

Technical Appendix to Financial markets aren't ignoring geopolitics

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Construction of GPR-B index

The GPR-B index was constructed by using the same keywords as [Caldara and Iacoviello \(2018\)](#), hereafter referred to as C&I. The exact terms entered in the Bloomberg Terminal news volume function (trend <go>) are shown in the table below.

Table 1: Keywords used to construct GPR-B

"GEOPOLITICAL"AND"RISK*"
"GEOPOLITICAL"AND"CONCERN*"
"GEOPOLITICAL"AND"TENSION*"
"GEOPOLITICAL"AND"UNCERTAINT*"
"United States"AND"tensions"AND("military" OR "war" OR "geopolitical" OR "coup" OR "guerrilla" OR "warfare")AND("Latin America" OR "Central America" OR "South America" OR "Europe" OR "Africa" OR "Middle East" OR "Far East" OR "Asia")
("nuclear war"OR"atomic war"OR"nuclear conflict"OR"atomic conflict"OR"nuclear missile*")AND("fear*"OR"threat*"OR"risk*"OR"peril*"OR"menace*")
"war risk*"OR"risk* of war"OR"fear of war"OR"war fear*"OR"military threat*"OR"war threat*"OR"threat of war"
("military action"OR"military operation"OR"military force")AND("risk*"OR"threat*")
"terrorist threat*"OR"threat of terrorism"OR"terrorism menace"OR"menace of terrorism"OR"terrorist risk"OR"terror risk"OR"risk of terrorism"OR"terror threat*"
"beginning of the war"OR"outbreak of the war"OR"onset of the war"OR"escalation of the war"OR"start of the war"
("war" OR "military")AND"air strike"
("war"OR"battle")AND"heavy casualties"
"terrorist act"OR"terrorist acts"

The number of articles matching search terms from Table 1 on a daily basis was divided by the total number of Bloomberg news articles published during that day, to establish the relative amount of articles mentioning keywords related to geopolitical risk. Financial markets are closed during the weekend, so the article count of Saturday and Sunday is added up to Monday. The total amount of articles containing the geopolitical keywords on Saturday, Sunday and Monday were divided by the total amount of articles published during these days.

Data description

Bloomberg News

Bloomberg News starts at 11/23/1985 and the final update of the index used for this research was 6/14/2018. Figure 1. shows the monthly GPR-B index in which the spikes are labelled. The news behind the spikes can be examined within the Bloomberg Terminal. Some examples of titles are given in Table 2. The major differences between the GPR-B and the GPR of C&I (2018) are that the GPR-B controls for news published during the weekend, is based upon a real-time news sources instead of

newspapers and the news source is especially designed for financial markets. Besides these differences, the two indices are similar, which is not surprising as they are both constructed with the same key words. Correlation between the daily indices is 0.61 and between the monthly indices 0.81. Similarity is important as C&I (2018) conducted an extensive audit to show that their index is a valuable measure of geopolitical risk. Since the C&I index and the GPR-B are similar, we rely upon the audits done by C&I and do not perform similar audits on our index. However, when checking the news that causes the GPR-B to spike, we confirm that it indeed mentions geopolitical events, as can be seen in Table 2.

