The Impact of Uncertainty Shocks: Evidence from Geopolitical Swings on the Korean Peninsula

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Motivation

- The role of uncertainty shocks in business cycle fluctuations:
  Geopolitical swings on the Korean peninsula

Image source: BBC news.
Motivation

- The role of uncertainty shocks in business cycle fluctuations
  - Geopolitical swings on the Korean peninsula

- Identification of geopolitical uncertainty shocks
  - News-based measure vs. Market-based measure

Image source: BBC news.
Research Questions

1. Can the impact of geopolitical swings be identified while addressing endogeneity issues?

2. Do the geopolitical swings in Korea affect Korean financial markets and economy?

3. What is the role of foreign exchange (FX) rate in Geopolitical Uncertainty?
Our contribution

1. We investigate the economic impact of geopolitical uncertainty on the Korean Peninsula.
   - South Korea has been constantly exposed to geopolitical swings, both tensing-increasing and peace-building.

2. We examine various channels of the propagation of geopolitical uncertainty shocks in a small open economy.
   - **Instrumental variables** (IVs) to capture exogenous variations in uncertainty
     - High frequency changes in financial asset returns and volatility around the geopolitical events
   - **SVAR model** to explore the transmission of uncertainty shocks through financial and currency market
Quick preview

1. **Heightened geopolitical uncertainty** has **negative** impacts on financial market and macroeconomic outcomes.

2. In the propagation of uncertainty shocks, FX rates act as a **shock absorber** rather than a shock amplifier.

3. Using **proxy VAR**, we exploit the **market-based information** for identification of geopolitical uncertainty shocks. We also consider the **news-based aspects** when selecting the geopolitical events.
   - IV FX (daily) and IV VKOSPI (daily) are found to be the most suitable for analysis.
Part I  Motivation and summary

Literature

1. Uncertainty shocks and economic fluctuation
   - Baker, Bloom and Davis (2016), Gilchrist, Sim and Zakrajek (2017), Ludvigson, Ma and Ng (2015), Bloom et al. (2018)

2. Measurement of uncertainty

3. Instrument variables for uncertainty shocks
   - (Disastrous events) Baker and Bloom (2013), Carriero et al. (2015), (Gold price) Piffer and Podstawski (2016), (Firms’ exposure to aggregate volatility shocks in energy, policy and treasuries) Alfaro, Bloom and Lin (2018)

4. Geopolitical swings in Korea
Empirical framework

- **SVAR model with external instruments:**
  Stock and Watson (2012) and Mertens and Ravn (2013)

- Reduced form representation:

  \[
  Y_t = \sum_{j=1}^{p} B_j Y_{t-j} + u_t
  \]  \hspace{1cm} (1)

  where \( Y_t \) is a vector of endogenous variables and \( \varepsilon_t \) is structural shocks and \( u_t = S \varepsilon_t \).

- Recovering the structural shock in uncertainty, \( \varepsilon_{1t} \).

  \[
  Y_t = \sum_{j=1}^{p} B_j Y_{t-j} + s \varepsilon_{1t}
  \]  \hspace{1cm} (2)
Empirical framework

- **Recursive identification scheme**: Uncertainty is completely exogenous to the other macro and financial variables.
Empirical framework

- **Recursive identification scheme**: Uncertainty is completely **exogenous** to the other macro and financial variables.

However, most uncertainty measures can be **endogenous** to other shocks.

  - Simultaneous interactions between financial asset prices and uncertainty.
  - In SOEs, financial and capital markets are easily affected by external factors implying the stronger link between uncertainty and financial markets.

- **SVAR with external instrument**
Endogenous variables

- \( Y_t = [VKOPSIt, KOSPI_t, FX_t, CF_t, KTBR3yt, CPI_t, IP_t] \)
  - Sample period: January 2003 – December 2017
  - The lag length is based on the Schwarz information criteria or Hannan-Quinn information criteria.

