Corporate Investment and Stock Returns Under North Korea Threats[1]

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Abstract

We study how geopolitical risk from North Korea affects South Korean firms' investment and stock returns. We construct a novel monthly GPRNK index from news articles, which spikes during nuclear tests or military confrontations and falls during summits. Heightened GPRNK reduces corporate investment and stock returns, with larger effects for capitalintensive, and geopolitically exposed firms. By contrast, firms with higher labor flexibility are less affected. Local projection estimates show that investment declines are persistent. These results highlight both real options and Oi–Hartman–Abel channels in the transmission of geopolitical risk.

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1 Introduction

Geopolitical risk has become a key determinant of financial markets and firm behavior. A growing literature shows that shocks related to wars, terrorism, or international tensions affect asset prices, investment, and financing by raising uncertainty and altering expectations (Caldara and Iacoviello, 2022; Wang et al., 2024). Most of these studies rely on global or national indices of geopolitical risk, which provide a broad picture but often mask the effects of risks stemming from a single geopolitical source.

This paper addresses the gap by constructing a new index of geopolitical risk related to North Korea (GPRNK) and examining its effects on South Korean firms' investment and stock returns. The GPRNK index is national in scope—capturing shocks most relevant to the South Korean economy—but localized in focus, as it isolates risks arising specifically from tensions with North Korea rather than global conflicts. The index is built using text-based frequency counts of news articles that simultaneously reference North Korea and conflict-related terms. To our knowledge, this is the first study to develop a dedicated measure of North Korea–related geopolitical risk and apply it to firm-level corporate behavior.

South Korea offers a unique setting to study how geopolitical risk affects both financial and real firm outcomes. The country is repeatedly exposed to abrupt swings in tensions with North Korea, ranging from threats of conflict to sudden episodes of reconciliation. Such shocks provide sharp variation in uncertainty that is plausibly exogenous to individual firm performance. On the real side, its economy is dominated by large, export-oriented and capital-intensive industries, where investment decisions are particularly vulnerable to heightened uncertainty. On the financial side, South Korea has deep and internationally integrated capital markets, with foreign investors holding nearly 30% of domestic equities, making stock prices highly sensitive to shifts in perceived risk.

We make three contributions to the literature. First, extending computational linguistics–based measures of uncertainty and risk (Baker et al., 2016; Caldara and Iacoviello, 2022), we construct a region-specific geopolitical risk index focused on North Korea.[1] By utilizing our monthly in-

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[1]Compared to AI-based applications such as the GDELT (2025), which focus on bilateral relations, the GPRNK

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dex, we depart from prior works that rely on event studies of discrete geopolitical incidents (Kim and Roland, 2014; Gerlach and Yook, 2016). Second, in line with real options theory (Dixit and Pindyck, 1994; Bloom et al., 2007), we find that North Korea related geopolitical risk has significant adverse effects on South Korean firms. When the GPRNK index doubles, quarterly investment expenditures and monthly stock returns decrease by roughly 0.3 percentage points of assets and 1.2 percentage points, respectively. These effects are robust after controlling for global geopolitical risk and economic policy uncertainty, highlighting the distinct role of localized geopolitical risk shocks. Local projections show that the effects on investment are persistent, lasting several quarters after the initial shock. Third, we demonstrate that the impact is heterogeneous across firms. Capital-intensive firms experience larger declines, consistent with the real options channel, whereas firms with greater labor flexibility or higher labor–capital substitutability are less affected, consistent with the convexity channel (Hartman, 1972; Abel, 1983).

The remainder of the paper is organized as follows. Section 2 describes the construction of the GPRNK index. Section 3 outlines the empirical framework. Section 4 discusses the main estimation results, and Section 5 concludes.

2   Measuring Geopolitical Risk from Inter-Korea Relations

Geopolitical risk on the Korean Peninsula has been shaped by recurring cycles of conflict and reconciliation between South and North Korea, influenced by the involvement of major regional powers. This alternating pattern of escalation and détente motivates our approach, which goes beyond existing studies in two respects.

First, we account for both escalation and reconciliation, capturing downside and upside swings in geopolitical risk. This allows us to track shifts in general perceptions of uncertainty rather than focusing solely on crises. In this respect, we are related to Ha et al. (2022), but we extend their event-based approach by applying a systematic textual analysis of news articles that reference both North Korea and conflict-related terms. Second, we emphasize the reciprocal link between

index provides greater contextual relevance by capturing multi-actor regional risks.

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geopolitical and economic dynamics. Military provocations often trigger sanctions that heighten tensions, while diplomatic initiatives and joint projects temporarily reduce uncertainty.

The news articles are retrieved from BigKinds[2], a platform established by the Korea Press Foundation. It provides analytics of South Korean news content in the Korean language, covering approximately 60 million articles across 54 media outlets. We select 18 newspapers and broadcasters that are representative of South Korean media and search for specific keywords in news headlines and/or content. Table 1 presents their English translations.

We classify news articles mentioning "North Korea" into negative (military threats, sanctions) and positive (talks, cooperation) categories and compute the net relative frequency of negative over positive reports. This series is transformed to ensure positivity, standardized within each outlet, and then averaged across 18 major newspapers and broadcasters. Finally, the aggregate series is normalized to yield the monthly GPRNK index with a mean of 100 over the period from 1995 to 2016 (see Appendix A1 for details).