Figure 1: GPR-B index

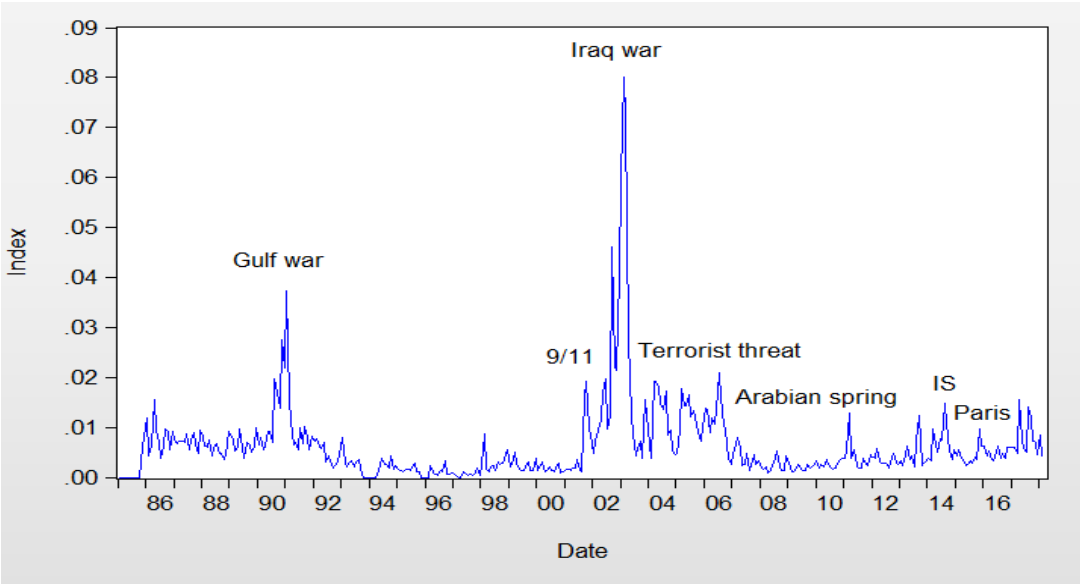


Table 2: Examples of article headlines per spike

January 1991 "Gulf War"	"War in the Gulf" "Confrontation in the Gulf"
September 2001 "9/11"	"Bush vows to hunt down terrorists" "Bush says Bin Laden cannot hide"
March 2003 "Iraq war"	"Iraq crisis" "War with Iraq"
March, April 2004 "Terrorist threat"	"Crude oil rises after suicide bombers attack Iraqi oil terminal" "Dow plunges more than 100 on Iraq worries" "Dollar may fall as rising terror threat increases risk aversion" (Madrid bombing)

Surprise indices

Economic surprise indices are used as control variables. These measure the difference between the announced value of relevant economic indicators and the consensus forecast of economists surveyed by Bloomberg. Surprise indices of the Eurozone, Japan, the UK and the USA are from Rabobank and the surprise indices for Australia, Canada, China, Korea, Norway, Russia and Sweden are from Citigroup. The Rabobank surprise are available from 3/01/2002 and the Citigroup surprise indices

start on 1/01/2003. The regressions samples are therefore determined by the control variables and not the main variable of interest, because the GPR-B we use runs from 1985 until early June 2018. The Rabobank surprises in this application are defined as the sum of economic surprises on a particular day. The Citigroup surprise index not only reflects changes on that day but also includes a decay function of earlier changes, in the regressions we use the change of the daily change Citigroup index to get as close as possible to the surprise on a particular day.

Specification

Daily changes in different financial market prices are regressed on the GPR-B and the economic surprise indices as control variables. Table 3 shows the dependent variables used and the variations on the control variables. Where appropriate economic surprise indices are used for multiple countries, for example for exchange rates where both the US surprises or the domestic surprises could have an impact.

