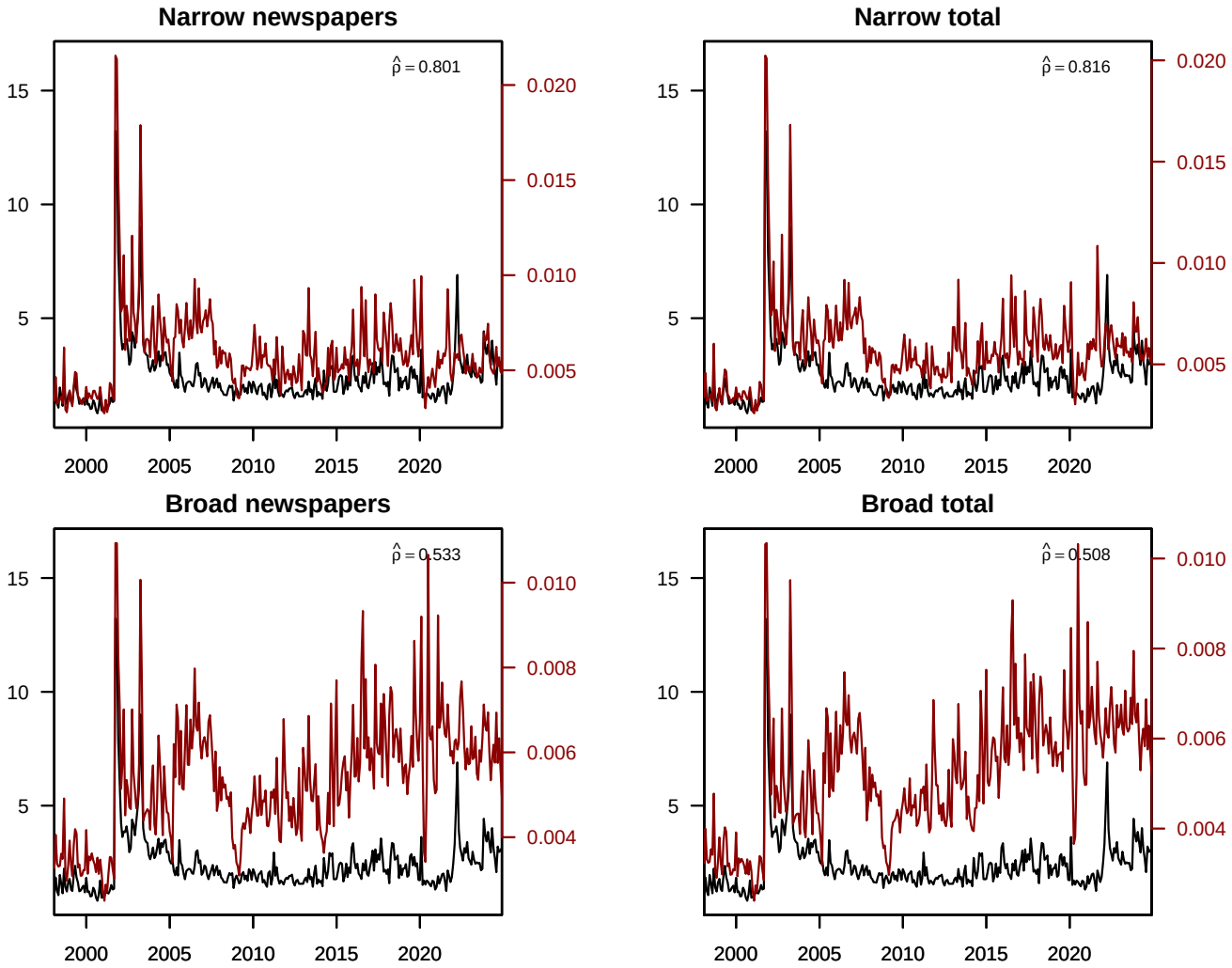

Figure 2: Comparison of GPR indices for the US (black is CI, red is our index)

