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The Impact of Geopolitical Risk on Stock Returns: Evidence from Inter- Korea Geopolitics

Seungho Jung, Jongmin Lee, Seohyun Lee

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The Impact of Geopolitical Risk on Stock Returns: Evidence from Inter-Korea Geopolitics

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Abstract

We investigate how corporate stock returns respond to geopolitical risk in the case of South Korea, which has experienced large and unpredictable geopolitical swings that originate from North Korea. To do so, a monthly index of geopolitical risk from North Korea (the GPRNK index) is constructed using automated keyword searches in South Korean media. The GPRNK index, designed to capture both upside and downside risk, corroborates that geopolitical risk sharply increases with the occurrence of nuclear tests, missile launches, or military confrontations, and decreases significantly around the times of summit meetings or multilateral talks. Using firm-level data, we find that heightened geopolitical risk reduces stock returns, and that the reductions in stock returns are greater especially for large firms, firms with a higher share of domestic investors, and for firms with a higher ratio of fixed assets to total assets. These results suggest that international portfolio diversification and investment irreversibility are important channels through which geopolitical risk affects stock returns.

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TABLE OF CONTENTS

ABSTRACT	<u>2</u>
1. INTRODUCTION	<u>4</u>
2. MEASURING GEOPOLITICAL RISK FROM INTER-KOREA RELATIONS	<u>7</u>
2.1. Scope of Geopolitical Risk	<u>7</u>
2.2. Data and Methodology	<u>7</u>
2.3. Evaluating the GPRNK Index	<u>10</u>
3. EMPIRICAL FRAMEWORK	<u>15</u>
3.1. Estimation Model	<u>15</u>
3.2. Data	<u>17</u>
4. RESULTS	<u>18</u>
4.1. Baseline Results	<u>18</u>
4.2. Robustness	<u>24</u>
5. CONCLUSION	<u>26</u>
REFERENCES	<u>27</u>
FIGURES	
1. The GPRNK Index (1995-2020)	<u>11</u>
2. The GPRNK Index by Topic	<u>12</u>
3. Comparing the GPRNK Index with Existing Measure	<u>13</u>
4. Assessing Potential Selection Bias of the GPRNK Index	<u>14</u>
TABLES	
1. Search Keywords	<u>9</u>
2. Variable Description	<u>17</u>
3. Summary Statistics	<u>18</u>
4. GPRNK and Firms' Stock Return: Average Effects	<u>19</u>
5. GPRNK and Firms' Stock Return: Differential Effects by Firm Characteristics	<u>21</u>
6. GPRNK and Firms' Stock Return: Result with Subtopic Indices	<u>22</u>
7. Regression Results with Alternative Measures	<u>23</u>
8. Robustness Check: Results from Restricted Sample	<u>25</u>
APPENDICES	
A.1. Details of Media Sample of GPRNK Index	<u>29</u>
A.2. Additional Robustness Checks	<u>29</u>
A.3. Additional Understanding of GPRNK Trend	<u>34</u>

1. Introduction

There has been growing interest in the impact of geopolitical risk, both from academia and policymakers, owing to rising geopolitical tensions around the world, including the U.S.-Iran conflicts over nuclear deals, terrorist attacks in Europe, conflicts between Hong Kong and mainland China, the recent U.S. withdrawal from Afghanistan, and other types of regional civil strife, as in Syria, Libya and Yemen. Heightened geopolitical risk may increase financial market volatility and induce delays in investment decisions, and, as a result, may have a negative impact on macroeconomic outcomes (Caldara and Iacoviello, 2019; Ha et al., 2021).

In this paper, we study the effects of geopolitical risk on stock returns by examining the response of South Korean stock markets to swings in the relationship between South and North Korea. The South Korean case provides a favorable setting to investigate the impacts of geopolitical risk for the following two reasons. First, South Korea has well-developed and functioning financial markets. At the end of 2019, the market value of the Korean Stock Exchange amounted to USD \$1.4 trillion, the 15th biggest in the world and the sixth in Asia. The degree of stock market openness is also high, with nearly 40% being owned by international investors.⁴ Second, South Korea has been exposed to high geopolitical risk, especially risk originating from North Korea's threat which is arguably unpredictable for investors. There were times of escalating geopolitical tension as well as peace-seeking periods, and recently the alternation between these two phases has become more frequent and unexpected. North Korea has carried out six nuclear weapons tests, four since 2012 when Kim Jong-Un came to power. It has launched missiles of various types and lengthened their range. After testing the Hwasong-15 missile in 2017, which is hypothetically capable of reaching the U.S., global concerns over North Korea's nuclear-capable missiles deepened. Although geopolitical tensions lessened substantially when consecutive inter-Korean and U.S.-North Korea summit meetings took place in 2018 and 2019, they continue to be at a high level due to the fact that substantive agreements concerning North Korean nuclear issues have yet to come out of any negotiations.

In order to investigate the economic consequences of geopolitical swings in South Korea, we first develop a novel measure of geopolitical risk associated with the inter-Korean relationship. Building on the literature of measuring uncertainty using media databases, as in Baker, Bloom and Davis (2016) and in Caldara and Iacoviello (2019), we construct an index of geopolitical risk that originates from North Korean threats, the "GPRNK index", using automated keyword searches from news articles in leading Korean-language newspapers and broadcasts since 1995. The idea of using the frequency of media articles to gauge risk is based on the assumption that the more the economic agents consider the future of inter-Korean relations to be uncertain, the more likely terms related to the issue will appear in the media. Our index is constructed based on four main drivers of inter-Korean relations: military conflicts, sanctions, talks, and economic engagement. We find that the index clearly reflects major geopolitical events, such as nuclear tests and aggressive action by North Korea, as well as agreements from bilateral and multilateral talks.

As for the empirical framework, we exploit firm-level panel data to take into account firm heterogeneity in exposure to inter-Korean geopolitics and to identify possible channels through which geopolitical risk shocks are transmitted. We estimate the average impact of geopolitical risk by regressing firm-level stock returns on the GPRNK index with firm fixed effects and find that heightened geopolitical risk reduces a company's stock returns. The adverse effects are still significant even when we add the overall market volatility and/or economic policy uncertainty as explanatory variables. We then estimate the differential

⁴ International investors own 37.2% of the KOSPI market and 13.3% of the KOSDAQ market. For details and more information about foreign ownership in South Korean equity markets, please visit the Korea Exchange website at <http://marketdata.krx.co.kr/mdi#document=13020403>.

effects by interacting firm characteristics with the GPRNK index and find significant heterogeneity in stock price response to geopolitical risk. Specifically, an increase in geopolitical risk depresses stock returns for companies with a large share of fixed assets or with experience of involvement in inter-Korean economic cooperation. We also find that companies with a large share of international investors exhibit relatively high stock returns during the tension-increasing periods. These results imply that international portfolio diversification and investment irreversibility are important channels through which geopolitical risk affects stock returns.

This study is related to several strands of literature. First, recent studies have quantified various sources of risk or uncertainty using methods developed in computational linguistics. Baker, Bloom and Davis (2016) measures economic policy uncertainty (the EPU index) in 12 economies based on monthly counts of news articles containing the words (i) uncertainty or uncertain, (ii) economic or economy, and (iii) one of the policy-related keywords. Similarly, Caldara and Iacoviello (2019) presents a novel measure of global geopolitical risk (the GPR index) using automated text-searches of 11 leading English-language newspapers. The GPR index is calculated from the frequency of articles that contain keywords in the following six categories: geopolitical threats, war threats, terrorist threats, nuclear threats, war acts, and terrorist acts. Both studies report adverse macroeconomic impacts caused by uncertainty shocks.

Our methodology of measuring risk mimics that of those two studies, but we depart from them by paying more attention to regional-specific geopolitical risk rather than to worldwide risk. More specifically, Caldara and Iacoviello (2019) considers news articles that were related with globally highlighted geopolitical issues such as war threats, terrorism or cross-border tensions, and measures geopolitical risk from a North American or British perspective, as the source of its press coverage is in leading English-language newspapers published in the U.S., the U.K., and Canada. Instead, we use media data from South Korean newspapers and broadcast services, trying to capture a Korea-specific context of geopolitical swings, such as North Korea's development of weapons of mass destructions (WMD), including nuclear missiles.

Among the literature investigating the effects of North Korean tensions on South Korean financial markets, a large number of earlier studies employ event studies to identify geopolitical risk. A prominent example using event studies is Kim and Roland (2014). They select 26 important events related to tensions on the Korean Peninsula to estimate the cumulative abnormal return (CAR) on the KOSPI index, the sovereign bond yield, and the Korean won exchange rate against the U.S. dollar. They find that the events had no significant impact on financial markets. Similarly, Kim and Jung (2014), who study 74 geopolitical events between 1999 and 2012, report a negative response of market returns to North Korea's nuclear/missile tests. Gerlach and Yook (2016) investigate investor trading behavior during 13 North Korean military provocations between 1999 and 2010. They find that foreign investors increased their holdings of Korean equity following such shocks, and outperformed domestic investors. Ha et al. (2021) compile 87 geopolitical events to construct external instrumental variables to be employed in an SVAR model, and find that increased geopolitical uncertainty has a negative impact on financial and macroeconomic variables.⁵

Although the event studies have contributed to making causal inferences concerning the reactions of South Korean financial markets to geopolitical risk, their estimation can only be applied to a few limited events, such as nuclear/missile tests and military aggressions. Moreover, event studies may fail to capture continuous variations in the intensity of risk. For example, during the North Korean crisis in 2017, Pyongyang and Washington exchanged serious verbal threats that escalated geopolitical tensions.

⁵ Ha et al. (2021) used financial asset price changes at around the times of geopolitical events as external instrumental variables. Their empirical framework is different from the conventional event studies literature.

However, it was unlikely that these tensions would be captured by conventional event studies. Likewise, event studies cannot capture the variations in geopolitical risk during the several stages of negotiations to hold summit meetings, which might have already been baked into asset prices before the summit is indeed held.

In order to measure geopolitical risk caused by North Korea, some recent studies use keyword searches. For instance, Dibooglu and Cevik (2016) develop the North Korean Threat Index (NKTl) by tracking aggressive and threatening language in articles in North Korean state media, and find causal effects of North Korean threats on exchange rate returns and stock returns in both South Korea and Japan. Huh and Pyun (2018) employ Google's Search Volume Index (SVI) to measure attention paid to North Korean nuclear threats, and suggest that the negative impact of North Korea risk on South Korean financial markets was subdued after the first nuclear test. Kim et al. (2019) quantify the level of political risk using the ratio of North Korea-related news articles to daily total news articles. They find that foreign investors reduced the value of their South Korean portfolio when North Korea risk escalated greatly. Park and Park (2020) utilize the monthly frequency of news articles covering North Korea's threats, and find that the South Korean exchange rate depreciated immediately after North Korean nuclear weapons tests, although its duration was not long. Pak et al. (2015) measure U.S. news sentiment on North Korea risk and estimate its effects on the stock price of the Korean firms listed on the New York Stock Exchange (NYSE). They find that negative news related to North Korea have a negative impact on the stock returns not only in South Korea but also in the U.S.

These studies successfully attempt to provide continuous measures of geopolitical risk, but have limitations in that they reflect only downside risk. Our index, however, can capture both downside and upside geopolitical risk by computing the relative frequency of net negative news articles compared to the total number of news articles.

Finally, our study is related to the literature on various channels of uncertainty effects.⁶ Among the many potential channels of uncertainty, the real options theory suggests that political instability can depress firm-level capital investment by inducing delays due to investment irreversibility (Dixit and Pindyck, 1994; Bloom et al. 2007; Gulen and Ion, 2015). The delays in investment may weaken a firm's growth outlook, leading to a decline in stock prices. Concerning financial market responses to geopolitical risk, the literature varies widely. While some, e.g., Gerlach and Yook (2016), support the *international diversification hypothesis* by arguing that foreigners outperformed domestic traders following North Korean military attacks, others, e.g., Kim and Jung (2014), and Kim et al. (2019), back the *information advantage hypothesis* as they find that domestic institutional investors outperformed foreign investors due to information asymmetry. By examining how geopolitical risk effects investor behavior, we provide important policy implications for South Korean financial markets, which are highly open to global investors. In panel regressions, we examine heterogeneous responses of stock returns, focusing on the above-mentioned hypotheses.