Figure 1 plots the monthly GPRNK index from 1995 to 2024. The index sharply increases during occurrences of nuclear tests, missile launches, or military confrontations, and it decreases significantly around the times of bilateral or multilateral meetings.

3 Empirical Framework

3. 1 Estimation Models

We examine the effect of geopolitical risk from North Korea on corporate investment and stock returns. For investment, we estimate

$$Inv_{i,t+1} = \alpha_i + \theta GPRNK_t + C'_{i,t}\gamma + \epsilon_{i,t+1} \tag{1}$$

where $Inv_{i,t+1}$ is a ratio of a firm i's investment expenditures in quarter $t + 1$ to asset size at the end of quarter t. $C_{i,t}$ is a vector of firm-level control variables: Tobin's q, leverage ratio, return

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[2]https://www.bigkinds.or.kr

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on asset ratio, asset size, and growth rate in sales. We include firm fixed effects (α_i) and calendar quarter dummies to control for unobserved heterogeneity and common cyclical factors. Standard errors are clustered at the firm level.

To examine heterogeneity, we extend Eq(1) by interacting $GPRNK_t$ with proxies for capital intensity and factor substitutability: fixed asset ratio, labor-capital ratio, and labor-capital substitutability. The fixed asset ratio captures investment irreversibility and relates to the real options mechanism, which predicts stronger adverse effects under uncertainty. By contrast, the labor-capital ratio and labor-capital substitutability (proxied by the industry-level standard deviation of the labor–capital ratio) capture the convexity channel, which predicts attenuated or offsetting responses when firms can adjust labor more flexibly relative to capital.

To study dynamics, we estimate local projections (Jordà, 2005) of investment on contemporaneous GPRNK shocks at horizons up to 12 quarters. Variables match those in Eq(1).

$$Inv_{i,t+h} = \alpha_i + \theta_h\, GPRNK_t + C'_{i,t}\gamma_h + \varepsilon_{i,t+h}, \quad h = 0, 1, \ldots, 12, \tag{2}$$

where $Inv_{i,t+h}$ is the investment rate of firm i at horizon h, θ_h traces the impulse response of investment to a one-unit shock in geopolitical risk, and $C_{i,t}$ denotes the set of firm-level controls. We include firm fixed effects and calendar quarter dummies. For the heterogeneity analysis, we extend the local projection by interacting $GPRNK$ with industry-level dummies that capture high fixed-asset ratios and high capital per worker.

Having established how geopolitical risk affects firms' real investment decisions, we next examine whether these same shocks are reflected in financial markets through firm-level stock returns. The baseline specification for stock returns is

$$R_{i,t} = \alpha_i + \beta GPRNK_t + C'_{i,t-1}\gamma + X'_t\delta + \epsilon_{it} \tag{3}$$

where R_{it} is the monthly return of firm i at time t, $GPRNK_t$ is the natural logarithm of our geopolitical risk index. We include C_{it-1} as a vector of one period lagged firm-level control variables:

price-to-book value ratio, leverage ratio, return on asset ratio, asset size, and X_t as a set of macroeconomic control variables: monthly return of the Dow Jones Industrial Average Index, the nominal KRW-USD exchange rate, and dummies for calendar months and calendar years. To isolate the effects of North Korea threat risk from other sources of uncertainty, we further include EPU and global GPR measures.

Next, we examine how firms differ in their stock return responses by interacting the GPRNK index with firm characteristics. First, the degree of investment irreversibility is proxied by the fixed-asset ratio (property, plant, and equipment to total assets), following Gulen and Ion (2016). Second, the labor-capital ratio serves as a proxy for the convexity of the profit function (Leahy and Whited, 1996; Wang et al., 2024). Finally, we include dummies for economic cooperation with North Korea and for the defense industry, as investors revise expectations for these sectors when inter-Korean tensions shift.

3. 2   Data

Our empirical analysis is based on information about 2,055 South Korean non-financial companies between 2000 and 2024. We use stock market data from DataGuide provided by Fnguide, and accounts data from KIS Value provided by the National Information & Credit Evaluation (NICE). The variables used in our regressions are described in Appendix A2 and Table 2 presents summary statistics for monthly and quarterly regressions.

4   Results

On average, geopolitical risk exhibits significant adverse effects on South Korean firms' investment (Table 3). When the GPRNK index doubles, quarterly investment decreases by roughly 0.3 percentage points of assets. The estimates remain robust after including controls for global and domestic uncertainty indices. The results confirm that the GPRNK index captures a localized source of risk that is distinct from global shocks.

The analysis of heterogeneous investment effects across firms reveals transmission mecha-

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nisms (Table 4). First, real options theory predicts stronger adverse responses for firms with more irreversible capital. Consistent with this prediction, Columns (1)-(2) show that firms with higher fixed-asset ratios experience significantly larger declines in investment when GPRNK rises. Second, the Oi–Hartman–Abel convexity effect suggests that firms with flexible labor inputs should be less sensitive to uncertainty shocks. Columns (3)-(6) confirm this pattern: firms with higher labor–capital ratios or greater substitutability between labor and capital exhibit more muted declines in investment. For these firms, the ability to adjust labor reduces the need to delay or cancel capital expenditures under uncertainty.