Figures: GPR III

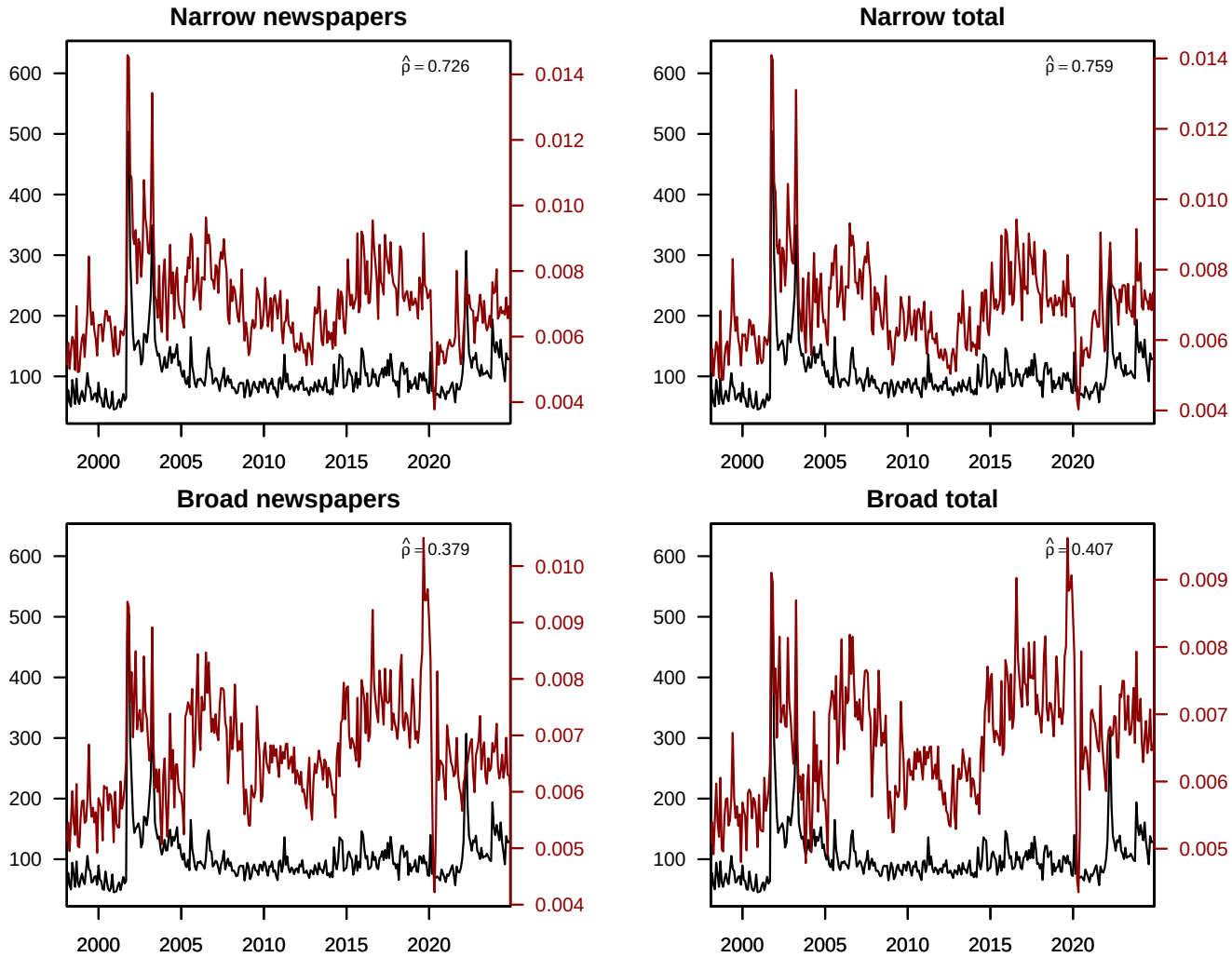

Figure 3: Comparison of global GPR indices (black is CI, red is our index)