The remainder of the paper is organized as follows. Section 2 describes the construction of the GPRNK index and evaluates the index. Section 3 outlines the empirical framework for estimating the impact of geopolitical risk on stock returns. Section 4 shows the estimation results from the baseline and discusses robustness of the results. Section 5 concludes.

⁶ Bloom (2014) comprehensively summarizes the theoretical channels for uncertainty to influence economic activities.

2. Measuring Geopolitical Risk From Inter-Korea Relations

2.1. Scope of Geopolitical Risk

The scope of geopolitical risk considered in our paper is limited to that which affects the Korean Peninsula and, therefore, that which is closely linked to the unique historical context of the region. Since the end of World War II, South and North Korea have been divided and experienced frequent geopolitical flare-ups, such as military conflict and tensions, but not without periods of détente when there were efforts at seeking a thaw. The interplay of the world's great powers -- the U.S., China, Japan, Russia -- on the Korean Peninsula has also led to a more complex and fluid inter-Korea relationship. Against this background, we identify four major drivers that interact with each other and form the geopolitical landscape of the Korean Peninsula: military conflict/tension, international sanctions against North Korea, bilateral and multilateral talks to seek reconciliation, and, finally, economic cooperation between South and North Korea.

There are two features that we highlight for distinguishing our study from existing ones. First, we take into account both negative and positive factors of geopolitical swings on the Korean Peninsula, to track changes in the general perception of risk. Earlier studies, for instance, Caldara and Iacoviello (2019), define geopolitical risk as the risk associated with various types of geopolitical events affecting the peace in international relations, such as wars, terrorism, and tension between states. However, we note that the inter-Korea relationship has exposed to both upside and downside risks over a long period of time. In order to capture such aspects of an alternating geopolitical landscape, we take a similar approach as seen in Ha et al. (2021) that includes both tension-escalating and peace-seeking geopolitical events in identifying geopolitical uncertainty. Nonetheless, we depart from their approach by employing a textual analysis of news articles that contain keywords identified by various drivers of geopolitical swings.

Second, we pay more attention to economic factors that may contribute to geopolitical swings. This is because geopolitical swings deeply interact with economic consequences. Historically, for example, a series of North Korean military provocations resulted in unilateral and multilateral economic sanctions. Since Kim Jong-Un came into office in 2012, the U.N. Security Council has passed eight resolutions sanctioning North Korea for having developed weapons of mass destruction (WMD) and related activities.⁷ Also, South Korea and the U.S. have significantly tightened economic and financial sanctions to block cash flows into North Korea that can be used for military development. The tightening sanctions sometimes, conversely, induced North Korea to take more aggressive action, aggravating geopolitical tension. Likewise, some bilateral and multilateral negotiations broke through the North Korean nuclear stalemate and facilitated economic cooperation projects with North Korea. The Korean Peninsula Energy Development Organization (KEDO), whose main activity is to construct two nuclear power plants in North Korea, was formed as a result of the Agreed Framework between the U.S. and North Korea in 1994. Inter-Korean dialogue produced key economic cooperation projects, too, like the Gaeseong Industrial Complex and the Mt. Geumgang tours. Although these projects were eventually unsuccessful, they helped ease geopolitical tensions, to some extent.

2.2. Data and Methodology

The news articles used to construct the GPRNK index come from BigKinds (<https://www.bigkinds.or.kr>), a news analysis company established by the Korea Press Foundation.⁸ BigKinds provides analytics of

⁷ United Nations Security Council resolutions (UNSCR) 2087, 2091, 2270, 2370, 2321, 2356, 2371, 2375 and 2397.

⁸ The Korea Press Foundation is a South Korean public institution that promotes quality journalism and supports new technology in the news media. It is established in accordance with the Act on the Promotions of Newspapers.

South Korean news content, in the Korean language, covering approximately 60 million articles across 54 media outlets. The database of news articles can be traced back to 1990, and it is updated in real time. BigKinds allows users to search any keyword of interest within a specific period, and across a selection of media and topics.

We select 18 newspapers and broadcasters that are representative of South Korean media. Among them, 10 are national daily newspapers and five are business or economics newspapers. The remaining three are national broadcasters.⁹ The topics of the news articles are limited to politics, economics, and international relations, to avoid any undesirable noise. We search for certain keywords in the headlines and/or content of the news articles.

We go through five steps in selecting the search keywords. First, we set “North Korea” as a default keyword to pick up any article associated with the geopolitical risk of the inter-Korea relationship.¹⁰ Second, we set up four topic categories, to reflect the main drivers of inter-Korea relations, with a focus on potential economic impacts on South Korea. Those are military tensions, sanctions, talks/agreements, and economic cooperation. Third, we start by a human reading of articles around the time of the major geopolitical events, and list all the keywords on the subjects of those events (the topic) and on the descriptions of the subjects (the action/status).¹¹ Fourth, we list the words that collocate with the topic, but negate the original aspects of the events, and we exclude those from the search keywords. By doing so, we avoid falsely finding articles that report the opposite.¹² Lastly, we finalize the words by iterations of the validation process, to select the ones that recur and that sufficiently cover the geopolitical events in the categories over time. The top panel of Table 1 shows the search keywords translated into English and the bottom panel shows those same words in the Korean original.¹³

⁹ Nationwide newspapers in Korea (10): Chosun Ilbo, Dong-a Ilbo, Joong-ang Ilbo, Kyunghyang Shinmun, Kookmin Ilbo, Munhwa Ilbo, Seoul Shinmun, Segye Ilbo, Hankyoreh, and Hankook Ilbo. Business and economics newspapers (5): Maeil Business Newspaper, Money Today, Seoul Gyeongje, Hankook Gyeongje, and Herald Economy. National broadcasting companies (3): KBS, MBC, and SBS.

¹⁰ Note that South Korean newspapers often use Chinese characters (北, or 北韓) when referring to North Korea.

¹¹ We refer to the geopolitical events provided by the Arms Control Associations and the Ministry of Unification.

¹² Without the fourth step, the index is highly correlated with the benchmark index. See the top panel of Figure A-5 for the trend of the index constructed without this additional screening process.

¹³ One of other important drivers of geopolitical risk in Korea is North Korea's aggressive reaction to the military exercises of South Korea jointly with the U.S. However, the inclusion of the topic “military exercise” makes little change in the frequency of the searched articles because the search query of the “military tension” category may already cover the topic of North Korea's threat in response to joint military exercises. See the bottom panel of Figure A-5 for the trend of alternative indexes, including the keywords “exercise” and “condemn”.

Table 1. Search Keywords

Panel A. Translated (English)					
Category		Topic	Action/Status	Excluded	Number of Articles
Default keywords		North Korea			1,039,297
Negative	Military tensions	(nuclear) or (missile) or (military) or (war)	(threat) or (tension) or (provocation)	(peace)	124,328
	Sanctions	(sanction) or (pressure)	(refute) or (dissent) or (criticize)	-	24,637
Positive	Talks/agreements	(talks) or (dialogue)	(resume) or (agreement) or (negotiation)	(fail) or (break) or (boycott)	124,824
	Economic cooperation	(economic cooperation) or (abbreviation of economic cooperation)	(progress) or (expectation)	(concern)	16,774
Panel B. Original (Korean)					
Category		Topic	Action/Status	Excluded	Number of Articles
Default keywords		North Korea			1,039,297
Negative	Military tensions	(핵) or (미사일) or (군사) or (전쟁)	(위협) or (긴장) or (도발)	(평화)	124,328
	Sanctions	(제재) or (압박)	(반발) or (불복) or (비난)	-	24,637
Positive	Talks/agreements	(대화) or (회담)	(재개) or (합의) or (협약)	(결렬) or (무산) or (거부)	124,824
	Economic cooperation	(경제협력) or (경협)	(추진) or (기대)	(우려)	16,774

Based on the keyword searches, we compute the frequency of news articles in each category and from each news outlet. Let $N_{j,it}$ denote the total number of articles containing the keywords in each category j from media i at time t . The four categories among the search keywords -- military threats, sanctions, talks, and economic cooperation -- can be combined into two, a negative ($N_{neg,it}$) and a positive ($N_{pos,it}$) category. The relative frequency of net negative news articles compared to the total number of news articles that are related to North Korea can be computed as follows:

$$X_{it} = \frac{N_{neg,it} - N_{pos,it}}{N_{it}}$$

where X_{it} denotes the relative frequency of net negative news articles for media i and time t . $N_{neg,it}$ denotes the total number of news articles reporting geopolitical events that could likely increase tension on the Korean Peninsula, and $N_{pos,it}$ is the total number of news articles reporting geopolitical events that could likely decrease tensions. N_{it} is the total number of articles with the default search keyword “North Korea” either in its title or content, for media i and time t . Then we transform X_{it} to have a positive value.¹⁴

$$\widetilde{X}_{it} = \frac{1}{2} \left\{ X_{it} + \sqrt{(X_{it})^2 + 0.1} \right\}$$

Next, for each media outlet, we standardize \widetilde{X}_{it} to obtain a series Y_{it} , with unit standard deviation.

$$Y_{it} = \frac{\widetilde{X}_{it}}{\sigma_i}$$

where σ_i is the time-series within-newspaper standard deviation of \widetilde{X}_{it} from January 1995 to December 2016. The above standardized index can be averaged across media outlets.

$$Y_t = \frac{1}{N} \sum_{i=1}^N Y_{it}$$

where N is the total number of media outlets. Then we normalize Y_t to obtain the index of geopolitical risk associated with the inter-Korea relationship ($GPRNK_t$) with a mean of 100.

$$GPRNK_t = \frac{100Y_t}{\bar{Y}}$$

where \bar{Y} is the mean value of Y_t from 1995 to 2016.

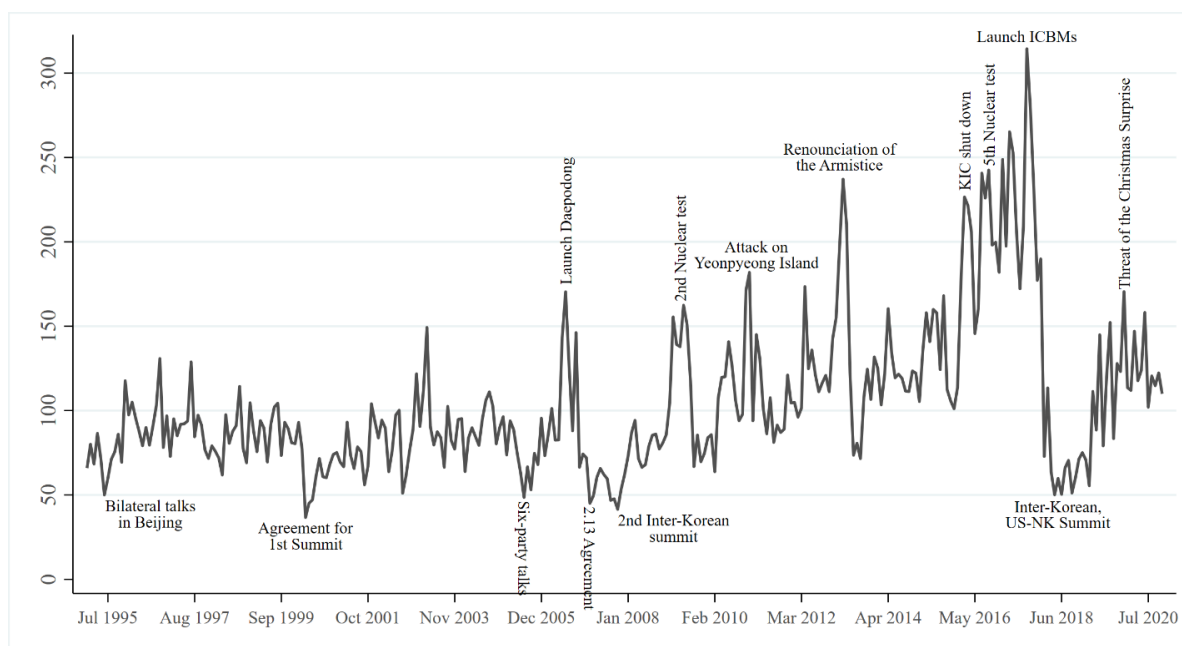
2.3. Evaluating the GPRNK Index

Figure 1 plots the GPRNK index from January 1995 to November 2020. We annotate the key events corresponding to the spikes and the plunges of the GPRNK index. The index sharply increases during the

¹⁴ $f(x) = \frac{1}{2} \{x + \sqrt{x^2 + \alpha}\}$, ($\alpha > 0$) is a monotonic and convex transformation that is asymptotic to the straight line, $y=x$, when x tends to $+\infty$, and to the x -axis ($y=0$) when x tends to $-\infty$. The parameter α determines how fast $f(x)$ approaches the asymptotes. If α is too big, $f(x)$ is not close to x until x is big enough. If α is too small, on the other hand, $f(x)$ does not vary much for $x < 0$. We choose $\alpha = 0.1$ to guarantee that the new series, \widetilde{X}_{it} , has a similar distribution with the relative frequency variables and to generate enough variations of \widetilde{X}_{it} for $X_{it} < 0$.

occurrences of nuclear tests, missile launches, or military confrontations, and it decreases significantly around the times of bilateral or multilateral meetings. The largest spikes in the GPRNK index are seen during the North Korea nuclear/missile crisis of 2017.