To study persistence, we estimate dynamic effects using local projections. Figure 2 shows that an increase in GPRNK induces an immediate decline in investment that persists for up to three years. The contraction is pronounced among capital-intensive industries, consistent with the real options channel, and industries with a low labor-to-capital ratio, in line with the convexity channel. This persistence highlights that geopolitical shocks have lasting consequences for corporate investment decisions.

Table 5 presents the baseline regressions of stock returns on the GPRNK index. A one-log-point increase in GPRNK reduces monthly returns by about 1.2 percentage points. The effect remains robust, though attenuated, after controlling for Korean EPU and other external factors. By examining firm heterogeneity in Table 6, our analysis sheds light on the underlying mechanisms through which geopolitical risk affects stock returns. The impact of GPRNK is stronger for more capital-intensive firms, consistent with the real options view. By contrast, firms with higher labor–capital ratios exhibit attenuated declines in stock returns, consistent with the Oi–Hartman–Abel effect. Firms engaged in inter-Korean economic cooperation are particularly vulnerable, and the defense industry also exhibits a more adverse effect, albeit with a weak statistical significance.

Table 7 reports a series of robustness checks based on alternative subsamples. The results are broadly consistent across manufacturing and non-manufacturing firms. After 2012, when geopolitical risk volatility increases, the investment effect becomes insignificant, while the stock return effect remains unchanged. Splitting the sample by ruling party, investment responds more nega-

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tively under conservative governments, whereas stock returns exhibit larger adverse effects under progressive administrations.

5 Conclusions

We develop a new index of geopolitical risk specific to inter-Korean relations, which captures both escalation and reconciliation episodes. Unlike existing global indices, our measure focuses on country-level risk factors that are particularly salient for South Korea.

Our empirical analysis shows that geopolitical risk shocks depress corporate investment and stock returns. The effects are stronger for firms with high capital intensity or direct exposure to inter-Korean economic cooperation, and weaker for firms with higher labor–capital ratios. Local projection estimates further indicate that investment responses is not only immediate but also persistent, highlighting the real economic costs of sustained geopolitical tensions. Our results suggest that investment irreversibility (real options theory) and labor-capital substitutability (the Oi-Hartman-Abel effect) are key but opposing mechanisms in explaining corporate investment and stock price responses to country-specific geopolitical risk.

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Tables and Figures

TABLE 1 Search keywords

Category		Topic	Action/Status	Excluded	Number of Articles
Default keywords		North Korea			1,441,420
Negative	Military tensions	(nuclear) or (missile) or (military) or (war)	(threat) or (tension) or (provocation)	(peace)	229,361
	Sanctions	(sanction) or (pressure)	(refute) or (dissent) or (criticize)	-	45,642
Positive	Talks/agreements	(talks) or (dialogue)	(resume) or (agreement) or (negotiation)	(fail) or (break) or (boycott)	250,639
	Economic cooperation	(economic cooperation) or (abbreviation of economic cooperation)	(progress) or (expectation)	(concern)	40,601

Notes: See Appendix Table A1 for Original Korean search keywords.

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FIGURE 1 The GPRNK Index (1995-2024)
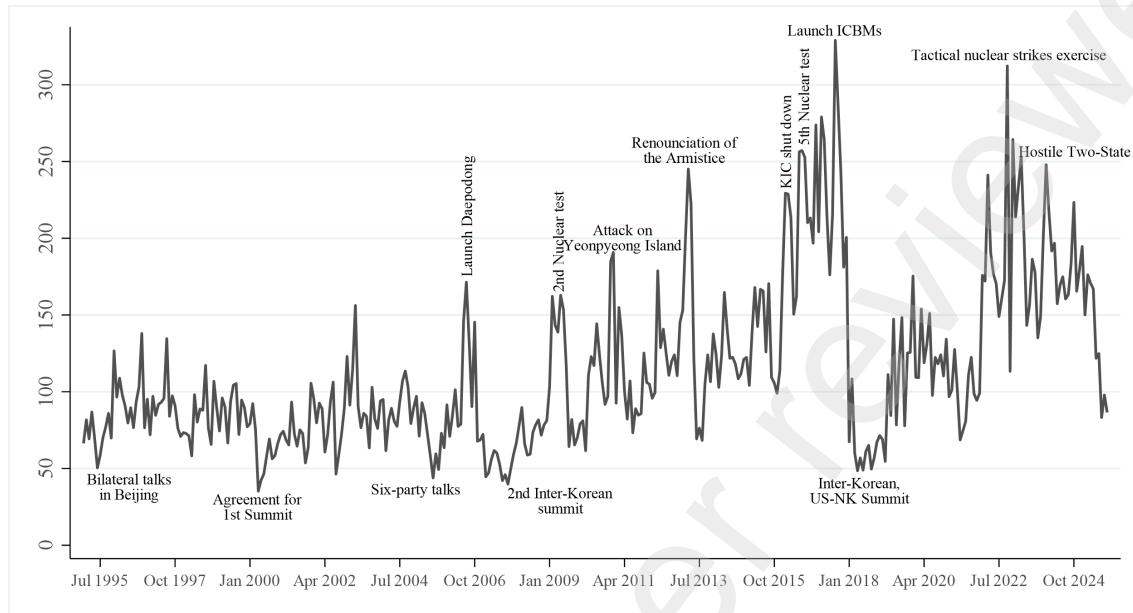
TABLE 2 Descriptive statistics