Economic effects of shocks to the GPR index

- Conducting three analyses to assess the economic usefulness of our GPR:
  1. Structural VAR model for the global crude oil market
  2. Country-by-country VAR models to measure output dynamics of global and local GPR shocks
  3. Predictive panel quantile regressions to evaluate the effect of GPR shocks on the distribution of economic growth
- We report results for four measures:
  - GPR^{CI} - benchmark by Caldara and Iacoviello (2022)
  - GPR^{NN} - narrow definition, using newspapers
  - GPR^{BN} - broad definition, using newspapers
  - GPR^{BT} - broad defintion, using newspapers and social media

Crude Oil SVAR: Setup I

- Several studies on the effect of GPR shocks on global oil markets: Caldara and Iacoviello (2022) find lowered demand and real prices using SVAR models, while Mignon and Saadaoui (2024) find only insignificant effects on real oil prices; Yang et al. (2023) use SVAR and find that oil price reactions to GPR shocks are time-dependent
- We extend the global crude oil market model by Kilian (2009) (describing joint dynamics of oil production, real economic activity and real oil prices) with GPR

Crude Oil SVAR: Setup II

- We estimate the following model:

$$\mathbf{y}_t = \mathbf{A}_0 + \sum_{p=1}^{P} \mathbf{A}_p \mathbf{y}_{t-p} + \mathbf{B}\mathbf{u}_t,\ \mathbf{u}_t \sim N(\mathbf{0}, \mathbf{I}) \tag{1}$$

  - where $\mathbf{y}_t = (GPR_t, \Delta OILP_t, GEA_t, WTI_t)'$ is the vector of endogenous variables (as defined in Kilian, 2009)
  - $\mathbf{u}_t$ is the vector of structural shocks
  - $\mathbf{B}$ represents the recursive identification matrix
  - As discussed in Caldara and Iacoviello (2022), the measure of GPR is considered to be the most exogenous
- Maximum lag length P is set to 12 months
- Model is estimated using monthly data for 1998:1-2024:9