Figure 1. The GPRNK Index (1995-2020)



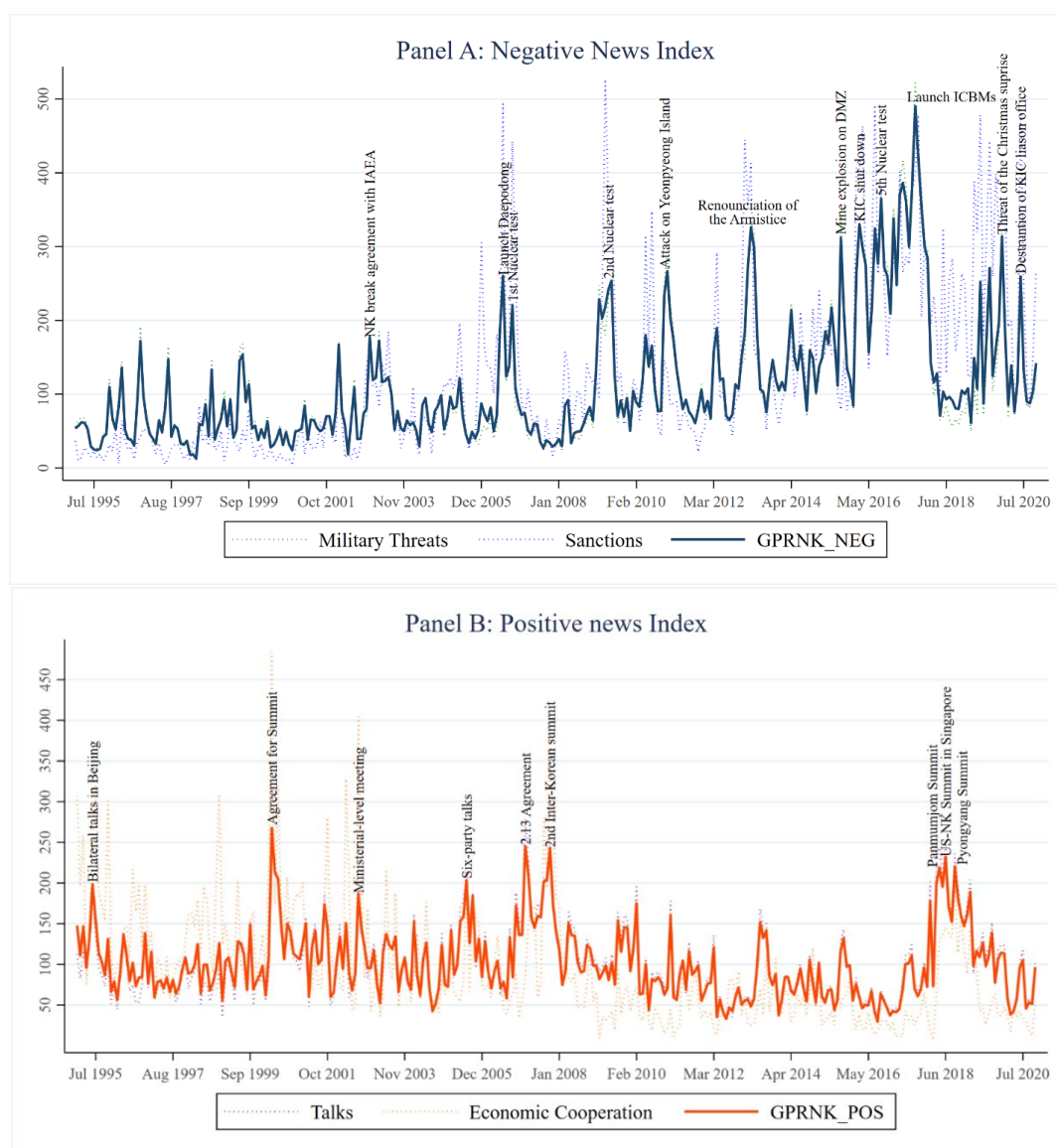
As seen in Figure 2, the negative and positive indices are mostly dominated by the military tension and talks categories.¹⁵ Still, the indices of each category in the positive or negative domain are closely correlated. The correlation coefficient is about 0.69 between the two indices in the negative domain, and 0.43 in the positive domain.

Now, we compare our index with two other existing indices that quantify geopolitical risks from North Korea, and highlight the differences. The top panel of Figure 3 shows the trend of the Korea Peace Index (KOPI) constructed by the Asia-Pacific Research Center at Hanyang University.¹⁶ Based on news articles put out by Yonhap News Agency, the KOPI generates daily scores and a monthly average index to capture fluctuations in inter-Korean relations from January 2005 to September 2012. Like the GPRNK index, it spikes during threatening incidents, such as the Cheonan sinking or the attack on Yeonpyeong Island, and it plummets during the six-party talks or during an inter-Korean summit. However, the KOPI underrates geopolitical tensions caused by North Korea's development of weapons of mass destruction (WMD) because it is based on qualitative ratings for geopolitically meaningful events and weighs the actual geopolitical events more heavily than it does the threats. The correlation is about 0.57, which is significantly positive, but moderate.

¹⁵ The correlation between the negative GPRNK index and the military tension index is 0.99. The correlation between the positive GPRNK index and the talks index is 0.98.

¹⁶ Available at <http://aprc.hanyang.ac.kr>.

Figure 2. The GPRNK Index by Topic

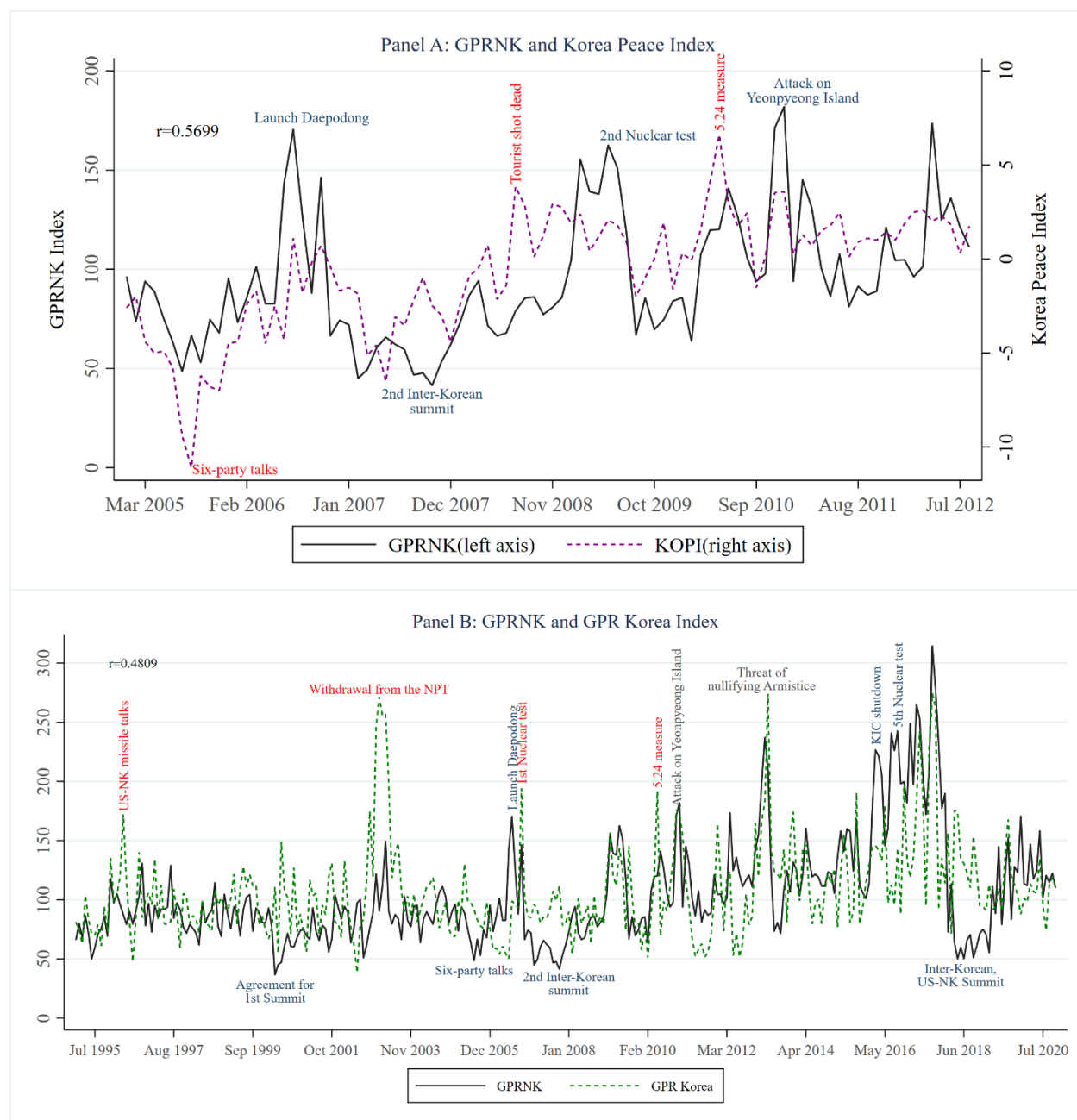


The bottom panel in Figure 3 compares the GPRNK index with the GPR Korea index by Caldara and Iacoviello (2019). The GPR Korea index uses automated text-searches to count the number of articles related to geopolitical risk in Korea. The search query of the GPR Korea index is a mixture of general keywords applicable to worldwide geopolitical risk.¹⁷ So it is suitable for measures of broader geopolitical risks that are of global interest, such as the threat of war, terrorism, or cross-border tensions, but may fail to capture the Korea-specific context, such as nuclear weapons development or bilateral talks. Furthermore, it may only take a perspective centered on the U.S., the U.K., and Canada, as the source of its press coverage is 11 leading English-language newspapers published in those countries. The GPR Korea index peaks around the time of North Korea's withdrawal from the Non-Proliferation Treaty and around the time when North Korea threatened to nullify the 1953 armistice accord, both of which were

¹⁷ The search query at the GPR Korea index is "Korea AND (tensions/risk/fear/chaos/uncertainty/unrest/violence...) AND (military/war/geopolitical/coup/terrorism/warfare/army/terrorism)". For details of the methodology and trends of the GPR Korea index, refer to their website (<https://www2.bc.edu/matteo-iacoviello/gpr.htm>).