	Mean	SD	Min	Max	Obs
Uncertainty Measures (monthly, log)					
GPRNK	4.75	0.46	3.56	5.80	422,774
EPU	5.00	0.48	3.50	6.29	422,774
GGPR	4.62	0.31	3.83	6.26	422,774
GEPU	5.01	0.50	3.90	6.07	422,774
Firm Characteristics (monthly)					
Stock return	-0.00	0.16	-4.74	2.28	422,774
Foreigner ownership	5.89	10.69	0.00	100.00	422,774
PBR (log)	0.11	0.94	-4.61	9.03	418,134
Firm Characteristics (quarterly)					
Investment expenditures	0.00	0.05	-0.86	5.70	127,000
Tobin's q	1.45	1.55	0.14	108.55	124,452
Leverage ratio	0.24	0.17	0.00	3.11	124,452
ROA	0.00	0.05	-0.94	2.64	124,610
Asset size (log)	25.75	1.31	21.90	33.39	125,101
Sales growth	0.01	0.42	-14.07	13.81	121,850
Capital intensity	0.52	0.19	0.00	1.00	125,101
Labor to capital ratio (log)	-18.56	1.32	-24.15	-4.54	123,263
Labor-capital substitutability	1.03	0.37	0.00	4.20	124,602

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TABLE 3 GPRNK and firms' investment: average effects

	(1)	(2)	(3)	(4)
GPRNK	-0.0028***	-0.0020***	-0.0014***	-0.0005**
	(0.0003)	(0.0003)	(0.0002)	(0.0002)
EPU		-0.0025***	0.0049***	0.0024***
		(0.0005)	(0.0008)	(0.0007)
Global GPR			-0.0027***	-0.0014***
			(0.0006)	(0.0006)
Global EPU			-0.0093***	-0.0032***
			(0.0007)	(0.0006)
Tobin's q	0.0007***	0.0006***	0.0007***	0.0008***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Leverage ratio	-0.0048***	-0.0051***	-0.0086***	-0.0114***
	(0.0016)	(0.0016)	(0.0016)	(0.0017)
ROA	0.0112***	0.0105***	0.0071***	0.0055***
	(0.0053)	(0.0053)	(0.0054)	(0.0054)
Asset size	-0.0090***	-0.0085***	-0.0063***	-0.0047***
	(0.0004)	(0.0005)	(0.0005)	(0.0005)
Sales Growth	0.0003	0.0003	0.0003	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Firm fixed effects	Yes	Yes	Yes	Yes
Calendar quarter dummies	Yes	Yes	Yes	Yes
Year-level linear trend	No	No	No	Yes
Number of obs.	117,930	117,930	117,930	117,930
Number of firms	2,049	2,049	2,049	2,049
Adjusted R^2	0.0299	0.0302	0.0318	0.0325

Notes: We regress firm-level investment rate on the GPRNK index. The dependent variable is investment expenditures in quarter $t + 1$ divided by asset size at the end of quarter t. The GPRNK is the logarithm of the 3-month average GPRNK index in quarter t. Standard errors are clustered at the firm level, and reported in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. We control Tobin's q, leverage ratio, return on asset ratio, natural logarithm of asset size, and sales growth rate. The sample covers 2003q1-2024q4.

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TABLE 4 GPRNK and firms' investment: differential effects by capital intensity

	(1)	(2)	(3)	(4)	(5)	(6)
GPRNK	0.0004		0.0132***		-0.0048***	
	(0.0007)		(0.0031)		(0.0009)	
GPRNK * capital intensity	-0.0011***	-0.0012***				
	(0.0003)	(0.0003)				
Capital intensity	0.0047***	0.0059***				
	(0.0013)	(0.0013)				
GPRNK * Labor-to-capital			0.0011***	0.0013***		
			(0.0002)	(0.0002)		
Labor-to-capital			-0.0060***	-0.0071***		
			(0.0011)	(0.0012)		
GPRNK * Labor-capital substitutability					0.0019**	0.0010
					(0.0008)	(0.0008)
Labor-capital substitutability					-0.0116***	-0.0056
					(0.0042)	(0.0041)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	No	Yes	No	Yes
Number of observations	117,930	117,930	116,086	116,086	117,512	117,512
Number of firms	2,049	2,049	2,049	2,049	2,046	2,046
Adjusted R^2	0.0301	0.0362	0.0299	0.0361	0.0299	0.0359

Notes: We regress firm-level investment rate on geopolitical risk from North Korea conditioned on capital intensity and convexity of the marginal product of capital. Standard errors are clustered at the firm level, and reported in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. We control Tobin's q, leverage ratio, return on asset ratio, natural logarithm of asset size, and sales growth rate. We include the first order term of GPRNK index in column (1), (3), (5), while we control time fixed effects thereby dropping the GPRNK term in column (2), (4), (6). The sample covers 2003q1 2024q4.