Crude Oil SVAR: Results I

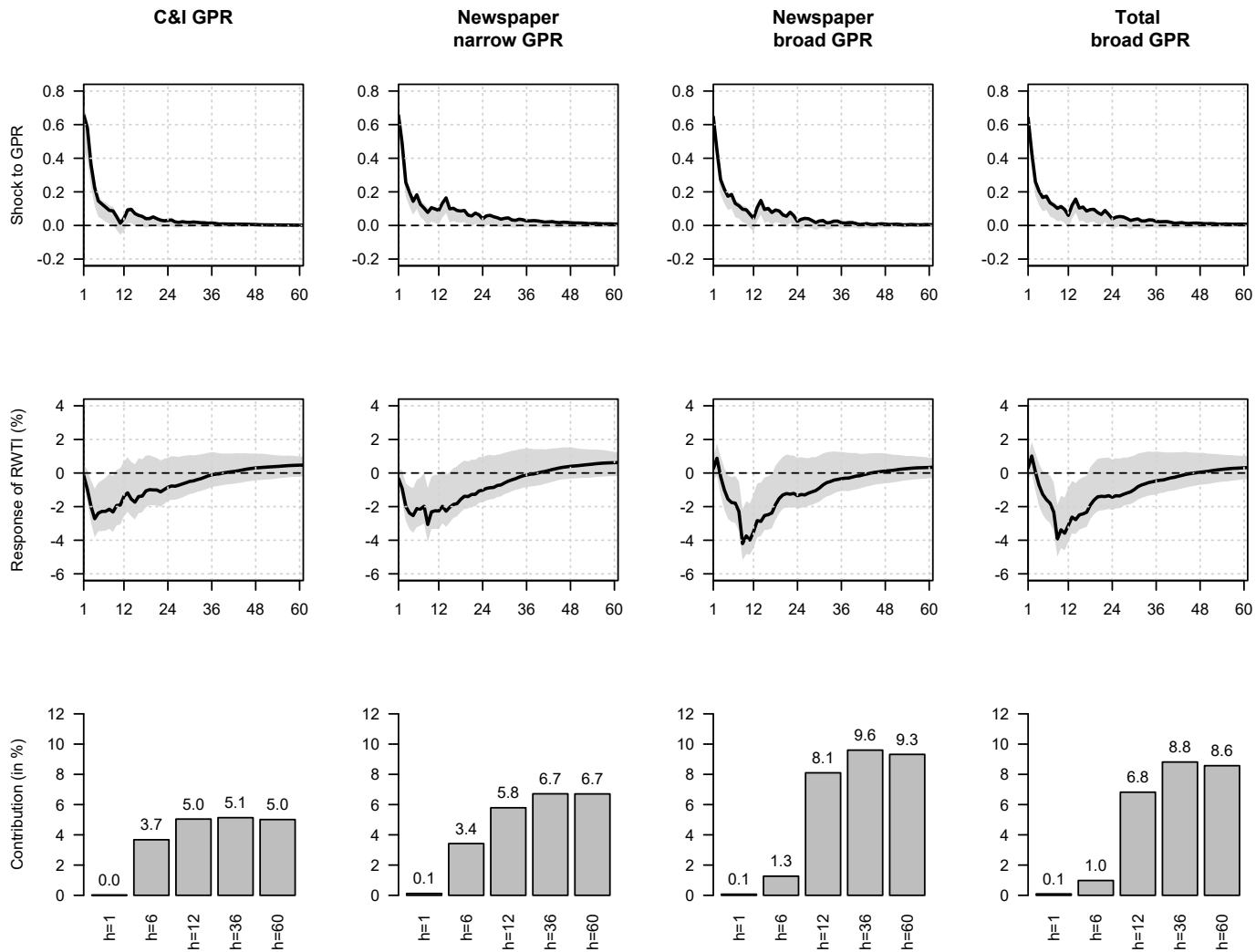

Figure 4: IRFs for four models - Upper row shows GPR shock, middle row shows real oil price response, bottom row shows variance contribution

Crude Oil SVAR: Results II

- SVAR model is estimated using four GPR measures (GPR^{CI}, GPR^{NN}, GPR^{BN}, GPR^{BT})
- In line with Caldara and Iacoviello (2022), all models show a decline in the oil prices
- Result for our narrow definition is very close to the CI benchmark
- Using the broad definition, the oil price response becomes more pronounced
- This is also reflected in the forecast error variance decomposition (GPR contributed 5-7% using the narrow, and 9-10% using the broad definition)
- Accounting for social media does not seem to make oil prices more responsive

Country SVARs I

- Cheng and Chiu (2018) use separate SVAR models for almost 40 economies and find that GPR shocks account for about 20% of output variation
- Our approach:
  - For each country $i = 1, 2, ..., N$ we estimate a SVAR model similar to the one above
  - Endogenous vector: $\mathbf{y}_{it} = (GPR_t^G, \Delta GDP_t^{US}, GPR_{it}^L, \Delta GDP_{it})'$
  - Each model describes joint dynamics of global (GPR^G) and local (GPR^L) GPR, as well as GDP growth rate in the US and the ith country
  - Global GPR and US GDP growth are treated as block exogenous variables by imposing zero restrictions on relevant parameters
  - Model is identified using a recursive scheme; maximum lag length is 4
- Model is estimated on quarterly data for 1998:1-2024-3, now using the four different GPR measures at both global and country levels