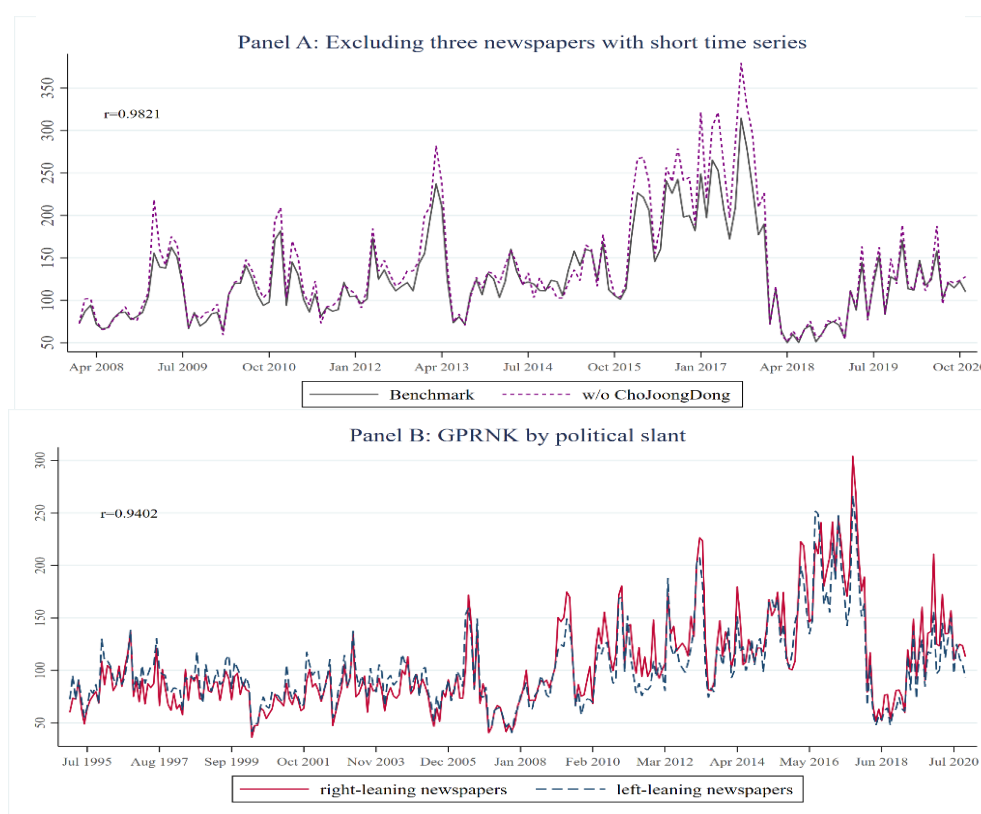
more significant in terms of the landscape of global diplomacy than for the inter-Korea relationship. However, compared with our index, the GPR Korea index is not able to capture important fluctuations in geopolitical risk, including the reduction in geopolitical risk during the summit meetings and the gradual escalation of geopolitical risk in 2016 and 2017. The correlation between the GPR Korea index and the GPRNK index is about 0.48.

Figure 3. Comparing the GPRNK Index with Existing Measures



In Figure 4, we check the robustness of the GPRNK index by examining potential biases due to sample coverage.¹⁸ Media bias may harm the representativeness of our index. If one finds systemic differences in the GPRNK index by a medium's political slant, the index produced by a simple average of individual media could fail to represent the unbiased media attention on North Korea-related issues in South Korea. In particular, our sample coverage for media outlets may raise concerns about selection bias, because three of the most-read and right-leaning newspapers in South Korea have a shorter sample period than the others in the original data source.¹⁹ We check the sensitivity of the GPRNK index to the exclusion of these newspapers (the top panel). We find that the correlation of the benchmark index and the index excluding the three newspapers is 0.98, confirming that the exclusion does not create a significant selection bias. We then compute the subgroup GPRNK indices by political leaning of the news outlet (the bottom panel).²⁰ The index computed from right-leaning newspapers and the one from left-leaning newspapers show close co-movement, with a correlation coefficient of 0.94.

Figure 4. Assessing Potential Selection Bias of the GPRNK Index



Note: The dotted line of the top panel denotes the GPRNK index excluding the newspapers with short time series: Chosun Ilbo (2018-), Dong-a Ilbo (2018-) and Joong-ang Ilbo (2008-).

¹⁸ Our media sample covers 68.9% of total newspaper circulation and 63.6% of total viewership among national broadcast channels. Appendix Table A-1 presents subscription rankings of newspapers in 2012.

¹⁹ The BigKinds database provides news articles from three of the most-read newspapers, with limited periods: Chosun Ilbo (2018-), Dong-a Ilbo (2018-), and Joong-ang Ilbo (2008-).

²⁰ Right-leaning newspapers are the Chosun Ilbo, Dong-a Ilbo, Joong-ang Ilbo, Kookmin Ilbo and Munhwa Ilbo. Left-leaning newspapers are the Kyunghyang Sinmun and Hankyoreh.

3. Empirical Framework

In this section, we introduce the empirical framework to estimate the impact of geopolitical risk on stock returns. In particular, our model is set to identify not only the average effects of geopolitical risk on the stock market, but also differential effects by firm characteristics, and thus shed light on the possible channels through which geopolitical risk shocks are transmitted.

3.1. Estimation Model

We first estimate the impact of geopolitical risk by regressing stock returns on the GPRNK index with firm fixed effects and time-varying aggregate-level control variables.

$$R_{it} = \alpha_i + \beta \cdot GPRNK_t + X_t' \gamma + \varepsilon_{it}$$

where R_{it} is the monthly stock return of firm i at time t , $GPRNK_t$ is our geopolitical risk index, X_t is a vector of control variables with time-series variations: monthly returns of the Dow Jones Industrial Average Index, the nominal exchange rates against the U.S. dollar, a dummy for the Korean financial crisis in 1997-1998, and a dummy for the Global Financial Crisis in 2008-2009. α_i denotes firm fixed effects.

In addition to the baseline, we examine whether the effect of geopolitical risk is still significant after controlling for the effects of two commonly used uncertainty variables: the implied volatility index of the Korean stock market (VKOSPI), and the Korean Economic Policy Uncertainty index (EPU) by Baker et al. (2016).

Next, we focus on the heterogeneous reactions of firm stock returns to geopolitical swings induced by inter-Korean relations. Although recent literature on geopolitical risk shows substantial empirical evidence of average effects on market returns in advanced economies, the heterogeneous effects across firms are still rarely studied.²¹ We run the following regression to test the heterogeneous effects of geopolitical risk across firms.

$$R_{it} = \alpha_i + F_{i,t-1}' \beta_1 + GPRNK_t \cdot F_{i,t-1}' \beta_2 + C_{it}' \beta_3 + \delta_t + \varepsilon_{it}$$

where R_{it} is monthly stock returns of firm i at time t , $GPRNK_t$ is the geopolitical risk index, $F_{i,t-1}$ is the vector of a firm's characteristics, lagged by one month, and C_{it} is a set of control variables. α_i and δ_t denote the firm and time fixed effects. Variables in C_{it} are selected with reference to previous literature on cross-section stock returns: the leverage ratio (Bhandari, 1988), the book-to-market ratio (Fama and French, 1992, 1993; Petkova and Zhang, 2005), and profitability (Basu, 1983; Haugen and Baker, 1996).

We identify the heterogeneous sensitivity of stock returns to geopolitical risk by including the interaction terms of the GPRNK with firm-specific characteristic, such as the degree of investment irreversibility, foreigners' stock investment, firm size, involvement in economic cooperation with North Korea, and whether or not a firm is in the defense industry.²²

²¹ Berkman et al. (2011) find that changes in rare disaster risk have large negative effects on stock returns. Caldara and Iacoviello (2019) also report that geopolitical risks depress stock returns significantly.

²² For each firm-level sensitivity measure, we use lagged variables in order to avoid the reverse causality problem. We also use the means over sample period, similar to Baker et al. (2016), which uses the revenue-weighted industry-level government purchase ratio averaged across time periods as a proxy for firm-level exposure to government policy uncertainty. The results are not materially different from our baseline and are available upon request.

The degree of investment irreversibility can be linked to a firm's investment decisions. As the real options theory suggests, firms with a high level of investment irreversibility may delay investment when uncertainty is high (Dixit and Pindyck, 1994; Bloom et al. 2007; Gulen and Ion, 2015). The delays in investment due to geopolitical risk can weaken a firm's growth outlook, leading to a decline in stock prices. In order to capture the irreversibility of investment, we use the fixed assets (property, plants, and equipment) to total assets ratio. Firms with a large proportion of fixed assets compared to their total assets could be more sensitive to geopolitical risk from North Korea, as these investments cannot be easily undone.²³

Foreigners' share of stock investment could be associated with stock returns in response to geopolitical risk. The literature surrounding international portfolio investment suggests two contrasting views as to the response of international investors to country-specific geopolitical risk relative to that of domestic investors. The home bias literature argues that foreign investors are likely to be reluctant to hold high-risk assets, and that they perform worse than domestic investors due to information asymmetry (Kang and Stulz, 1997; Hau, 2001; Choe et al., 2005; Kim et al. 2019). On the other hand, foreign investors may have advantages in managing investment portfolios across different markets, and may be willing to hold risky assets in order to benefit from international risk diversification (Solnik, 1974; De Santis and Gerard, 1997; Gerlach and Yook, 2016). Foreign participation in the South Korean stock market amounted to 33.6% of the total market capitalization in 2017, and the share of foreign holdings varies substantially across firms.²⁴ We hypothesize that if information disadvantage is the main driving factor making trading behavior of international investors different from domestic investors, international investors would be more likely to be net sellers during periods of high geopolitical risk. Thus, the stock returns of firms with a large fraction of foreign ownership would be lower. On the other hand, if the international investors' main motivation is diversification, they have the advantage of bearing the risks from geopolitical swings, and thus stock returns would be higher for those with higher foreign ownership when geopolitical risk increases.

Firm size can play a role in determining the impact of geopolitical risk on stock returns. There is empirical evidence that industries dominated by small firms in the U.S. respond more to uncertainty shocks. The higher sensitivity to uncertainty for these firms is mainly due to their lending constraints (Ghosal and Loungani, 2000). On the other hand, recent studies propose that large firms can respond more negatively to uncertainty shocks because of insufficient internal funding (Byun and Jo, 2018). We examine the relationship between firm size and the magnitude of the response of stock returns to geopolitical risk in Korea.

Involvement in economic cooperation with North Korea or the defense industry is another commonly used determinant of the geopolitical risk effect in the context of South Korean equity markets (Kim and Jung, 2014). Inter-Korean economic cooperation, first allowed after the July 7 Declaration in 1988, has been continuously growing in size, and has expanded across sectors, such as tourism, fabric processing, and infrastructure. Many South Korean firms have been participating in economic cooperation with North Korea, including those at the Kaesong Industrial Complex (KIC) before it was indefinitely shut down in the

²³ We acknowledge that using the fraction of fixed assets as a proxy variable to examine the role of investment irreversibility should be taken cautiously, as Kim and Kung (2017) document. The liquidation costs of fixed assets may not be high when such assets can be easily resold in the market. Thus, a firm that has a large fraction of this kind of redeployable asset is likely to face low irreversibility of investment. See Kim and Kung (2017) for the measures of asset redeployability and the estimation of uncertainty effect through this channel.

²⁴ At the end of 2017, about half of the 2,313 KRX-listed stocks have foreign ownership of less than 2%, while 5% of them have more than 32% foreign ownership. Since foreign ownership is positively correlated with the size of market capital, foreign investment tends to be concentrated on the small number of big companies in South Korea.

aftermath of the fourth nuclear test. As inter-Korean tensions tighten or loosen, investors may expect these businesses to fail or flourish. We test the hypothesis that an increase in the GPRNK index would reduce stock returns at firms involved in economic cooperation with the North. Similarly, we test whether investors expect the South Korean defense industry to expand, and thus stock returns of these firms increase in response to an increase in geopolitical risk.

