International Area Studies Review
2025, Vol. 28(1) 24–48

https://doi.org/10.69473/iasr.2025.28.1.24

Article

Measurement for Media Sensitive-Trade Nexus: Case for U.S.-China-South Korea Trilateral Relationship

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Abstract

Political stability, often cracked by geopolitical tensions, plays a critical role in shaping the economic landscape, particularly through its impact on trade and investment flows. Media, as the primary conduit of information, significantly influences public perception and, consequently, market behavior. However, there is a lack of empirical studies to explain such a media role in trade. This study attempts to create a media sensitive-trade index, with a focus on the geopolitical dynamics between the Unities States, China, and Korea. Using advanced Natural Language Processing (NLP) techniques and Large Language Models (LLMs), the research quantifies media sentiment and links it to economic outcomes, such as Korea's Trade Business Diffusion Index (TBDI) and Balance of Payments (BOP). The analysis shows that Korea's trade trends are more influenced by the broader U.S.-China relationship than by its direct relations with either nation. Notably, the study finds that media sentiment, particularly in the service sectors, plays a predictive role in economic trends, with positive sentiment correlating with improved performance in areas such as transportation and intellectual property services. The developed index in this study supplements ex-post indicators, with the characteristics of ex-ante indicators, regarding to the short-term detection strategy for media sensitive economic system.

Keywords

National Security Index, Media sensitivity, International trade, Geopolitical tensions, News sentiment, Economic Shock, Natural Language Processing, Artificial Neural Network Language Model

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Introduction

In an increasingly interconnected world, the dynamics of international relations have profound implications on global imbalance. Political stability, often cracked by geopolitical tensions, plays a critical role in shaping the economic landscape, particularly through its impact on trade and investment flows. Media, as the primary conduit of information, significantly influences public perception and, consequently, market behavior. As nations navigate complex international relationships, the media, where political events are reported and perceived, can directly affect economic outcomes.

This study attempts to create a media sensitive-trade index, with a focus on the geopolitical dynamics between the Unities States, China, and Korea. This study focuses on the relationship between political stability and key trade indicators within the context of the trilateral relations between the United States, China, and Korea from 2021 to 2023. In particular, the research examines how media sentiment, reflecting political stability, correlates with trade performance indicators, such as the Trade Business Diffusion Index (TBDI) and the Balance of Payments (BOP).

To explore these relationships, the study employs advanced analytical techniques, including Natural Language Processing (NLP) and Large Language Models (LLMs), to quantify sentiment from a vast array of media sources. These tools enable the transformation of qualitative text data into quantifiable metrics, offering a robust method for analyzing the impact of media sentiment on economic trends. By applying these methods to media coverage related to U.S., China, and Korea, the study aims to provide a nuanced understanding of the economic implications from the reported political stability.

The analysis reveals that geopolitical tensions, particularly between the United States and China, exert a pronounced influence on trade performance, especially in export activities. The study finds that fluctuations in media sentiment are often smoothed out when viewed through the lens of monthly trends, offering a more stable perspective on the evolving dynamics of international relations. Additionally, the research highlights the correlation of media sentiment for trade trends, particularly in the service sectors, where positive sentiment is linked to improvements in areas such as transportation and intellectual property services.

The findings in this study hold significant implications for policymakers, economists, and business leaders. The developed index in this study supplements ex-post indicators, with the characteristics of ex-ante indicators, regarding the short-term detection strategy for media sensitive economic system. By recognizing the critical role of media with short-term detection linking to the specific economic sector, stakeholders can better anticipate economic trends and make informed decisions in response to the shifting landscape of international relations.

Theoretical Background

Geopolitical uncertainty has long been recognized as a significant factor influencing global markets and economic stability. The complexity of international relations, particularly among major powers, creates a volatile environment where unexpected political events can lead to rapid shifts in economic conditions. Scholars like Caldara and Iacoviello (2022) have developed indices to measure geopolitical risk, demonstrating its direct impact on market behavior and investment decisions. Recent studies have further expanded on this concept, particularly in the context of specific geopolitical events. For instance, Wang et al. (2022) evaluated the transmission of returns and volatility across commodity markets due to the war in Ukraine, highlighting a substantial

increase in volatility spillover, which might underscore the profound impact of geopolitical risk on global economic stability. Similarly, Shahzad et al. (2023) explored the interconnectedness between geopolitical risk, financial instability, and precious metals markets during the Russia-Ukraine conflict, revealing how such events could intensify market vulnerabilities.

In general, IR scholars argue that while hegemonic leadership facilitates international cooperation, smaller states can sustain global stability through multilateral agreements, even in the absence of a dominant hegemon. This argument is significant in analyzing how smaller economies like South Korea might navigate periods of political instability between powerful states in the global system by leveraging international institutions and alliances (Snidal, 1985). In addition to this, "soft power" by Nye (1990) can be crucial to understanding how both the U.S. and China wield influence over smaller countries like South Korea, which might influence on shaping economic decisions and geopolitical alignments.