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FIGURE 2 Impulse response functions from local projection

Baseline Results

Industries with high fixed asset ratio

Industries with low labor-to-capital ratio

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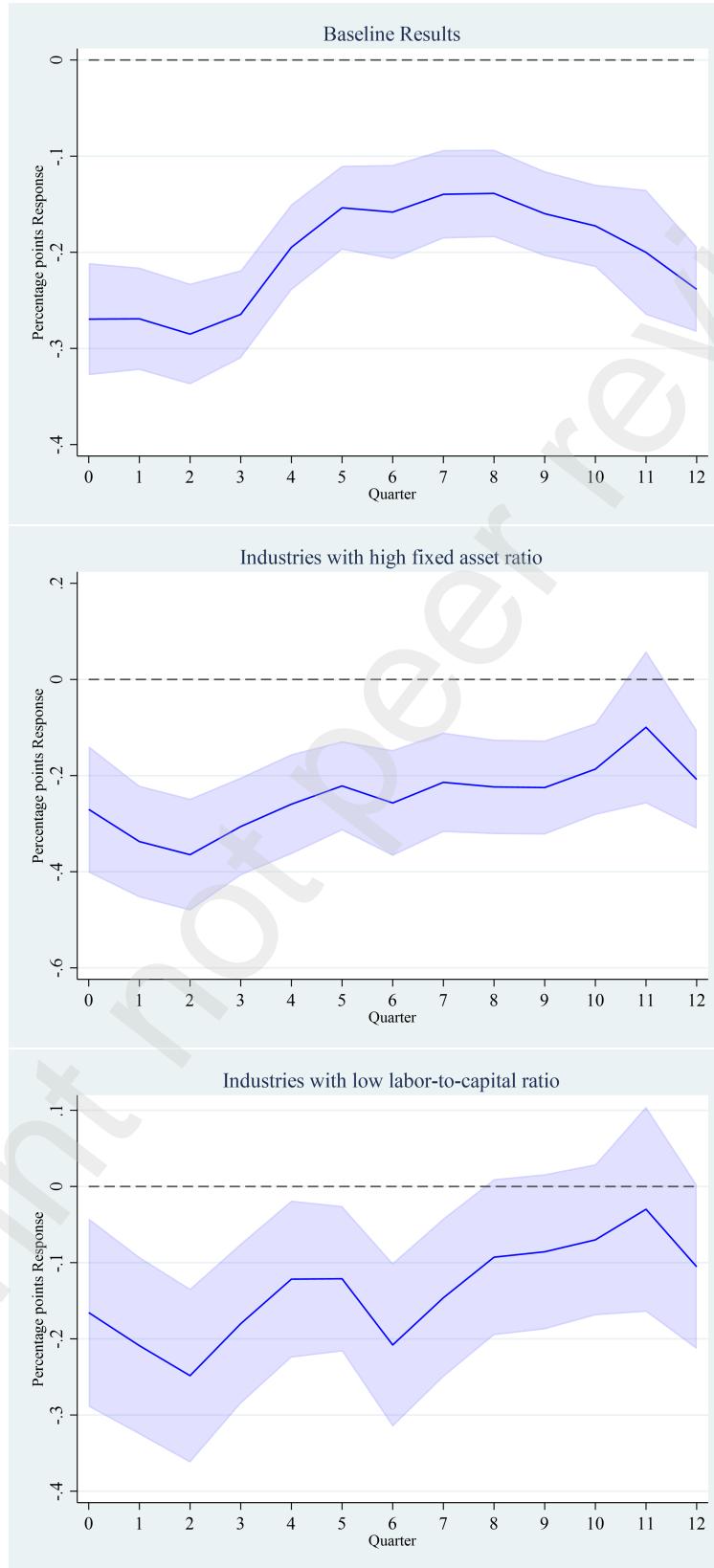
TABLE 5 GPRNK and firms' stock returns: average effects

	(1)	(2)	(3)	(4)
GPRNK	-0.0123***	-0.0094***	-0.0095***	-0.0067***
	(0.0010)	(0.0010)	(0.0010)	(0.0010)
EPU		-0.0154***	-0.0218***	-0.0079***
		(0.0008)	(0.0012)	(0.0012)
Global GPR			0.0063***	0.0102***
			(0.0010)	(0.0010)
Global EPU			0.0125***	0.0061***
			(0.0020)	(0.0019)
Dow Jones Index return				0.0089***
				(0.0001)
KRW-USD exchange rate				-0.0292***
				(0.0061)
PBR	-0.0272***	-0.0274***	-0.0274***	-0.0266***
	(0.0012)	(0.0012)	(0.0012)	(0.0011)
Leverage ratio	0.0535***	0.0542***	0.0542***	0.0537***
	(0.0045)	(0.0045)	(0.0045)	(0.0045)
ROA	0.0757***	0.0757***	0.0758***	0.0732***
	(0.0151)	(0.0151)	(0.0151)	(0.0145)
Asset size	-0.0228***	-0.0228***	-0.0228***	-0.0222***
	(0.0011)	(0.0011)	(0.0011)	(0.0011)
Firm fixed effects	Yes	Yes	Yes	Yes
Calendar month dummies	Yes	Yes	Yes	Yes
Calendar year dummies	Yes	Yes	Yes	Yes
Number of obs.	390,870	390,870	390,870	390,870
Number of firms	2,055	2,055	2,055	2,055
Adjusted R^2	0.0478	0.0485	0.0487	0.1006

Notes: The dependent variable is monthly stock returns. Standard errors are clustered at the firm level, and reported in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. The coefficients represent the effect of 1 log-point increase of the GPRNK index on stock returns. We control calender year and calender month dummies to control common trend and cyclical factors in stock returns. In Column (4), we also include returns of Dow Jones Industrial Average Index and Won-Dollar exchange rate. The sample covers from 2000m1 to 2024m12.