3.2. Data

Our empirical analysis is based on information about 3,251 South Korean non-financial companies between 1996 to 2019. We use stock market data from DataGuide provided by Fnguide, and accounts data from KIS Value provided by National Information & Credit Evaluation (NICE). The variables used in our regressions are described in Table 2.

The original sample covers every firm once listed on the Korea Exchange (KRX) during the sample period. In order to reduce the possibility that the regression results are driven by a small number of extreme observations, we set screening procedure that restricts the sample according to the following criteria. First, we exclude firms observed during less than 10% of the sample period. Second, we drop firms that experienced any capital impairment. Third, we also eliminate observations that record operational losses exceeding the value of total assets. As a result, the final sample includes 2,467 firms.

Table 2. Variable Description

Variable	Description	Source
Stock Returns	Log difference in last day's revised stock price between period t and period t-1	DataGuide
Price-to-Book Ratio (PBR)	The ratio of share price to book value per share at the end of month.	DataGuide, KisValue
Foreigner Ownership	The proportion of foreigner's share in market capital.	DataGuide
Asset Size	Log of total value of asset at the end of quarter.	KisValue
Return on Assets (ROA)	The ratio of operating profit to total asset value	KisValue
Fixed-to-Total Assets	The ratio of fixed capital to total asset value	KisValue
Leverage Ratio	The ratio of total debt to market capitalization	KisValue
Economic Cooperation ¹	Dummy variable indicating involvement in economic cooperation	Kim and Jung (2014)
Defense	Dummy variable indicating business related to defense industry	Kim and Jung (2014)

Notes: 1. The appendix Table A-2 presents the list of stocks related to economic cooperation with North Korea. We collected this list from previous literature (Kim and Jung, 2014), and from Korea Investment Securities.

Table 3 presents the summary statistics of the variables and compares their mean values during high-GPRNK periods and low-GPRNK periods. The sample average of monthly stock returns is -0.7% over the whole sample period, which turns into -0.9% when the GPRNK index is greater than 100, and -0.4% when the index is below 100. However, this does not necessarily mean that high geopolitical risk moves up average stock returns. As an economy highly dependent on exports, stock returns in South Korea are mainly affected by external economic conditions, and they show close co-movements with U.S. stock markets. Therefore, the average effect of geopolitical risk on stock returns estimated by adding other controls in the next section provides a more comprehensive picture.

Table 3. Summary Statistics

	Mean	SD	Min	Max	Obs	High GPRNK		Low GPRNK	
						Mean	SD	Mean	SD
Log(GPRNK)	4.619	0.409	3.600	5.751	400,818	.	.	.	.
Log(GPRNK_POS)	4.528	0.437	3.388	5.590	400,818	.	.	.	.
Log(GPRNK_NEG)	4.621	0.678	2.508	6.194	400,818	.	.	.	.
Log(EPU)	4.769	0.502	3.110	6.288	400,818	4.907	0.475	4.645	0.494
Log(VKOSPI)	2.921	0.360	2.365	4.398	329,356	2.794	0.328	3.075	0.336
Stock return	-0.007	0.202	-5.306	2.381	400,818	-0.009	0.219	-0.004	0.180
Foreigner ownership	0.065	0.118	0.000	0.998	400,307	0.063	0.118	0.067	0.118
Log(asset size)	25.554	1.468	19.887	33.020	399,426	25.412	1.480	25.713	1.438
Fixed-to-total	0.517	0.194	0.000	1.000	399,139	0.506	0.192	0.528	0.196
Log(PBR)	-0.016	1.064	-4.605	11.486	392,557	-0.111	1.164	0.088	0.930
RoA	0.036	0.100	-0.977	0.935	399,384	0.038	0.105	0.033	0.092
Leverage ratio	0.282	0.194	0.000	0.996	397,739	0.306	0.202	0.255	0.181

4. Results

4.1. Baseline Results

In this section, we present the baseline results from the regressions. Column (1) of Table 4 shows the estimated coefficient from regressing firm-level stock returns on the GPRNK index with time-varying controls and firm fixed effects. The coefficient of the GPRNK is statistically significant and suggests that a one log point increase in geopolitical risk reduces the stock returns by 0.0068%p on average. A decrease in the GPRNK index by a magnitude of what we have seen from 2017 to 2018 (123 log points, approximately equivalent to three standard deviations) is associated with an increase in monthly stock returns of 0.83%p on average, controlling for other factors.

Following prior studies that stress the negative relationship between stock returns and market volatility (French et al., 1987; Haugen et al., 1991) or between stock returns and economic policy uncertainty (Baker, Bloom, Davis, 2016), we additionally include these variables in our regressions. After controlling for market uncertainty measured by the implied volatility of the stock market (VKOSPI) in Column (2), the adverse impact of geopolitical risk becomes larger than that of the baseline, i.e., the absolute value of the estimated coefficient increases from 0.0068 to 0.0158.²⁵ This implies that the GPRNK index is likely to be negatively correlated with the VKOSPI, potentially picking up geopolitical risks that cannot be captured by the VKOSPI that measures broader market risks.²⁶ Given that geopolitical risks tend to be short-lived shocks, the implied volatility of the stock price in monthly frequency may not be able to appropriately identify the fluctuations in geopolitical risk. The coefficient on the VKOSPI is also negative and highly significant, implying that a one log point increase in VKOSPI is associated with downward shift of 0.0158%p in average stock returns.

²⁵ The VKOSPI index has been reported since 2003, thus the sample period of regressions with the control of the VKOSPI is shorter. When we set the sample period of Column (1) to start from 2003, the coefficient becomes greater than that from the full sample period regressions, but still below than that of Column (2).

²⁶ See the top panel of Figure A-4.

In Column (3), the coefficient on the GPRNK index is still estimated to be negative and significant after adding the EPU index into the regression. Unlike the specification of adding the VKOSPI index, the negative effect of geopolitical risks becomes less pronounced than that of the baseline model, i.e., the absolute value of the estimated coefficient decreases from 0.0068 to 0.0019. This suggests that the correlation between the GPRNK index and the EPU index is positive. Although the two indices measure different aspects of the perception of risk or uncertainty, there are periods where both the GPRNK index and the EPU index increase by large amounts.²⁷ The magnitude of the effects of economic policy uncertainty is larger than that of geopolitical uncertainty. This is potentially because heightened economic policy uncertainty may affect the outlook of overall economic activities and change stock valuations more substantially than geopolitical shocks do. In Column (4), we pool the GPRNK index, the VKOSPI, and the EPU index into one equation. The negative effects of the three different sources of uncertainty are still significant under this specification.

Finally, in Column (5), we add the global GPR index and the global EPU index, considering the high dependence of the Korean economy on international trade and on foreign investment. The results are in line with those in Column (4), except that the coefficient on the EPU (Korea) index is estimated to be insignificant.

Table 4. GPRNK and Firms' Stock Return: Average Effects

Measure of Uncertainty	(1)	(2)	(3)	(4)	(5)
Log(GPRNK)	-0.0068*** (0.0007)	-0.0158*** (0.0009)	-0.0019** (0.0007)	-0.0140*** (0.0009)	-0.0148*** (0.0009)
Log(VKOSPI)		-0.0158*** (0.0012)		-0.0134*** (0.0012)	-0.0266*** (0.0014)
Log(EPU)			-0.0225*** (0.0007)	-0.0204*** (0.0008)	0.0017 (0.0011)
Log(Global GPR)					0.0020*** (0.0007)
Log(Global EPU)					-0.0382*** (0.0014)
Other controls (aggregate level)	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	400,818	329,356	400,818	329,356	329,356
Number of firms	2,467	2,402	2,467	2,402	2,402
Adjusted R2	0.0397	0.0337	0.042	0.0352	0.0374

Notes : The dependent variable is monthly stock return. The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard errors clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. Every coefficients represent the effect of 1 log-point increase of the uncertainty measure on stock returns. We control monthly return in Dow Index and Won-Dollar exchange rate, global financial crisis and the Korean foreign currency crisis dummy variables. The sample covers 1996m2~2019m12 in column(1) and (3), 2003m1~2019m12 in column(2), (4) and (5).

²⁷ For example, in 2016, the EPU index increased due to Brexit and the impeachment trial of former President Park, while the GPRNK index also surged reflecting an escalation in North Korea's nuclear threats. See the bottom panel of Figure A-4.

In Table 5, we test whether there are differential effects of geopolitical risk across firm characteristics. We add time fixed effects to control unobserved common factors that affect stock returns in each period. The $\log(\text{GPRNK})$ drops out, as it is collinear with the time dummies. We also control the price-to-book value ratio, the leverage ratio, and the ROA.

Columns (1) to (5) show the results testing the key hypotheses separately. In Column (1), we find evidence that firms with a large share of foreign investors have relatively higher stock returns when geopolitical risk is high. When the GPRNK index increases by one log point, a firm that has a one-standard-deviation-larger share of its equity owned by foreigners would have higher stock returns of 0.0034%p. The findings support the prediction of international diversification hypothesis, where foreign investors benefit from holding internationally diversified portfolios and are able to bear country-specific geopolitical risk (Gerlach and Yook, 2016; Bouras et al., 2019).²⁸ Another possible explanation is that foreign investors, presumably more sophisticated investors, might be react less sensitively to the geopolitical risk, given that the previous threat of North Korea ended up being resolved rather than leading to war crisis. Previous studies indicate that the effects of the North Korea's nuclear risk on asset prices were large in the early period of nuclear development and became subdued in the later period (Kim and Jung, 2014; Hun and Pyun, 2018; Park and Park, 2020). There is also some historical evidence on the different reactions of Investors to the war threat and the start of war. The stock prices of European market exhibit mean-reversion when the news on war threat increases and show a negative drift after the outbreak of war (Verdict, 2020). So, the positive coefficient may show habituation learning in foreign investor's assessment about North Korea risk.

In Column (2), the coefficient on the GPRNK interaction with asset size is estimated to be negative, but statistically insignificant. Column (3) shows that the coefficient on the interaction with the ratio of fixed asset total asset is significantly negative, suggesting that geopolitical tension with North Korea has more negative effects on firms with a large share of fixed assets. We find that the negative effect of a one log point increase in the GPRNK index on stock returns is 0.0017%p bigger for a firm with a one-standard-deviation-greater share of fixed assets.

In Columns (4) and (5), we estimate the differential effects of the GPRNK index on stock returns by whether a firm is involved in economic cooperation with North Korea or in the production of defense goods. As anticipated, geopolitical risk negatively affects stock returns at firms involved in economic cooperation. A one log point increase of the index reduces the stock returns of such firms by 0.0142%p relative to those of non-involved firms. On the other hand, firms in the defense industry do not show any significant impact in stock returns in response to geopolitical risk.

Next, in Column (6), we pool all of the interaction terms into one regression. The estimates are similar with previous results in the signs and statistical significance, but the coefficient of the GPRNK interaction with total assets becomes significant and about four times larger in absolute value. The coefficient on interaction with the share of foreign ownership also becomes about twice as large. This suggests a positive correlation between a firm's asset size and foreign ownership. Foreign investors participating in the South Korean stock market have preferred large firms, presumably due to information asymmetries (Suh, 2007).²⁹

²⁸ Bouras et al. (2019) study the role of global and country-specific geopolitical risk in the emerging markets and find that country-specific GPR do not have a significant effect on stock market while global GPR significantly increases stock price volatility.

²⁹ Foreign ownership is also positively correlated with the size of market capital. When we replace the term $\log(\text{GPRNK}) \times \log(\text{asset})$ with $\log(\text{GPRNK}) \times \log(\text{market capitalization})$, the coefficients are estimated to be very similar with those in baseline results.