**VKOSPI_t**

- **News-based index** is useful but has drawbacks (measurement error, news may have mixed signals).
- **Market-based measure** can gauge the precision of the signals evaluated by financial market participants.
  - *e.g.* The news about North Korea’s empty threat is counted for the news-based index but may be irrelevant information for the market participants.
Endogenous variables

\[ Y_t = [VKOPSI_t, KOSPI_t, FX_t, CF_t, KTB3y_t, CPI_t, IP_t] \]

- Sample period: January 2003 – December 2017
- The lag length is based on the Schwarz information criteria or Hannan-Quinn information criteria.

**FX\_t**

- **Shock absorber**: SOEs with flexible FX rate may cope with negative shocks better.
- **Shock amplifier**: FX rate may affect investors’ risk-taking behaviors and the supply of credit.

→ **Counterfactual analysis**: Impulse responses of FX rate are set to zero.
Event selection for IVs

- We collect a wide range of geopolitical events from Arms Control Association and Ministry of Unification of South Korea.

- **Tension-increasing events**: missile tests, nuclear-related events, and regional military conflicts.

- **Reconciliation events**: bilateral talks and agreements between South and North Korea and multilateral talks among South and North Korea, US, China, Russia, and Japan.
  - We exclude events that are characterized by verbal threats.
  - We exploit the Google Trend data to incorporate the relative importance of the event perceived by individuals.

⇒ 87 events (40 tension-increasing events; 47 reconciliation events).
Construction of IVs

- Around the selected geopolitical events, we compute the changes in:
  1. **IV FX**: foreign exchange rate,
  2. **IV CDS**: sovereign CDS premium,
  3. **IV FX VOL**: the implied volatility of foreign exchange rate,
  4. **IV VKOSPI**: the implied volatility of equity index.

- These financial variables have exhibited immediate but sensitive responses during the time of uncertainty due to geopolitical swings.

- We aggregate the computed daily or intraday series of $\Delta p^j$ into a monthly series by summing changes within a month.
Overview of computed IVs

IV FX (daily) vs. IV VKOSPI (daily)

- NK test missiles.
- NK fires artillery rounds at Yeonpyeong.
- NK launches ballistic missiles and tests ICBM.
- US removes NK from the list of state sponsors of terrorism.
- NK launches ballistic missiles and tests ICBM.
- NK conducts an underground nuclear test.
- NK launches LRBMs.
- SK-China summit meeting.
### Overview of computed IVs

#### Table 1: Daily changes during the events

<table>
<thead>
<tr>
<th></th>
<th>FX</th>
<th></th>
<th>CDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peace</td>
<td>Tension</td>
<td>All</td>
</tr>
<tr>
<td>Average</td>
<td>-0.318</td>
<td>0.050</td>
<td>-0.150</td>
</tr>
<tr>
<td>Obs.</td>
<td>51</td>
<td>43</td>
<td>94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>FX VOL</th>
<th></th>
<th>VKOSPI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peace</td>
<td>Tension</td>
<td>All</td>
</tr>
<tr>
<td>Average</td>
<td>-0.346</td>
<td>1.733</td>
<td>0.591</td>
</tr>
<tr>
<td>Obs.</td>
<td>50</td>
<td>41</td>
<td>91</td>
</tr>
</tbody>
</table>

**Notes:** Averages and percentiles are computed using daily changes in percentage.
Performance of IVs

- Let $Z_t'$ be a vector of instrumental variable and $\varepsilon_t^*$ be structural shocks other than the uncertainty shock.

$$u_t = s_1 \varepsilon_{1t} + \mathbf{S}^* \varepsilon_t^* \tag{3}$$

- The relevance and exclusion restriction conditions

$$E[\varepsilon_{1t} Z_t] = \phi \tag{4}$$

$$E[\varepsilon_t^* Z_t] = 0 \tag{5}$$
Performance of IVs

Table 2: IV Relevance (by base assets)

<table>
<thead>
<tr>
<th>Daily IVs</th>
<th>Intraday IVs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>IV FX</td>
<td>8.455</td>
</tr>
<tr>
<td>IV CDS</td>
<td>2.210</td>
</tr>
<tr>
<td>IV FX VOL</td>
<td>3.113</td>
</tr>
<tr>
<td>IV VKOSPI</td>
<td>6.587</td>
</tr>
</tbody>
</table>

Notes: $F$ denotes the $F$-statistic. All instrumental variables are computed using the changed in each base asset surrounding the positive and negative events.