Country SVARs II

- Country sample ($N = 27$) is limited by Caldara and Iacoviello (2022)
- Results:
  - For narrow GPR indices, the average contribution of GPR shocks to GDP variance is typically well below 10% (on average, it amounts to 6.4% (GPR^{CI}) to 7.9% (GPR^{NN}))
  - Using the broad definition (GPR^{BN}), the average contribution roughly triples to 23.0%
  - Results are similar for GPR^{BN} and GPR^{BT}
- To summarize:
  1. Extending the GPR index with social media news does not change the dynamics of GPR and GDP growth
  2. Moving from a narrow to a broad definition allows for a better description of GDP dynamics within the SVAR model

Quantile Regressions

- Looking at the differences between our GPR indices and the benchmark GPR^{CI} using *quantile regressions*
- Idea: Compare how the GPR proxies predict the future GDP growth distribution
- Using a cross-country panel to estimate the following relationship:

$$\mathcal{Q}_\tau(\Delta GDP_{it+1}|X_{it}) = \alpha_{i\tau} + \rho_\tau \Delta GDP_{it} + \gamma_\tau GPR_t^G + \delta_\tau GPR_{it}^L. \quad (2)$$

  - where $\mathcal{Q}_\tau(Y|X)$ denotes the τ-th quantile of Y conditional on X
  - $i = 1, 2, ..., N$ represent countries and $t = 1, 2, ..., T$ years
  - Explanatory variables X_{it} include current GDP growth (to account for persistence), and both local and global GPR measures
- Model is estimated for our four GPR indices by minimizing the loss function $\mathcal{L}$
- Sample covers 1998-2022 and $N = 43$ countries (limited by Caldara and Iacoviello, 2022)

Quantile Regressions: Results I

Table 1: Quantile predictive regressions for GDP growth

	Dependent variable: ΔGDP_{it}			
GPR measure	GPR^{CI}	GPR^{NN}	GPR^{NB}	GPR^{TB}
	$\tau = 0.1$			
ΔGDP_{it}	0.446	0.386	0.291	0.275
	(0.092)	(0.110)	(0.045)	(0.056)
GPR_t^G	0.749	0.135	-1.093	-1.127
	(0.186)	(0.214)	(0.170)	(0.215)
GPR_{it}^L	-0.386	0.540	-0.020	-0.070
	(1.339)	(0.349)	(0.226)	(0.381)
Loss function $\mathcal{L}$	638.3	648.4	600.1	602.7
	$\tau = 0.5$			
ΔGDP_{it}	0.107	0.094	0.091	0.095
	(0.027)	(0.029)	(0.023)	(0.026)
GPR_t^G	0.151	0.086	-0.391	-0.366
	(0.035)	(0.046)	(0.050)	(0.053)
GPR_{it}^L	-0.077	-0.233	-0.134	-0.189
	(0.109)	(0.114)	(0.108)	(0.101)
Loss function $\mathcal{L}$	1105.2	1107.0	1087.1	1088.5
Obs.	1066	1066	1066	1066
Countries	43	43	43	43

Table 2: Quantile predictive regressions for GDP growth (cont.)

	Dependent variable: ΔGDP_{it}			
GPR measure	GPR^{CI}	GPR^{NN}	GPR^{NB}	GPR^{TB}
	$\tau = 0.9$			
ΔGDP_{it}	-0.079	-0.065	-0.076	-0.080
	(0.035)	(0.038)	(0.030)	(0.035)
GPR_t^G	-0.092	-0.253	-0.370	-0.342
	(0.063)	(0.089)	(0.049)	(0.069)
GPR_{it}^L	-0.602	-0.463	-0.512	-0.531
	(0.095)	(0.138)	(0.126)	(0.120)
Loss function $\mathcal{L}$	441.1	434.4	428.8	430.4
Obs.	1066	1066	1066	1066
Countries	43	43	43	43

Notes: Standard errors are reported in parentheses.