Table 5. GPRNK and Firms' Stock Return: Differential Effects by Firm Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
Log(GPRNK) * foreigner ownership	0.0034*** (0.0009)					0.0060*** (0.0010)
Log(GPRNK) * log(asset)		-0.0005 (0.0008)				-0.0023** (0.0010)
Log(GPRNK) * fixed asset/total asset			-0.0017** (0.0007)			-0.0019** (0.0008)
Log(GPRNK) * fcoop dummy				-0.0142*** (0.0028)		-0.0142*** (0.0028)
Log(GPRNK) * defense dummy					-0.0039 (0.0035)	-0.0041 (0.0033)
Foreigner ownership	-0.0216*** (0.0040)					-0.0312*** (0.0047)
Log of asset size		-0.0226*** (0.0039)				-0.0127*** (0.0048)
Fixed asset/total asset			0.0062* (0.0035)			0.0076** (0.0038)
Other controls (firm level)	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	391,666	392,085	391,824	392,085	392,085	391,405
Number of firms	2,426	2,426	2,426	2,426	2,426	2,426
Adjusted R2	0.1685	0.1693	0.1682	0.1682	0.1681	0.1696

Notes : The dependent variable is monthly stock return calculated based on log differntiation. The figures in the table are fixed effect OLS coefficients and the figures in the parentheses are robust standard erros clustered at the firm level. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. The coefficients on cross-product terms represent the interaction effects of 1 log-point increase of the GPRNK index. Foreigner ownership, log(asset) and fixed-to-total asset ratio are standardized to have unit standard deviation. We control Price-to-book value ratio, leverage ratio, ROA. The sample covers 1996m2~2019m12

The impacts of geopolitical risks are estimated differently across various firm characteristics. An increase in the GPRNK by two standard deviations is associated with an increase in stock returns of 0.49%p for a firm with a one-standard-deviation-larger amount of shares owned by foreigners, a decrease of 0.19%p for a firm with a one-standard-deviation-larger amount of assets, a decrease of 0.16%p for a firm with a one-standard-deviation-larger share of fixed assets, and a decrease of 1.16%p for a firm involved in economic cooperation with North Korea.

Table 6 shows the regression results from various types of the GPRNK index. In Column (1), we use the index calculated using negative news only. The coefficients of interaction term are estimated to be similar with the regression results using our benchmark GPRNK index, but the interaction with asset size becomes smaller and statistically insignificant. Column (2) shows the regression results using the positive news index. The coefficients are statistically significant and the signs of the estimated coefficients on the interaction terms become opposite of the regression results from the benchmark GPRNK index. These results lend plausibility to our strategy of using both negative and positive news to construct the GPRNK

index. The absolute values of the magnitude of the estimated coefficients are larger in the regression of the positive GPRNK index, implying the asymmetric effects of geopolitical risk.

Columns (3) to (6) in Table 6 show the regression results of the impact of geopolitical risks using four different types of GPRNK index, separately. We find that firms with a large share of foreign ownership exhibit positive returns in response to news about military threats or sanctions, and negative returns in response to news about dialogue or economic cooperation with North Korea. The effects by firm asset size are insignificant, except for the index of “talk” category. The interaction terms with the fixed-to-total assets ratio are estimated to be positive for the two category specific measures of “good news” and negative for the index of “sanctions” category. We also find that stock returns of firms involved in business with North Korea show sensitive reaction to the category-specific measures of geopolitical risk, except for news on “sanctions”. Overall, the estimates with category-specific indexes are consistent with the results in Table 5.

Table 6. GPRNK and Firms' Stock Return: Result with Subtopic Indices

	Subtopic index					
	(1) Negative news	(2) Positive news	(3) Military threat	(4) Sanctions	(5) Talks	(6) Economic Cooperation
Log(Index) * foreigner ownership	0.0020*** (0.0006)	-0.0054*** (0.0009)	0.0019*** (0.0006)	0.0012** (0.0005)	-0.0047*** (0.0009)	-0.0018*** (0.0006)
Log(Index) * log(asset)	-0.0004 (0.0006)	0.0018* (0.0009)	-0.0000 (0.0006)	-0.0004 (0.0005)	0.0022** (0.0009)	0.0001 (0.0006)
Log(Index) * fixed asset/total asset	-0.0009* (0.0005)	0.0025*** (0.0008)	-0.0007 (0.0005)	-0.0014*** (0.0004)	0.0025*** (0.0007)	0.0010** (0.0005)
Log(Index) * ecoop dummy	-0.0040** (0.0018)	0.0140*** (0.0026)	-0.0041** (0.0017)	-0.0017 (0.0013)	0.0135*** (0.0025)	0.0044*** (0.0017)
Log(Index) * defense dummy	-0.0014 (0.0020)	0.0045 (0.0035)	-0.0018 (0.0018)	-0.0013 (0.0021)	0.0051 (0.0038)	-0.0014 (0.0016)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	391,405	391,405	391,405	391,405	391,405	391,405
Number of firms	2,426	2,426	2,426	2,426	2,426	2,426
Adjusted R2	0.1696	0.1695	0.1695	0.1695	0.1696	0.1695

Notes : Robust standard errors are in the parentheses. Every estimate represents the interaction effect of 1 1 log-point increase of the subtopic index. Foreigner ownership, log(asset) and fixed-to-total asset ratio are standardized to have unit standard deviation. All column include firm and time fixed effects. Price-to-book value ratio, leverage ratio, ROA are included as control variables. The first order terms of firm-level sensitivity measures are also included. The sample covers 1996m2 ~ 2019m12.

In Table 7, we compare our baseline results with those using alternative measures of geopolitical risk. Column (2) replaces our index with a simple measure calculated by the relative frequency of North Korea-related articles compared to the total number of articles. In doing so, we test whether any media exposure about North Korea, regardless of the contents of the article, capture the geopolitical risks and affect South

Korean stock markets.³⁰ The coefficients on the interaction with asset size, share of fixed assets to total assets, and economic cooperation are estimated to be significant, but the signs are opposite to the baseline results. This suggests that such a simple measure may fail to distinguish the risks of the two different domains—upside or downside—as higher media exposure on a North Korean topic might mean either upside or downside risks. This evidence further highlights the advantage of using a net negative index as a measure of geopolitical risk.

Table 7. Regression Results with Alternative Measures

	Index of Geopolitical Risk		
	(1) GPRNK Benchmark	(2) NK-to-All Index	(3) GPR Korea Index
Panel A : Average Effects			
Log(Index)	-0.0068*** (0.0007)	-0.0207*** (0.0008)	-0.0165*** (0.0008)
Other controls (aggregate level)	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Number of observations	400,818	400,818	400,818
Panel B : Differential Effects			
Log(Index) * foreigner ownership	0.0060*** (0.0010)	-0.0011 (0.0010)	0.0035*** (0.0010)
Log(Index) * log(asset)	-0.0023** (0.0010)	0.0026** (0.0010)	0.0002 (0.0011)
Log(Index) * fixed asset/total asset	-0.0019** (0.0008)	0.0015* (0.0009)	-0.0000 (0.0009)
Log(Index) * ecoop dummy	-0.0142*** (0.0028)	0.0056** (0.0028)	0.0027 (0.0029)
Log(Index) * defense dummy	-0.0041 (0.0033)	-0.0026 (0.0042)	0.0037 (0.0046)
Other controls (firm level)	Yes	Yes	Yes
Firm and time fixed effect	Yes	Yes	Yes
Number of observations	391,405	391,405	391,405

Notes : Robust standard errors are in the parentheses. Every estimate represents the interaction effect of 1.1 log-point increase of the GPR measure. Foreigner ownership, log(asset) and fixed-to-total asset ratio are standardized to have unit standard deviation. All regressions include firm fixed effects and the bottom panel also include time fixed effect. The first order term of firm-level sensitivity measures are also included in the bottom panel.

In Column (3), we use the GPR Korea index proposed by Caldara and Iacoviello (2019). The coefficient on the interaction with foreign ownership is similar to that of our GPRNK index, but interactions with the other sensitivity variables are not significant. The insignificant estimate for the economic cooperation interaction term suggests that the GPR Korea index may not capture upside risks coming from

³⁰ Using this type of measure, Kim et al. (2019) estimate the effects of geopolitical risk on investor's trading behavior in South Korean markets. However, the sample period of this study was limited to 2015 to 2017, when tension-escalating events dominated the news on North Korea. If the sample period were expanded, one might find the opposite results under the same framework.

geopolitical swings related to the inter-Korea relationship, as the index intends to measure more broader geopolitical risks, mainly focusing on downside risks from tension-increasing events.

4.2. Robustness

In this section, we check the robustness of our regression results with a wide range of restricted samples, by firm and by period.³¹ First, Column (1) of Table 8 considers the possibility that firms delisting can affect stock returns and have systemic correlations with sensitivity to external shocks. So we eliminate observations from companies that have been delisted as of 2019. In Column (2), the sample is limited to manufacturing firms because stock return volatility in the service sector is likely to be greater than that of manufacturing, and the estimation results might be driven by the service sector. We find our main results to be robust under these restricted samples by firm.

In Column (3), we remove December and January observations each year, considering the seasonality of stock returns and the well-known year end and New Year's effects. The estimates keep the signs and statistical significance of the main results. Column (4) presents the results excluding the extreme values in the dependent variables. The estimates are in line with the baseline results. In column (5) and (6), we separate the whole sample into the periods of positive market returns and negative market returns. The effect is more prominent and consistent with the main results in the periods with positive market returns than those with negative market returns.

Columns (7) and (8) check whether the main results change with more recent samples. After experiencing the Asian financial crisis and the burst of the IT bubble in the early 2000s, the South Korean stock market has grown stably since the mid-2000s. To rule out variations in stock returns from financial market instability before the 2000s, we restrict the sample period by including observations from 2003 in Column (7). The results are not essentially different from the baseline results, but the coefficient on the share of fixed assets becomes smaller and statistically insignificant. Column (8) restricts the sample period to only after 2012, when the number of smartphone users first exceeds 50% of the population.³² In South Korea, internet portal sites, such as Naver and Daum, act as major online news platforms, and their influence has expanded with the wide use of smartphones. The interaction coefficients in Column (8) are only significant for foreign ownership and the economic cooperation dummy.

³¹ In Section 2 of the Appendix, we present additional robustness results, controlling for interaction with other uncertainty measures and GPRNK measures from wider windows.

³² <http://www.gallup.co.kr/gallupdb/reportContent.asp?seqNo=943>

Table 8. Robustness Check : Results from Restricted Sample

	(1) Exclude delisted firms	(2) Manufacturing	(3) Exclude Jan and Dec	(4) Exclude extreme DV	(5) Market Return>0	(6) Market Return<0	(7) Year>=2003	(8) Year>=2012
Log(GPRNK) * foreigner ownership	0.0052*** (0.0009)	0.0044*** (0.0012)	0.0057*** (0.0011)	0.0054*** (0.0009)	0.0063*** (0.0014)	0.0062*** (0.0016)	0.0052*** (0.0011)	0.0046*** (0.0017)
Log(GPRNK) * log(asset)	-0.0058*** (0.0008)	-0.0010 (0.0013)	-0.0030*** (0.0011)	-0.0054*** (0.0008)	0.0013 (0.0013)	-0.0078*** (0.0016)	-0.0031*** (0.0011)	0.0004 (0.0011)
Log(GPRNK) * (fixed asset/total asset)	-0.0017** (0.0007)	-0.0026** (0.0011)	-0.0017* (0.0009)	-0.0014** (0.0006)	0.0001 (0.0010)	-0.0048*** (0.0013)	-0.0008 (0.0008)	-0.0004 (0.0009)
Log(GPRNK) * ecoop dummy	-0.0180*** (0.0030)	-0.0134*** (0.0029)	-0.0131*** (0.0030)	-0.0152*** (0.0030)	-0.0190*** (0.0035)	-0.0084* (0.0043)	-0.0175*** (0.0031)	-0.0245*** (0.0039)
Log(GPRNK) * defense dummy	-0.0062** (0.0031)	-0.0072* (0.0041)	-0.0015 (0.0034)	-0.0043 (0.0031)	-0.0032 (0.0042)	-0.0057 (0.0059)	-0.0062* (0.0034)	-0.0030 (0.0045)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	331,168	256,464	326,679	390,336	216,128	175,277	325,513	165,060
Number of firms	1,836	1,598	2,426	2,426	2,426	2,426	2,379	2,012
Adjusted R2	0.2074	0.1752	0.1603	0.2056	0.1036	0.1574	0.1357	0.1248

Notes : Every estimate represents the effect of 1 log-point increase of GPRNK index. All column include firm and time fixed effects. Price-to-book value ratio, leverage ratio, ROA are included as control variables. The first order term of firm-level sensitivity measures are included in the regressions. We exclude items that have been delisted as of Dec. 2019 in column (1). The sample is restricted to manufacturing companies in column (2). We drop December and January observations in column (3). Column (4) restrict sample so that the dependent variable have range from -100 log-point to 100 log-point. Column (5) and (6) separate sample into periods with positive and negative market return. In column (7) and (8) the sample is restricted to the periods after 2003 and 2012, respectively.