- Plan ahead: weak instrument-robust F-statistics and confidence set for IRFs (Montiel Olea, Stock and Watson, 2018)
### Part III Empirical results

## Performance of IVs

### Table 3: Sargan Overidentifying Test

<table>
<thead>
<tr>
<th></th>
<th>KOSPI</th>
<th>FX</th>
<th>CF</th>
<th>KTB3y</th>
<th>CPI</th>
<th>IP</th>
<th>$\chi^2_{0.05}(r)$</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV FX(intraday)</td>
<td>2.856</td>
<td>0.898</td>
<td>0.705</td>
<td>0.041</td>
<td>1.372</td>
<td>1.707</td>
<td>3.841</td>
<td>1</td>
</tr>
<tr>
<td>IV FX(daily)</td>
<td>1.212</td>
<td>2.440</td>
<td>0.120</td>
<td>1.559</td>
<td>2.184</td>
<td>0.167</td>
<td>3.841</td>
<td>1</td>
</tr>
<tr>
<td>IV VKOSPI(daily)</td>
<td>0.140</td>
<td>0.395</td>
<td>0.006</td>
<td>0.046</td>
<td>0.010</td>
<td>1.789</td>
<td>3.841</td>
<td>1</td>
</tr>
<tr>
<td>IV All(daily)</td>
<td>0.514</td>
<td>1.059</td>
<td>1.970</td>
<td>3.958</td>
<td>2.496</td>
<td>2.947</td>
<td>7.815</td>
<td>3</td>
</tr>
</tbody>
</table>

**Notes:** $r$ denotes the degree of freedom.
Overview of results

A heightened geopolitical uncertainty shock has

1. (Baseline) a negative impact on macroeconomic outcomes: a decline in production, lower stock returns, currency depreciation and a drop in foreign capital.


2. Credit spread is widened as currency risk-taking channel predicts.

3. Other real activities, such as consumption, investment and employment, also respond negatively.

4. Sentiment of consumer and business are significantly weakened.
Baseline

Notes: The shaded areas show the 68% and the 95% error bands.
Credit spread

Notes: The shaded areas show the 68% and the 95% error bands. F-statistics: (a) 7.15, (b) 6.40
Other real activities

(a) Consumption

(b) Investment

(c) Employment

Notes: The shaded areas show the 68% and the 95% error bands. All are estimated with IV FX (daily). F-statistics: (a) 9.22, (b) 6.89, (c) 7.88
Part III  Empirical results

Sentiment

(a) CCI (IV FX)

(b) BCI (IV FX)

Notes: The shaded areas show the 68% and the 95% error bands. CCI, BCI denote consumer and business confidence index respectively. F-statistics: (a) 6.34, (b) 5.80
Counterfactual analysis

1. FX rates depreciate on a negative geopolitical uncertainty shock. How does the reaction of FX rates affect the economy?

   - **Shock absorber** (wealth effect, trade effect) vs. **Shock amplifier** (Currency risk-taking)

2. We conduct a counterfactual analysis (muting the responses of FX rates).

   - The effects on **stock market** is amplified while the responses of **government bond rates** are shifted downwards from the baseline estimations.
   - Finally, **CPI** and **industrial production** decline further compared to the benchmark.

⇒ **Shock absorber** > **Shock amplifier**
Counterfactual analysis

Notes: The shaded area shows the 68% error bands. Blue dotted lines are the counterfactual IRFs blocking the exchange rate channel.
Robustness

We check the robustness of results by substituting the endogenous variables with

1. Alternative uncertainty measures (e.g. FX volatility, EPU, GPR)
2. Alternative FX rate measures (e.g. broad/narrow NEER, REER)
3. Alternative capital inflow measures (e.g. short- and long-term capital inflow, net capital inflow).
Conclusions

1. We examine the economic impact of the geopolitical uncertainty on the Korean Peninsula by estimating a structural VAR model with the external instrument identification scheme.