Table 3: Specifications per dependent variable

Dependent variable	Independent variables
Exchange rates (value of US dollar in foreign currency, % daily USD appreciation)	
Australia (AUD)	GPR-B USESI D(AUESI) C
Canada (CAD)	GPR-B USESI D(CAESI) C
China (CNY)	GPR-B USESI D(CNESI) C
Eurozone (EUR)	GPR-B USESI EZESI C
UK (GBP)	GPR-B USESI UKESI C
Japan (JPY)	GPR-B USESI JPESI C
S. Korea (KRW)	GPR-B USESI D(KRESI) C
Norway (NOK)	GPR-B USESI D(NOESI) C
Russia (RUB)	GPR-B USESI D(RUESI) C
Sweden (SEK)	GPR-B USESI D(SEESI) C
Government benchmark yields (10 year, daily change)	
Australia (AU)	GPR-B D(AUESI) C
Canada (CA)	GPR-B D(CAESI) C
Germany (DE)	GPR-B EZESI C
Japan (JP)	GPR-B (JPESI) C
Norway (NO)	GPR-B D(NOESI) C
Sweden (SE)	GPR-B D(SEESI) C
United States (US)	GPR-B USESI C
Government benchmark yield spreads (10 year, over Germany, daily change)	
Spain (ES),	GPR-B EZESI C
Italy (IT)	GPR-B EZESI C
Netherlands (NL)	GPR-B EZESI C
Equity market volatility index (daily change)	
Volatility (VIX)	GPR-B USESI C
Equity markets (index, % daily change)	
United States (S&P 500)	GPR-B USESI C
MSCI All Country World (MSCI ACW)	GPR-B EZESI C
MSCI Netherlands vs. MSCI ACW (MSCI NL)	GPR-B EZESI C
Key to independent variables	
GPR-B	Bloomberg-based geopolitical risk index
US-, EZ-, JP-, UKESI	Rabobank economic surprises per day for US, Eurozone, Japan and UK
D(AU-, -CA-, -CN-, -KR-, -NO-, -RU-, SEESI)	Daily change in Citigroup economic surprise indices for Australia, Canada, China, S. Korea, Norway, Russia and Sweden

It is not obvious how to include the GDP-B in the regressions. Should we take the level (N), the daily change (D), only consider increases in the index (U) or follow C&I and use a residual from an AR process? Each of these has its own interpretation:

Levels (N)	The volume of articles all represent news to the market and should impact prices.
Changes (D)	Only the increase in the news volume is extra information for the market, and a decline in news volume indicates a decline in risk.
Upward moves in the index (U)	Because it is difficult to interpret a decline in the news as a decline in risk, the risk has not necessarily gone away if no articles are being published on the topic, therefore we also look at increases in the index
Residuals from ARIMA (AR)	To examine the impact of their monthly index on equity markets C&I use the residuals of an autoregressive process. We do something similar by using the residuals of an autoregressive moving average process on the changes of our daily index (ARIMA). The intuition here is that any changes in the news flow that can be forecast from past changes are not a surprise to the market.
C&I GPR (G)	To compare our index to C&I's daily index we also include results from a regression of the ARIMA residuals of their index. We choose this specification from the above because, as is shown below, this has the most best results in terms of statistical significance. The available C&I daily data runs from 1985 until November 2017.

Table 4 shows the significance of the coefficient on the GDP variable, per independent variable (rows) and GPR specification (columns). Heteroscedasticity and autocorrelation consistent standard errors are used. The XD, U and AR specifications all demonstrate a significant effect of geopolitical risk on moves in interest rates and equity markets, and some exchange rates. The AR specification is significant for more dependent variables and is also similar to the approach used by C&I, so we use this in the tables in the main text. Interestingly, the C&I index shows significance for several exchange rates, but not for interest rates and equity markets.

Table 5 shows the scale of these effects for those coefficients that are statistically significant. Rather than show the coefficient, which has no intuitive interpretation, we multiple the coefficient with the largest single day move in the index (24 Sept 2002). For the C&I daily index we use the largest single day move for their index. The ratio between the standard deviation and the largest move is about the same for both indices, so we the scale of the results to be comparable.

Table 4: Significance

	N	D	U	AR	G
AUD	-	-	-	-	-
CAD	**	-	-	-	**
CNY	-	-	-	-	-
EUR	-	-	-	-	**
GBP	-	-	-	-	*
JPY	-	-	-	*	-
KRW	-	-	*	*	-
NOK	-	-	-	-	-
RUB	-	**	*	*	-
SEK	-	-	-	-	*
AU	-	***	**	***	-
CA	-	***	-	***	-
DE	-	***	***	***	-
JP	**	-	-	*	-
NO	-	-	-	-	**
SE	-	***	**	***	**
US	-	***	*	***	-
ES	-	**	-	**	-
IT	-	***	**	**	*
NL	-	-	-	-	-
VIX	-	***	***	***	-
SP500	-	***	***	***	-
MSCI ACW	-	**	-	-	-
MSCI NL	-	-	-	-	-