Quantile Regressions: Results II

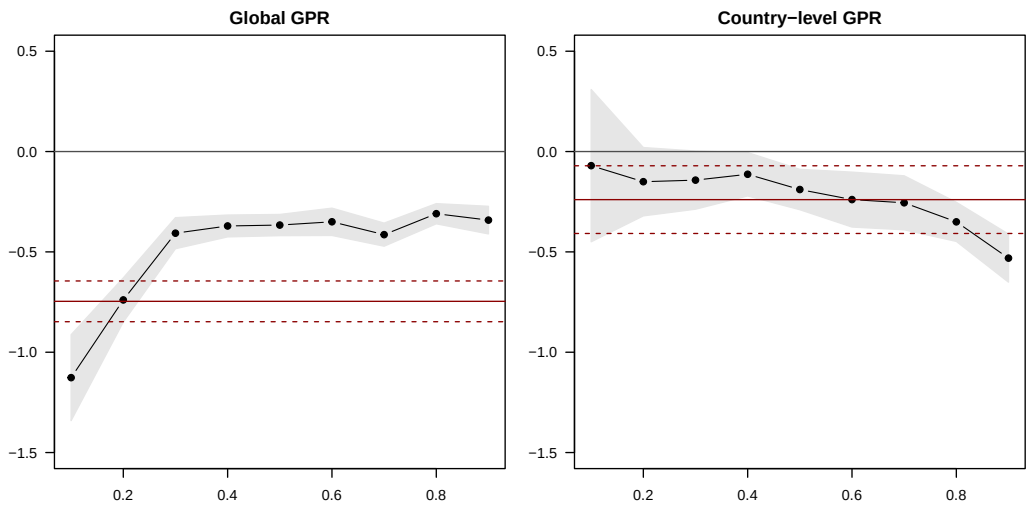

Figure 5: The impact of GPR^{BN} on GDP growth quantiles. Shaded areas represent the 68% confidence interval. The numbers on the x-axis refers to quantiles.

- Results for global GPR:
  - Link between global GPR and future GDP growth depends on the GPR proxy
  - GPR shocks in both broad indices shift downward the entire distribution of future GDP growth

Quantile Regressions: Results III

- This effect is strongest for the lowest quantiles
- For narrow GPR indices, effects of global GPR are insignificant or of unexpected sign

- Results for local GPR:
  - Impact of GPR^L is insignificant for lowest quantiles and significantly negative for higher quantiles
  - Therefore, spikes in GPR decrease the probability of economic expansions
- The width of future GDP growth distribution is negatively related to the current-year GDP dynamics
- Loss functions indicate that broad GPR definitions provide a better fit to the data than narrow ones - a broad definition results in stronger economic effects

VAR Extension I

- Extending the analysis in two ways:
  1. Assessing macroeconomic effects for the full set of 182 countries
  2. Explicitly modelling the relevance of media sentiment as a propagation mechanism
- VAR analysis now includes GPR, oil production, economic activity, oil prices and *sentiment*
  - Media sentiment measure is build using the same underlying data and approach as for GPR
  - Both are related: GPR is constructed as a percentage of overall news coverage, which is reflected in the sentiment
  - Accounting for media sentiment allows to analyze whether GPR is transmitted via overall news coverage

VAR Extension: Results

Results:

- Negative effect of GPR on economic activity prevails, as before
- Positive tonality sentiment increases lead to positive effects on economic activity (in line with van Binsbergen et al., 2024)
- Sentiment effects are more pronounced than GPR effects
- Similar results for oil price as the endogenous variable
- Strong indication for an interaction between sentiment and GPR
  - Higher GPR has a negative effect on sentiment
  - This points to a sentiment channel for the transmission of GPR shocks
  - Using the CI GPR index instead gives no significant interaction effect with sentiment - possibly explained by different underlying data sources

Sentiment Effects I

- Using a panel regression model to explain GDP growth from t to t+1 with global and domestic GPR as well as global and domestic sentiment
- As controls, we add overall uncertainty, economic activity (Kilian index), real commodity prices as well as dummies indicating the global financial crisis and the Covid-19 period
- Idea: analyze effects of sentiment and GPR as well as their interaction at both the country and the global level
- Previous literature highlighted that both domestic and global sentiments can play an important role (Fraiberger et al., 2021)