2. The reactions of financial market to geopolitical swings are consistent with the theoretical predictions.

3. The heightened (reduced) geopolitical uncertainty has negative (positive) impact on macroeconomic outcomes in South Korea, leading to a decline in production, lower stock returns, depreciation and a decrease in foreign capital inflows.
The identification of structural shocks can be boiled down to estimating

\[ E(u_t Z_t) = s_1 E(\varepsilon_{1t} Z_t) = s_1 \phi \]  

(6)

where \( s_1 \) be the responses of \( u_t \) to structural shocks in uncertainty, \( \varepsilon_{1t} \).

Let \( u_{1t} \) be the residual for the uncertainty measure and \( u_t^* = (u_{2t}, \ldots, u_{kt})' \) be the residuals for other variables in the VAR.

Define a \((k - 1) \times 1\) vector \( \lambda = (\frac{s_{21}}{s_{11}}, \frac{s_{31}}{s_{11}}, \ldots, \frac{s_{k1}}{s_{11}})' \), so that

\[ E(u_t^* Z_t) = \lambda E(u_{1t} Z_t). \]

\( \lambda \) can be consistently estimated by least squares of the following.

\[ \hat{u}_t^* = \lambda \hat{u}_{1t} + \xi_t \]  

(7)

\[ \rightarrow \hat{\lambda} = (\frac{\hat{E}(\hat{u}_{21} Z_t)}{\hat{E}(\hat{u}_{1t} Z_t)}), \ldots, \frac{\hat{E}(\hat{u}_{k1} Z_t)}{\hat{E}(\hat{u}_{1t} Z_t)})' \]
Proxy VAR

- Now define partitioned matrices, $S$ and $\Sigma$, as follows.

$$
S = \begin{bmatrix} s_{11} & s_{12}' \\ s_{21} & S_{22} \end{bmatrix}, \quad \Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12}' \\ \sigma_{21} & \Sigma_{22} \end{bmatrix}
$$

- Estimate $s_1 = (s_{11}, s_{21}')'$

with $\hat{s}_1 = \hat{s}_{11} \cdot (1, \hat{\lambda}')'$ and $\hat{s}_{11} = \pm \sqrt{\hat{\sigma}_{11} - \hat{s}_{12}'s_{12}}$

where

$$
\hat{s}_{12}'s_{12} = (\hat{\sigma}_{21} - \hat{\sigma}_{11}\hat{\lambda})'\hat{\Gamma}^{-1}(\hat{\sigma}_{21} - \hat{\sigma}_{11}\hat{\lambda})
$$

$$
\hat{\Gamma} = \hat{\Sigma}_{22} + \hat{\sigma}_{11}\hat{\lambda}\hat{\lambda}' - \hat{\sigma}_{21}\hat{\lambda}' - \hat{\lambda}\hat{\sigma}_{21}.
$$
Computing IVs

Daily changes

Given the event, $e_j$ for $j = 1, \ldots, N$, we compute the percentage variations ($\Delta p^j$) between the last available daily quote before the time of the event and that after the time of the event.

($d_{0j}$ denotes the date of an event $j$; $\tau^j$ denotes the time stamp on the day; and $P_{0j}$ denotes the last price of day $d_{0j}$.)

1. If $\tau^j$ falls on a weekday (Monday to Friday) and between trading hours or before the trading hours, $\Delta p^j$ is simply changes between the last price of $d_{0j}$ and the last price of $d_{-1j}$, i.e. $(P_{0j}/P_{-1j} - 1) \times 100$.

2. If the event happens on a weekday (Monday to Thursday) and after trading hours, we compute $\Delta p^j = (P_{1j}/P_{0j} - 1) \times 100$.