5. Conclusion

We develop a new measure of geopolitical risk in the context of inter-Korean relations. Compared to existing measures of geopolitical risk, our index focuses more on country-specific risk factors and captures the fluctuations in geopolitical risk by accounting for both tension-increasing and tension-decreasing moments. It comprehensively includes North Korea-related issues, such as the threat of war, the development of WMDs, sanctions, talks and economic cooperation.

The GPRNK index indicates that geopolitical tension on the Korean Peninsula was at its peak during the North Korea nuclear missile crisis of 2017. The index also sharply increases with the occurrence of nuclear tests, missile launches, and military aggression from the North. Conversely, the agreement to hold the first inter-Korean summit eased tensions most dramatically. The index also drops around the time of bilateral or multilateral talks.

In the firm-level regressions, we find that heightened geopolitical risk stemming from inter-Korea relations depresses stock returns in South Korea, especially for firms with a larger share of domestic investors, firms with a higher share of fixed assets compared to their total assets, and for firms that are involved in inter-Korea economic cooperation. Our results suggest that irreversibility of investment and international portfolio diversification are important mechanisms in explaining a firm's stock price reaction to country-specific geopolitical risk.

Our work is expected to extend the existing literature by providing an interesting case of measuring country-specific geopolitical risk. It can also deepen understanding of the reaction of South Korean markets to geopolitical swings by estimating differential effects by firm-specific characteristics.

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Appendices

A.1 Details of Media Sample of GPRNK Index

Before the construction of the GPRNK index, we performed an audit study to list keywords that indicate an escalation or reduction in geopolitical tension in Korea. We read articles published in South Korea around the time of major geopolitical events. Figure A-1 shows some newspaper front pages on the dates of key events associated with swings in inter-Korean relations.

Our selection of media samples is based on popularity. Table A-1 shows the subscription numbers of newspapers in 2012. We include the top 10 daily newspapers and the top five business or economic-focused magazines by paid subscriber numbers.

A.2. Additional Robustness Checks

In this appendix section, we discuss additional robustness tests of the firm-level regression results. First, we check the selection issue for “economic cooperation”. The list of firms on Table A-2 is from Kim and Jung (2014), and those used by Korea Investment Securities. Some of these firms seem to be on the list because their stock returns soared during times of great expectations for economic cooperation, which can induce an endogeneity problem. Thus, we check this concern by restricting the economic cooperation dummy to those that once participated in business with North Korea, the companies named in the shaded cells. The results are very similar to the baseline regression of Table 5, although the coefficient of GPRNK interaction with economic cooperation is slightly smaller.

Table A-1. Ranking of Korean Newspapers by Paid Subscription (2012)

Ranking	Name	Circulation	Paid Subscription
1	Chosun Ilbo	1,769,310	1,325,555
2	Joongang Ilbo	1,292,498	916,770
3	Dong-a Ilbo	1,060,760	753,237
4	Maeil Business	836,316	554,922
5	The Korea Economic Daily	517,193	349,765
6	The Farmer's Newspaper	306,174	301,123
7	Sports Chosun	304,888	240,606
8	Hankyoreh	269,174	210,098
9	The Daily Sports	263,632	183,409
10	Kyunghyang Shinmun	232,660	176,202
11	Hankook Ilbo	263,718	168,378
12	Kukmin Ilbo	206,035	147,848
13	Sports Seoul	201,145	142,572
14	Sports Dong-a	191,749	141,543
15	Munhwa Ilbo	174,525	140,359
16	Seoul Shinmun	163,713	110,195
17	Segye Ilbo	85,865	60,529
18	Seoul Economic Daily	85,878	59,838
19	Sports Kyunghang	79,628	57,846
20	Money Today	84,086	56,771
21	Electronic Times	63,000	51,308
22	Naeil Shinmun	60,849	42,166
23	Herald Business	56,652	36,645
24	The Asia Business Daily	29,578	22,393
25	The Korea Herald	33,039	21,514

Table A-2. Firms Involved in Economic Cooperation with North Korea

ACEBED	EMERSON PACIFIC	ILSUNG CONSTRUCTION	PAN-PACIFIC CO.,LTD
ASIA AGRICULTURAL MACHINERY	EUGENE Corp.	IN THE F	PULOON Technology Inc.
BOSUNG POWER	GAON CABLE CO.,LTD	INZI CONTROLS CO.,LTD	ROMANSON
BUSAN INDUSTRIAL, CO. LTD.	GEUMHWA PSC	JAEOYOUNG SOLUTEC	SAMBU
CHEIL INDUSTRIES INC	GOODPEOPLE	JAHWA ELECTRONICS CO.,LTD	SAMCHULY BICYCLE
CHERYONG	GREENCROSS	KOLON CORPORATION	SAMHYUN STEEL, CO., LTD.
CHERYONG ELECTRIC	GS CONSTRUCTION	KOREA ELECTRIC POWER CORPORATION	SAMSUNG C&T
CHOBİ	HAEIN	KOREA ELECTRIC TERMINAL CO.,LTD	SEMYUNG ELECTRONIC
CN PLUS	HALIM	Korea Engineering Consultants Corp.	SEOJEON Electric Machinery CO, LTD
DAEATI Co.,Ltd.	HANIL HYUNDAI CEMENT CO.,LTD.	KOREA PETROLEUM GROUP	SEONDO ELECTRIC
DAEDONG STEEL, INC.	HANSSEM CO.,LTD.	KT	SHINWON
DAEHO, Co., LTD	HDC HOLDINGS CO.,Ltd	KUMHO ENGINEERING AND CONSTRUCTION	SUNGBO CHEMICAL
DAELIM	Heerim Architects & Planners Co., Ltd.	KUNNG NONG	SUNGSHIN CEMENT CO., LTD
DAEWON CABLE	HISTEEL CO., LTD	KWANGMYUNG ELECTRIC	TAEKWANG INDUSTRIAL CO.,LTD
DAEWOO ENGINEERING AND CONSTRUCTION	HUNDAI STEEL COMPANY	LG INTERNATIONAL	TONG YANG MOOLSAN
DAEWOO INTERNATIONAL CORPORATION	HYOSUNG	LOTTE CONFECTIONERY CO.,LTD	TONGYANG
DOHWA ENGINEERING	Hyundai BNG Steel	LOTTE FINE CHEMICALS	VITZROSYS
DONG YANG STEEL PIPE	HYUNDAI CORPORATION	LOTTE TOUR	VITZROTECH
DONGBU CNI	HYUNDAI ELEVATOR	LS INDUSTRIAL SYSTEMS	WOOWON INFRA
DONGBU HITEK	HYUNDAI ENGINEERING & CONSTRUCTION	MANIKER CO.,LTD	YONG PYONG RESORT
DS STEEL	HYUNDAI MERCHANT MARINE COMPANY LIMITED	MIJU STEEL MFG.CO.,LTD.	YOOSHIN ENGINEERING CORPORATION
ECOMAISTER	HYUNDAI ROTEM COMPANY	NAMHAE CHEMICAL	
EE-HWA CONSTRUCTION	ILJIN ELECTRIC	NAMKWANG	
EHWA TECHNOLOGIES INFORMATION	ILSHIN STONE	NK CO.,LTD.	

Note: The shaded cells denote companies that have participated in economic cooperation with North Korea.

Second, Table A-3 and A-4 show the results after adding interactions from other uncertainty measures -- VKOSPI and EPU -- with firm characteristics. In Table A-3, we consider the overall stock market volatility by including interactions with the VKOSPI-200 index. We still find strongly significant coefficients for the interactions with foreign ownership and the economic cooperation dummy.

Similarly, in Table A-4 we control for the interaction terms of the economic policy uncertainty (EPU) in Korea. We find that the inclusion of the EPU interactions does not much change the estimates of GPRNK effects shown in Table 5, above.

Table A-3. Robustness Check: Control of the Market Volatility

	(1)	(2)	(3)	(4)	(5)	(6)
log(GPRNK) * Foreigner ownership	0.0039*** (0.0010)					0.0052*** (0.0012)
log(GPRNK) * log(asset)		0.0010 (0.0009)				-0.0005 (0.0011)
log(GPRNK) * (Fixed asset/Total asset)			-0.0006 (0.0008)			-0.0009 (0.0009)
log(GPRNK) * Ecoop dummy				-0.0200*** (0.0035)		-0.0207*** (0.0035)
log(GPRNK) * Defense dummy					-0.0014 (0.0039)	-0.0028 (0.0041)
log(VKOSPI) * Foreigner ownership	0.0064*** (0.0011)					0.0007 (0.0014)
log(VKOSPI) * log(asset)		0.0086*** (0.0011)				0.0092*** (0.0015)
log(VKOSPI) * (Fixed asset/Total asset)			0.0012 (0.0012)			-0.0002 (0.0013)
log(VKOSPI) * Ecoop dummy				-0.0062 (0.0041)		-0.0103*** (0.0038)
log(VKOSPI) * Defense dummy					0.0168*** (0.0049)	0.0103** (0.0050)
Number of Observations	325,774	325,774	325,513	325,774	325,774	325,513
Number of firms	2,379	2,379	2,379	2,379	2,379	2,379
Adjusted R2	0.1345	0.1356	0.1342	0.1342	0.1341	0.136
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes : Robust standard errors are in the parentheses. Every estimates represent the interaction effects of 1 log-point increase of the uncertainty index with 1 standard deviation increase of firm-level sensitivity measures. The first order term of firm-level sensitivity measures are also included. The sample covers 2003m1~2019m12.

Table A-4. Robustness Check: Control of the Economic Policy Uncertainty

	(1)	(2)	(3)	(4)	(5)	(6)
log(GPRNK) * Foreigner ownership	0.0016* (0.0009)					0.0049*** (0.0011)
log(GPRNK) * log(asset)		-0.0023*** (0.0008)				-0.0036*** (0.0010)
log(GPRNK) * (Fixed asset/Total asset)			-0.0020*** (0.0008)			-0.0016** (0.0008)
log(GPRNK) * Ecoop dummy				-0.0168*** (0.0027)		-0.0154*** (0.0027)
log(GPRNK) * Defense dummy					-0.0053 (0.0039)	-0.0036 (0.0035)
log(EPU) * Foreigner ownership	0.0050*** (0.0008)					0.0028*** (0.0009)
log(EPU) * log(asset)		0.0060*** (0.0007)				0.0047*** (0.0009)
log(EPU) * (Fixed asset/Total asset)			0.0011 (0.0007)			-0.0008 (0.0008)
log(EPU) * Ecoop dummy				0.0075*** (0.0025)		0.0032 (0.0026)
log(EPU) * Defense dummy					0.0046 (0.0039)	-0.0018 (0.0038)
Number of Observations	391,666	392,085	391,824	392,085	392,085	391,405
Number of firms	2,426	2,426	2,426	2,426	2,426	2,426
Adjusted R2	0.1686	0.1695	0.1682	0.1682	0.1681	0.1698
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes : Robust standard errors are in the parentheses. Every estimates represent the interaction effects of 1 log-point increase of the uncertainty index with 1 standard deviation increase of firm-level sensitivity measures. The first order term of firm-level sensitivity measures are also included. The sample covers 1996m2~2019m12.