Sentiment Effects II

We estimate the following predictive regression model following van Binsbergen et al. (2024):

$$\begin{aligned} GDP_{t+1} = \rho GDP_t + \alpha_1 Sent.Dom_{it} + \alpha_2 Sent.Glob_t + \alpha_3 GPR.Dom_{it} \\ + \alpha_4 d_{it} GPR.Dom_{it} + \alpha_5 GPR.Glob_t + \alpha_6 d_t GPR.Glob_t + \alpha_7 VIX_t \\ + \alpha_8 COM_t + \alpha_9 IGREA_t + \alpha_{10} d_{2009} + \alpha_{11} d_{2020} + u_i + \epsilon_{it} \end{aligned} \tag{3}$$

- Where GDP_t is the current GDP growth
- $Sent.Dom_{it}$ and $Sent.Glob_t$ are sentiment at the country and global (standardized) level
- $GPR.Dom_{it}$ and $GPR.Glob_t$ are geopolitical risk at the country and global level
- VIX_t, COM_t and economic activity $IGREA_t$ are control variables, while d_{2009} and d_{2020} are dummies

Sentiment Effects: Results I

Table 3: Results across country groups

	ALL	HGH	EME	LOW	EUN
	(1)	(2)	(3)	(4)	(5)
GDP	0.134	0.135	0.128	0.135	0.327
	(0.093)	(0.123)	(0.147)	(0.070)	(0.071)
Sent.Dom	0.091	-0.011	0.129	0.053	-0.033
	(0.125)	(0.170)	(0.166)	(0.346)	(0.160)
Sent.Glob	0.522	0.921	0.472	-0.149	0.660
	(0.155)	(0.259)	(0.209)	(0.428)	(0.185)
GPR.Dom	0.104	-0.181	0.266	-0.069	-0.198
	(0.126)	(0.242)	(0.156)	(0.312)	(0.104)
NEG.GPR.Dom	-0.121	-0.192	-0.057	-0.272	-0.269
	(0.076)	(0.100)	(0.093)	(0.347)	(0.110)
GPR.Glob	-0.714	-0.624	-0.759	-0.639	-0.630
	(0.117)	(0.196)	(0.172)	(0.375)	(0.122)
NEG.GPR.Glob	0.063	0.059	0.057	0.076	0.070
	(0.040)	(0.044)	(0.058)	(0.139)	(0.050)