- p-value \geq 10%, using HAC standard errors

* p-value < 10%

** p-value < 5%

*** p-value < 1%

Table 5: Effects

	N	D	U	AR	G
AUD	-	-	-	-	-
CAD	-0.12	-	-	-	0.19
CNY	-	-	-	-	-
EUR	-	-	-	-	0.20
GBP	-	-	-	-	0.16
JPY	-	-	-	-0.17	-
KRW	-	-	0.30	0.21	-
NOK	-	-	-	-	-
RUB	-	0.23	0.27	0.20	-
SEK	-	-	-	-	0.21
AU	-	-0.04	-0.04	-0.04	-
CA	-	-0.02	-	-0.02	-
DE	-	-0.02	-0.03	-0.03	-
JP	0.00	-	-	-0.01	-
NO	-	-	-	-	0.01
SE	-	-0.02	-0.03	-0.03	0.02
US	-	-0.03	-0.02	-0.03	-
ES	-	0.02	-	0.02	-
IT	-	0.02	0.02	0.02	0.02
NL	-	-	-	-	-
VIX	-	0.96	1.05	1.03	-
SP500	-	-0.68	-0.84	-0.75	-
MSCI ACW	-	-0.76	-	-	-
MSCI NL	-	-	-	-	-

- p-value \geq 10%, using HAC standard errors

Stability tests

An important question is how stable these results are. We run Quandt-Andrews (QA) tests for all specifications. This tests for a break anywhere in the sample. Table 6 reports the regressions where there is evidence of a break, with the date of the clearest break (break point test with the maximum LR F-statistic) and the associated statistical significance. There may be more breaks in those samples. For those estimates that show a break we run a separate regression for the period January 2016 to June 2018 and report the effect in Table 7 if the coefficient on the GPR-B is significant.

Table 6: Quandt-Andrews break tests

	N	D	U	AR	G
AUD	(11/17/2004)**	(11/17/2004)**	(11/17/2004)**	(11/08/2004)**	(10/01/2004)**
CAD	(1/15/2015)***	(1/15/2015)***	(1/15/2015)***	(1/15/2015)**	(1/15/2015)**
CNY	(1/15/2014)***	(1/15/2014)***	(5/03/2017)***	(4/11/2017)***	(6/27/2017)***
EUR	-	-	-	-	(7/17/2008)*
KRW	-	-	-	-	(3/12/2009)*
NOK	(2/14/2013)**	(2/14/2013)***	(2/14/2013)**	(2/14/2013)**	(2/14/2013)**
RUB	-	-	(7/29/2008)**	-	(7/31/2008)*
SEK	(6/22/2012)***	(6/22/2012)***	(6/22/2012)***	(6/22/2012)***	(6/22/2012)***
NO	(4/30/2004)**	(2/11/2005)**	(2/11/2005)**	(2/11/2005)**	(2/11/2005)**
US	(6/04/2012)***	(6/04/2012)**	(6/04/2012)***	(6/04/2012)***	(6/04/2012)***
IT	-	-	-	-	(1/10/2012)*
NL	-	-	-	(12/30/2002)*	-
SP500	-	-	-	-	(12/30/2002)*
MSCI ACW	(12/02/2008)***	(3/13/2009)***	(12/02/2008)***	(12/02/2008)***	(12/02/2008)***
MSCI NL	-	(2/25/2009)**	-	-	(8/15/2008)**

- p-value \geq 10%, using HAC standard errors, no evidence of break

* p-value < 10%

** p-value < 5%

*** p-value < 1%

Table 7: Effect estimate for sample 2016-2018

	N	D	U	AR	G
AUD	0.46	-	-	-	0.44
CAD	-	-	-	-	0.54
CNY	-	-0.23	-0.38	-	-
EUR					0.41
KRW					-
NOK	-	-	-	-	0.39
RUB			1.45		-
SEK	-	-	-	-	-
NO	-	-	-	-	-
US	-	-	-	-	-
IT					-
NL				-	
MSCI ACW	-0.60	-	-0.74	-0.70	-
MSCI NL		-			-

Blank = QA-test is not significant at 10% p-value

- Coefficient not significant at 10% p-value