Table A-5. Robustness Check: Alternative Calculation of Index

	Moving-averaged index with window: [t-1, t+1]		Moving-averaged Index with window: [t-2, t]		Subscription- weighted index
	Equal weight	Double weight on t	Equal weight	Double weight on t	
log(GPRNK) * Foreigner ownership	0.0070*** (0.0012)	0.0069*** (0.0011)	0.0056*** (0.0011)	0.0060*** (0.0011)	0.0056*** (0.0009)
log(GPRNK) * log(asset)	-0.0022** (0.0011)	-0.0023** (0.0011)	-0.0029*** (0.0011)	-0.0028*** (0.0011)	-0.0015* (0.0009)
log(GPRNK) * (Fixed asset/Total asset)	-0.0017** (0.0009)	-0.0018** (0.0009)	-0.0012 (0.0009)	-0.0015* (0.0009)	-0.0014** (0.0007)
log(GPRNK) * Ecoop dummy	-0.0146*** (0.0030)	-0.0149*** (0.0030)	-0.0075*** (0.0026)	-0.0097*** (0.0027)	-0.0130*** (0.0024)
log(GPRNK) * Defense dummy	-0.0073** (0.0033)	-0.0066** (0.0033)	-0.0095*** (0.0031)	-0.0082*** (0.0032)	-0.0033 (0.0031)
Number of Observations	391,405	391,405	391,405	391,405	391,405
Number of firms	2,426	2,426	2,426	2,426	2,426
Adjusted R2	0.1696	0.1696	0.1695	0.1696	0.1696
Other Controls	Yes	Yes	Yes	Yes	Yes
Firm and time fixed effects	Yes	Yes	Yes	Yes	Yes

Notes : Robust standard errors are in the parentheses. Every estimates represents the effect of 1 log-point increase of GPRNK index. The first order term of firm-level sensitivity measures are included in the regressions. We use three-month moving-averaged index with window [t-1, t+1] in column (1) and (2), [t-2, t] in column (3) and (4), weighted index by paid subscription in column (5) and standardized index in column (6), respectively.

Table A-5 checks for any possible bias caused by the timing of the effects. If the variation of the GPRNK index is mainly driven by the events that occur early in each month, the estimates can be interpreted as cumulative effects of the month. On the other hand, if the index is driven by events that occur at the end of each month, it may affect stock prices the following month. With this in mind, we calculate the three-month moving average index to expand the window of effect so as to reduce any timing biases. Columns (1) and (2) apply a window from t-1 to t+1, with equal weight in Column (1) and double weight on t in Column (2), while Columns (3) and (4) use a window from t-2 to t. These alternative time settings of the index all yield similar results with Column (6) in Table 5, above.

A.3. Additional Understanding of GPRNK Trend

Figure A-2. GPRNK by Type of News Media

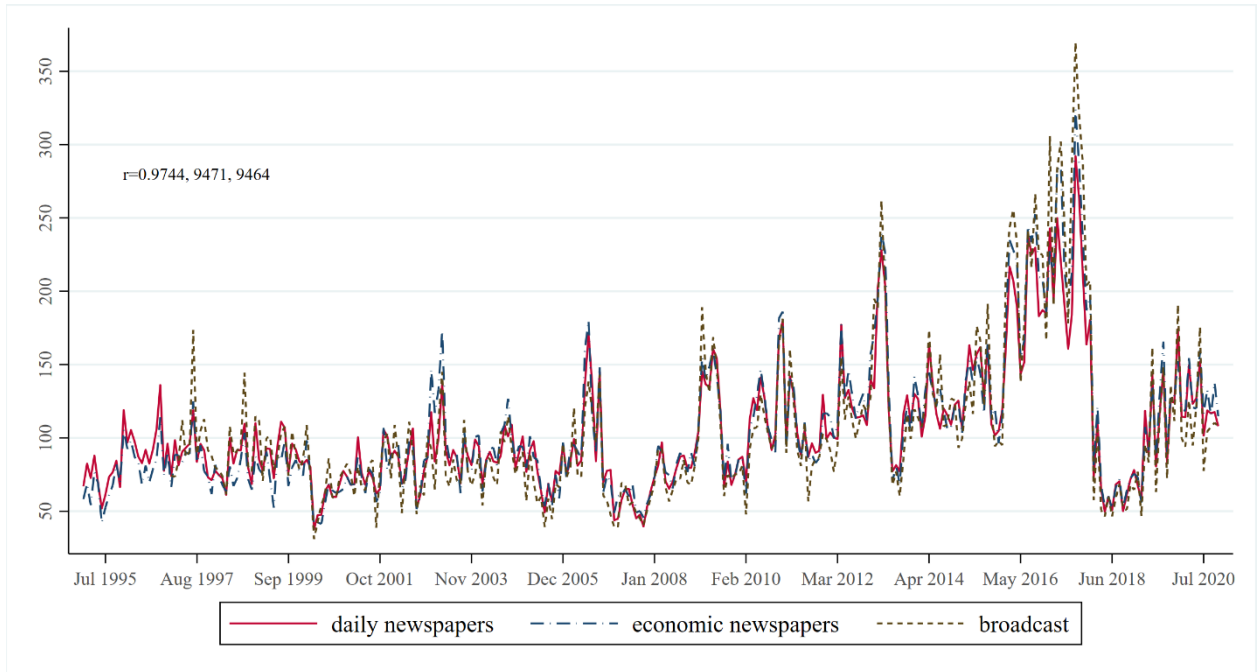


Figure A-3. Weighted GPRNK Index

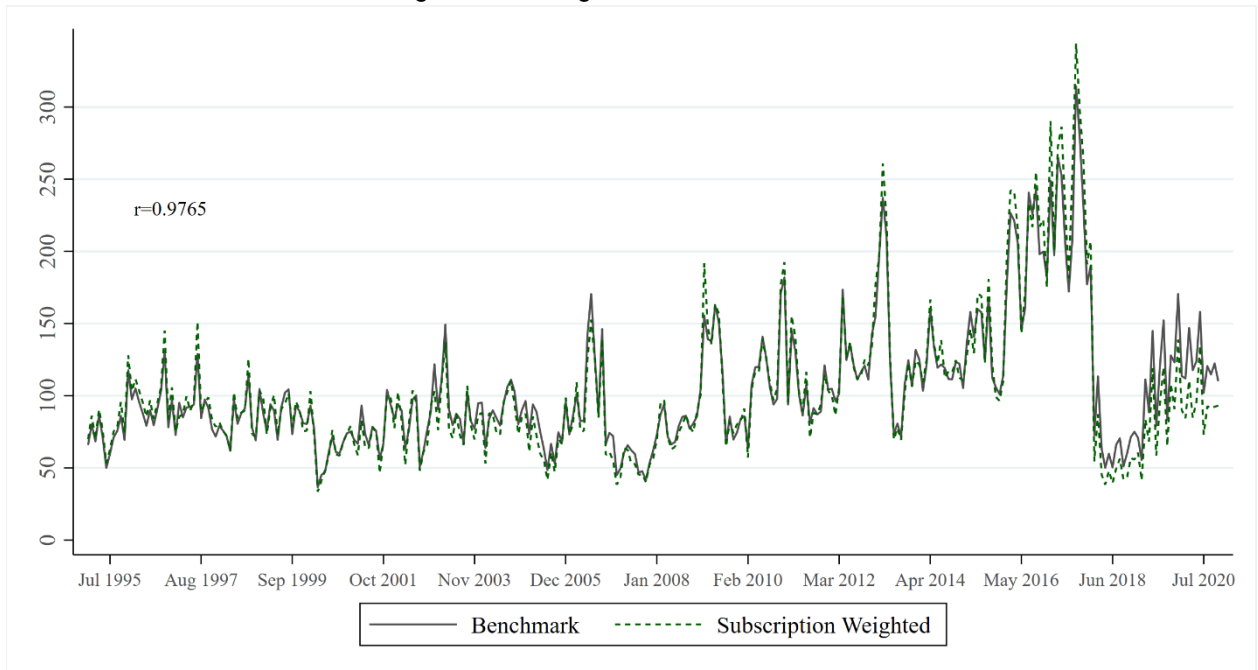


Figure A-4. Comparison with Economic Uncertainty Indices

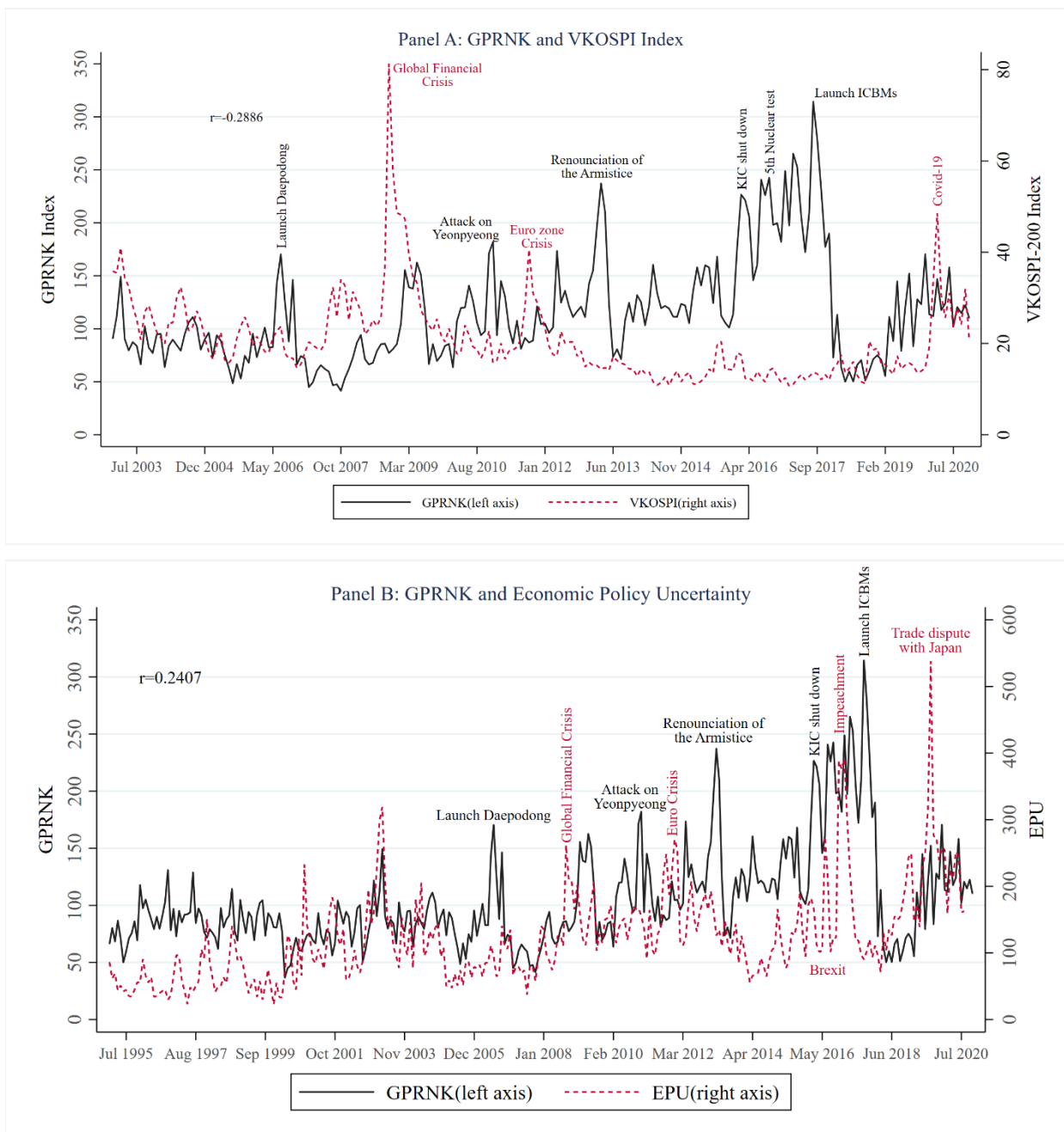


Figure A-5. GPRNK, Based on Broader Sets of Articles