3. Similarly, when the event happens after Friday trading hours and before Monday trading hours, $\Delta p^j = (P_{Mj}/P_{Fj} - 1) \times 100$, where $P_{Mj}$ is the last price next Monday after the event and $P_{Fj}$ is the last price on the day of the event.
Computing IVs

Intraday changes

- Intraday changes are calculated in either 5- or 30-minute intervals.
  1. If the event occurs during the trading hours, we compute the changes between the price at 5th or 30th minute and the price at the time of the event, \( \Delta P^j = \left( \frac{P_{mj}}{P_{0j}} - 1 \right) \times 100 \), where \( P_{mj} \) denotes the price of base asset at the \( m^{th} \) minute after the event \( j \) happens.
  2. If the event occurs after the trading hours, we compare the closing price before the event and the opening price of the next day.
  3. Public holidays and Saturdays/Sundays are all treated in the same way as in daily IV computation.

- We then aggregate the computed daily or intraday series of \( \Delta p^j \) into a monthly series by summing the daily changes within a month.
Computing IVs

- Due to the instantaneous and detrimental nature of tension-increasing events, we can easily trace these events time-stamped up to minutes from the information sources.
- However, the meetings, talks and/or agreements are identified up to dates.
  - These events maintain the continuity of the series of processes by nature.
  - The information in the beginning of the summit meeting may have less value than that at the time of announcement of agreements if it is difficult to predict the contents and the scope of the agreement.
  - Therefore, news agencies or other information sources tend not to record the exact hours or minutes of these events.
  - Market responses to the reconciliation events tend not to be as prompt as the responses to the events induced by the military aggression.

⇒ Tension (intraday changes), Reconciliation (daily changes).
Other IVs

IV CDS (daily)

- NK conducts an underground nuclear test.
- NK fires artillery rounds at Yeonpyeong.
- SK-NK minister meeting, red-cross talks.
- NK troops fired at balloons from SK.
- SK-NK exchange gunfires.
- NK tests Hwasong-12 missile, overflew Japan.
- UN adopt Olympic Truce.
Other IVs

IV FX VOL (daily)
## Performance of IVs

**Table 4: IV Relevance (By type of events)**

<table>
<thead>
<tr>
<th></th>
<th>$F$</th>
<th>$R^2$</th>
<th>$t_1$</th>
<th>$t_2$</th>
<th>$t_3$</th>
<th>$t_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Reconciliation</td>
<td>5.069</td>
<td>0.105</td>
<td>-2.472</td>
<td>0.835</td>
<td>-1.077</td>
<td>-2.052</td>
</tr>
<tr>
<td>IV Tension</td>
<td>1.773</td>
<td>0.039</td>
<td>1.526</td>
<td>1.321</td>
<td>-0.288</td>
<td>-0.882</td>
</tr>
<tr>
<td>IV All</td>
<td>2.895</td>
<td>0.063</td>
<td>-1.514</td>
<td>2.974</td>
<td>-0.359</td>
<td>-1.659</td>
</tr>
</tbody>
</table>
Robustness

Alternative uncertainty measure (FX Volatility)

(a) IV FX (intraday)  
(b) IV FX (daily)  

Notes: The shaded area shows the 68% and 95% error bands. F-statistics: (a) 9.27, (b) 10.23.
Robustness

Alternative uncertainty measure (EPU)

(a) IV VKOSPI (intraday)

(b) IV VKOSPI (daily)

Notes: Shaded area shows the 95% error bands. F-statistics: (a) 1.28, (b) 1.96.
Robustness

Alternative FX rate (NEER)

(a) IV FX (intraday)  
(b) IV FX (daily)

Notes: Shaded area shows the 95% error bands. F-statistics: (a) 5.05, (b) 7.50.
Robustness

Alternative capital flow measure (Short-term net capital flows)

(a) IV FX (intraday)  
(b) IV FX (daily)

Notes: Shaded area shows the 95% error bands. F-statistics: 6.55, 8.67.
Robustness

Alternative capital flow measure (Short- and long- term)

(a) IV FX (intraday)   (b) IV VKOSPI (daily)

Notes: Shaded area shows the 95% error bands. F-statistics: (a) 5.53, (b) 8.29.