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TABLE 6 GPRNK and firms' stock returns: differential effects by firm characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
GPRNK	-0.0050***		0.0111		-0.0111***	
	(0.0019)		(0.0087)		(0.0010)	
GPRNK * capital intensity	-0.0027***	-0.0029***				
	(0.0006)	(0.0006)				
Capital intensity	0.0092***	0.0106***				
	(0.0030)	(0.0028)				
GPRNK * labor-to-capital			0.0018***	0.0020***		
			(0.0006)	(0.0006)		
Labor-to-Capital			-0.0074***	-0.0092***		
			(0.0030)	(0.0029)		
GPRNK * economic cooperation					-0.0179***	-0.0179***
					(0.0031)	(0.0029)
GPRNK * defense					-0.0059*	-0.0054
					(0.0035)	(0.0034)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	No	Yes	No	Yes
Number of obs.	390,494	390,494	375,969	375,969	390,870	390,870
Number of firms	2,055	2,055	2,055	2,055	2,055	2,055
Adjusted R^2	0.0482	0.1990	0.0494	0.2032	0.0480	0.1987

Notes: The dependent variable is monthly stock returns. Standard errors are clustered at the firm level, and reported in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, 1% level, respectively. Foreign ownership, log of labor-capital ratio, and capital intensity ratio are standardized to have unit standard deviations. We include price-to-book value ratio, leverage ratio, ROA and asset size as firm level control variables. The sample covers 2000m1-2024m12.

TABLE 7 Robustness check: subsample analysis

	(1) Manufacturing	(2) Non-manufacturing	(3) Year<2012	(4) Year>=2012	(5) Progressive ruling party	(6) Conservative ruling party
Panel A: Investment						
GPRNK	-0.0030***	-0.0021***	-0.0032***	-0.0000	-0.0016***	-0.0071***
	(0.0003)	(0.0004)	(0.0009)	(0.0002)	(0.0005)	(0.0004)
Number of obs.	81,408	36,522	35,607	82,323	51,369	66,561
Adjusted R^2	0.0278	0.0624	0.0168	0.0664	0.0185	0.0864
Panel B: Stock Returns						
GPRNK	-0.0108***	-0.0156***	-0.0154***	-0.0152***	-0.0266***	-0.0043***
	(0.0012)	(0.0017)	(0.0017)	(0.0013)	(0.0015)	(0.0013)
Number of obs.	269,259	121,611	132,725	258,145	183,059	207,811
Adjusted R^2	0.0482	0.0496	0.0685	0.0422	0.0506	0.0604
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Calendar month (quarter) dummies	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at the firm level, and reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
We include price-to-book value ratio (tobin's q), leverage ratio, ROA and asset size as firm level control variables.
The sample covers 2000m1-2024m12 in Panel A and 2003q1-2024q4 in Panel B.

Appendix

A1.The GPRNK index

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.[3] Second, within the set of articles selected in the first step, we flag articles that mention four types of geopolitical risk to reflect the main drivers of inter-Korea relations, focusing 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). 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. 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.

Next, we compute the frequency of news articles so that $N_{j,it}$ denotes the total number of articles containing the keywords in each category j from media i at time t. The four categories—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 related to North Korea is computed as follows:

$$X_{it} = \frac{N_{neg,it} - N_{pos,it}}{N_{it}} \tag{1}$$

where X_{it} denotes the relative frequency of net negative news articles for media i and time t. N_{it} is the total number of articles with the default search keyword "North Korea". After transforming X_{it} to have a positive value,[4] we standardize $\widetilde{X_{it}}$ to obtain a series Y_{it}, with unit standard deviation for each media outlet.

$$Y_{it} = \frac{\widetilde{X_{it}}}{\sigma_i} \tag{2}$$

where σ_i is the time-series within-newspaper standard deviation of ($\widetilde{X_{it}}$) from January 1995 to

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

[4]$\widetilde{X_{it}} = \frac{1}{2}\left\{ X_{it} + \sqrt{X_{it}^2 + 0.1} \right\}$

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December 2016. The standardized index is averaged across outlets.

$$Y_t = \frac{1}{N} \sum_{i=1}^{N} Y_{it} \tag{3}$$

where N is the total number of media outlets. Then we normalize Y_t, such that $GPRNK_t = \frac{100Y_t}{\bar{Y}}$ where $\bar{Y}$ is the mean value of Y_t from 1995 to 2016.

In Figure A.1, we check the robustness of the GPRNK index by examining potential biases due to sample coverage.[5] Media bias may harm the representativeness of our index. If one finds systemic differences in the GPRNK index due to 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.

We compute the subgroup GPRNK indices by the political leaning of the news outlet (top panel).[6] 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. In addition, we compare the GPRNK index with its sub indices constructed by press type–daily newspapers, economic newspapers, and broadcast media (bottom panel). The correlations are uniformly high, ranging from 0.94 to 0.97.