Sentiment Effects: Results II

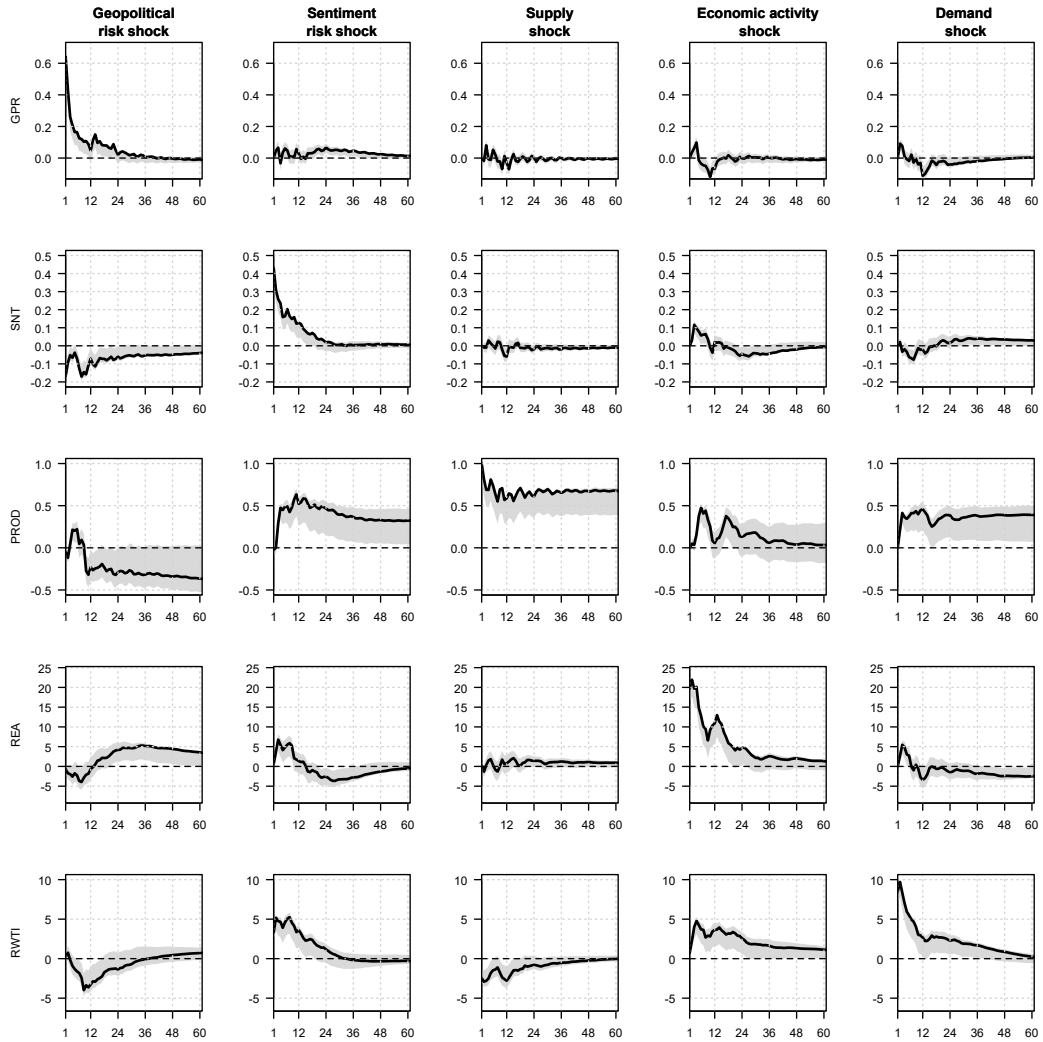

Figure 6: Impulse response functions from model with sentiment. Shaded areas represent the 68% bootstrapped confidence interval.

Sentiment Effects: Results I

Results for our broad measure (newspaper and social media coverage):

- We distinguish between country groups: HGH (high income), low (low income), EU (EUN), and OECD (OEC)
- Effects of controls in line with expectations: Uncertainty and commodity prices lead to lower growth while the Kilian index tends to increase GDP; dummies enter with a positive sign
- Effects of both sentiment and GPR are mainly transmitted via global measures - these are much more significant
- As expected, higher sentiment increases GDP, while higher GPR lowers it
- Differences across country groups:
  - Global sentiment has strong effects for all groups except low income countries, while domestic sentiment adds no effect

Sentiment Effects: Results II

  - For GPR, effects at global level are clearly negative for all groups, but only weakly significant for low income countries
  - At country level, additional negative GPR effect is observed for EU countries, and weakly significant positive effects for emerging markets
- Looking at magnitudes, global sentiment has stronger effects in high-income countries while GPR has slightly stronger effects in emerging economies, as one might expect
- No interaction between global sentiment and global GPR
- At the country level, negative sentiment propagates GPR effects for high-income and EU countries

Conclusion

- Using a novel cross-country dataset on media coverage for 182 countries, we provide a new measure of geopolitical risk that can distinguish between news and social media coverage
- GPR has substantial macroeconomic effects, which are more pronounced when using a broad definition of GPR
- GPR effects at the country level are robust when taking overall media sentiment into account
- While media sentiment is mostly characterized by global dynamics, GPR materialized when using both global and domestic measures

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