Next, we compare our index with two other existing indices that quantify geopolitical risks from North Korea (Figure A.2). First, we compare the GPRNK index with the GPR Korea index by Caldara and Iacoviello (2022). 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.[7] Therefore, 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 it 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 more significant in terms of the landscape of global diplomacy than for the inter-Korea relationship. However,

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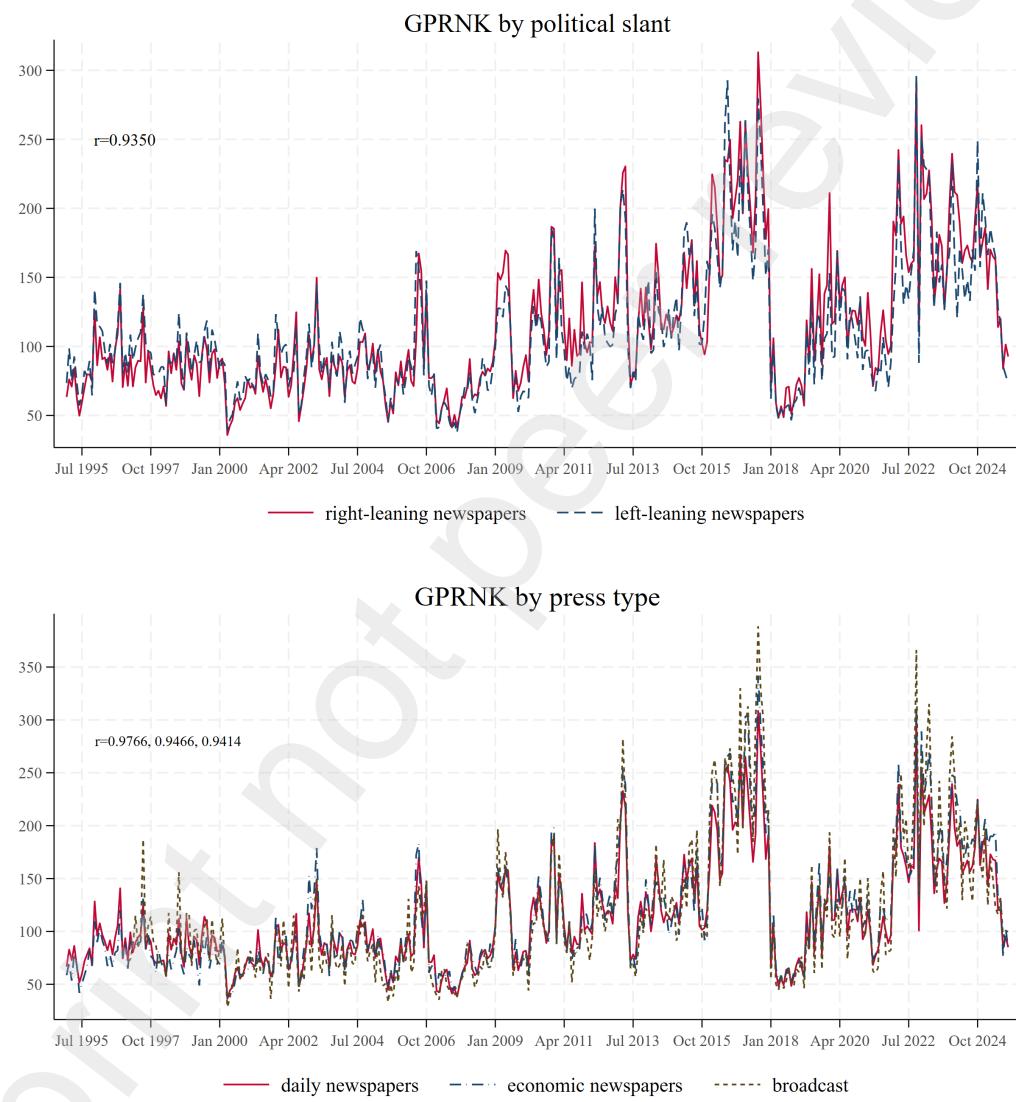
[5]Our media sample covers 68.9% of total newspaper circulation and 63.6% of total viewership among national broadcast channels.

[6]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.

[7]The search query for the GPR Korea index is "Korea AND (tensions/risk/fear/chaos/uncertainty/unrest/violence...) AND (military/war/geopolitical/coup/guerrilla/warfare/army/terrorism)". For details of the methodology and trends of the GPR Korea index, refer to their website (https://www.matteoiacoviello.com/gpr.htm).

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FIGURE A.1 Assessing Potential Selection Bias of the GPRNK Index

GPRNK by political slant

r=0.9350

Jul 1995 — Oct 2024

— right-leaning newspapers   - - - left-leaning newspapers

GPRNK by press type

r=0.9766, 0.9466, 0.9414

Jul 1995 — Oct 2024

— daily newspapers   -·-· economic newspapers   ---- broadcast

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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 approximately 0.33.
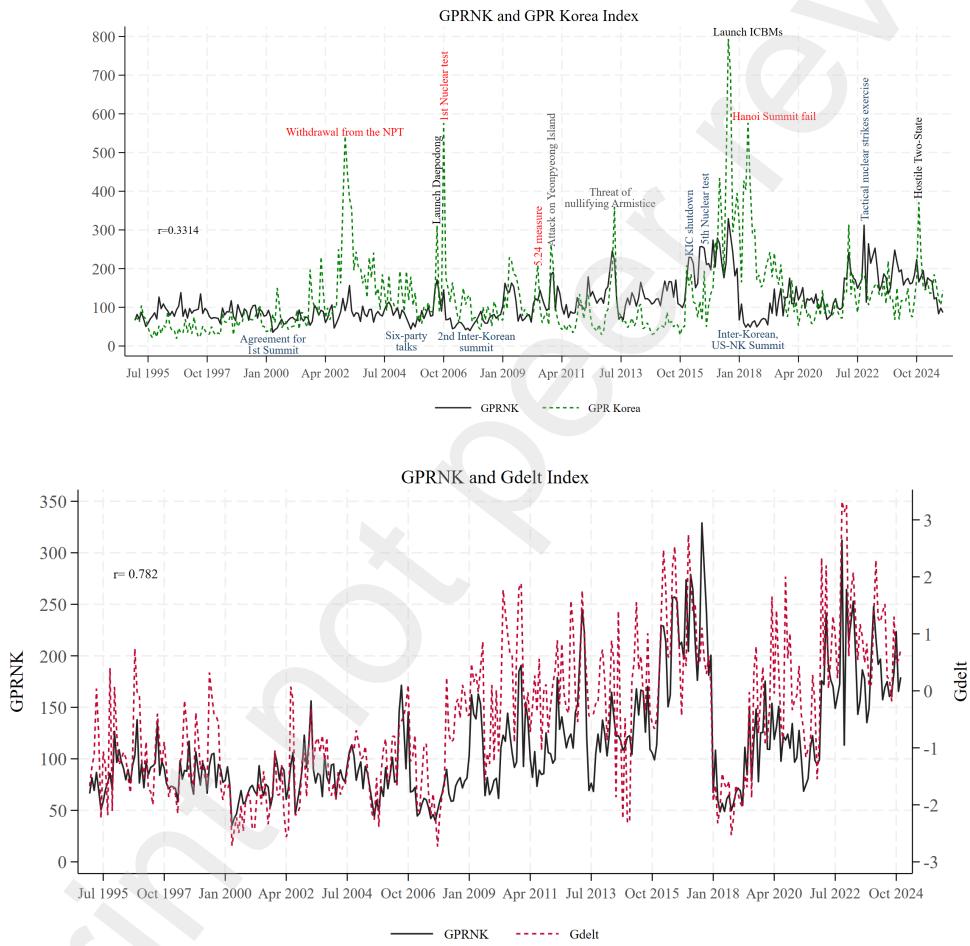
Second, we compare our index with the GDELT-based measure of inter-Korean relations (in the bottom panel of Figure A.1. The GDELT-based measure is constructed using the Global Database of Events, Language, and Tone (GDELT)[8], which records dyadic events between countries and classifies each event by the acting country, the target country, and the nature of the interaction. Focusing on events between South Korea and North Korea, we utilize the Goldstein scale, which assigns each event a score ranging from -10 (most conflictual) to +10 (most cooperative). Specifically, we compute the monthly average Goldstein score for events in which South Korea is the acting country and North Korea is the target, as well as for events in which North Korea is the acting country and South Korea is the target. The overall GDELT-based inter-Korean relations index is then defined as the simple average of these two directional measures, capturing the prevailing tone of bilateral interactions between the two Koreas. Since the GDELT index increases when bilateral relations improve, we multiply it by -1 so that higher values consistently indicate heightened geopolitical risk.

The GDELT-based index primarily focuses on bilateral relationships, limiting its ability to fully capture the complex multi-actor regional risks posed by North Korea. By contrast, the GPRNK index is, by design, constructed to reflect region-wide geopolitical risk that extends beyond a single bilateral relationship, relying on targeted textual analysis. Moreover, it explicitly distinguishes between positive events–such as diplomatic dialogue or economic cooperation–and negative events–such as military threats or sanctions–thereby enhancing transparency and interpretability. Despite these conceptual differences, the GPRNK and GDELT-based inter-Korean relations indices are strongly correlated, with a correlation coefficient of 0.78, indicating that both measures capture common underlying geopolitical dynamics.

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[8]See https://www.gdeltproject.org/ for the details.

FIGURE A.2 Comparing the GPRNK Index with Existing Measures

GPRNK and GPR Korea Index

GPRNK and Gdelt Index

A2. Variable Description

TABLE A1 Variable Description

Variable	Description	Frequency	Source
Stock returns	Log difference in stock price between at the end of the month and the previous month	Monthly	DataGuide
Foreigner ownership	Foreign investors' shareholding ratio for the stock	Monthly	DataGuide
Price-to-book ratio (PBR)	Natural logarithm of the ratio of share price to book value per share	Monthly	DataGuide, Value Search
Investment expenditures	Capital expenditures plus R&D expenditures scaled by the lagged total assets	Quarterly	Value Search
Tobin's q	Market capitaizaiton plus total debt divided by the book value of physical asset	Quarterly	DataGuide, Value Search
Leverage Ratio	The ratio of total debt to market capitalization	Quarterly	DataGuide, Value Search
Return on Assets (ROA)	The ratio of operating profit to total asset value	Quarterly	Value Search
Asset Size	Natural logarithm of total asset value	Quarterly	Value Search
Sales Growth	Growth rate of sales calculated by log differences	Quarterly	Value Search
Capital intensity	Value of fixed asset divided by value of total asset	Quarterly	Value Search
Labor to capital ratio	Natural logarithm of the ratio of the number of employees to physical asset value	Quarterly	Value Search
Labor-capital substitutability	Industry-level standard deviation of the labor–capital ratio	Quarterly	Value Search
Economic cooperation	Dummy variable indicating involvement in economic cooperation	-	Author's Compilation
Defense industry	Dummy variable indicating business related to defense industry	-	Author's Compilation

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