Political tension is widely recognized as a detrimental factor for economic growth and instability. Alesina et al. (1996) provided early evidence of this relationship by demonstrating that political instability significantly reduces per capita GDP growth across a large sample of countries. They showed that frequent government changes and social unrest disrupt economic activities, leading to slower growth. Building on this, Aisen and Veiga (2013) further confirmed that higher degrees of political instability are associated with lower growth rates of GDP, particularly by lowering productivity growth rates. These findings align with the work of Bloom (2009, 2014), who demonstrated that uncertainty shocks, including those driven by political instability, result in significant declines in production, employment, and consumption, as businesses and consumers delay decisions amid uncertainty. The collective body of research might underscore the critical impact that political stability has on economic performance, highlighting the importance of stable governance for sustained economic growth.

Much of studies have consistently shown that political disputes, whether arising from territorial conflicts or trade wars, have a negative effect on trade flows between the countries involved. Glick and Taylor (2010) analyzed the economic impact of war and found that conflicts significantly reduce bilateral trade, often leading to long-term disruptions in economic relations. Similarly, the recent trade tensions between the United States and China have provided empirical evidence of how trade disputes can lead to decreased trade volumes, higher tariffs, and shifts in global supply chains, as documented by Amiti et al. (2019).

In terms of measuring the media's effects on economic system, the measurement of media sentiment has evolved significantly with advancements in artificial intelligence and natural language processing (NLP). Much of research have utilized these technologies to analyze large datasets of news articles, speeches, and social media posts, transforming qualitative information into quantifiable sentiment scores. Bollen et al. (2011) were among the first to demonstrate how media sentiment, particularly from social media, can be predictive of market movements. Building on this foundational work, recent studies have expanded the scope and methods of sentiment analysis. Shapiro et al. (2022) developed a news sentiment index that extracts sentiment directly from news content, offering a more direct and dynamic measure compared to traditional survey-based sentiment indicators. Similarly, Doms and Morin (2004) focused on the tone and volume of economic reporting, showing how media coverage influences consumer sentiment. Additionally, Zhou (2018) highlighted various measures of investor sentiment derived from market, survey, and media data, emphasizing the importance of text and media analysis in capturing the mood of the market. During the COVID-19 pandemic, Buckman et al. (2020) further advanced this field by updating sentiment measures with real-time news data, illustrating the immediate impact of news sentiment on economic perceptions and market behavior. Chen and Hsu (2021) examined China's international human rights policy under Xi Jinping,

highlighting a shift from moderation to an assertive promotion of China's illiberal governance model as a global standard, marking a more ambitious and revisionist approach compared to the Hu Jintao era.

Measurement

Text Data in Media

The dataset in this study was obtained through a comprehensive scraping of the ProQuest database. The database is a rich source of scholarly literature and includes various types of documents, such as journal articles, dissertations, reports, and conference papers. The scraping process was carefully designed to capture a wide array of variables, which are crucial for conducting a detailed analysis. The variables extracted from the database include:

- *Publication Date:* The date when the document was published.
- *Title:* The title of the document.
- *Document Type:* The category or type of documents (e.g., newspaper, dissertation, report, and magazine).
- *Publishing Company:* The company responsible for publishing the document.
- *Place of Publication:* The geographic location where the document was published.

For the purpose of this study, we narrowed our focus to a subset of the following conditions:

- Period: January 2021 to December 2023.
- Place of Publication: Worldwide.
- Document Type: Newspaper (English).
- Keyword Search Criteria:[1]
  ((fulltext(U.S. AND China) AND title(U.S. OR China)) NOT title(Korea))
  ((fulltext(Korea AND China) AND title(Korea OR China)) NOT title(U.S.))
  ((fulltext(U.S. AND Korea) AND title(U.S. OR Korea)) NOT title(U.S.))

We limited our analysis to the post-COVID period from 2021 to 2023 on a global scale. As illustrated in Figure 1, the top 20 places of publication are predominantly in New York, Bangkok, Seoul, and Beijing, which together account for over 50% of the total. Although various document types were available, we specifically selected newspapers due to their timeliness, which provides a comparative advantage in terms of both relevance and accessibility of information. The news data presented here tell a story that is clear, diverse, and geographically comprehensive (Meyer, 2018).

In the ProQuest Central News Database, searches are conducted based on keyword search algorithms, allowing for various grammatical options to refine the search for relevant newspapers online. Setting the 'Keyword Searching Criteria' is crucial, as it significantly impacts the research outcomes. For instance, when examining newspapers covering relations between the United States and China, we used the following search criteria: "*((fulltext(U.S. AND China) AND title(U.S. OR China)) NOT title(Korea))*". Firstly, the full text of the newspaper must contain both keywords, 'U.S.' and 'China', with at least one of these keywords also appearing in the news title. Secondly, the results are then filtered to focus specifically on the bilateral relationship by excluding any newspapers where the title includes 'Korea'. This process ensures a more targeted dataset, emphasizing the U.S.-China relationship while excluding irrelevant mentions of Korea.

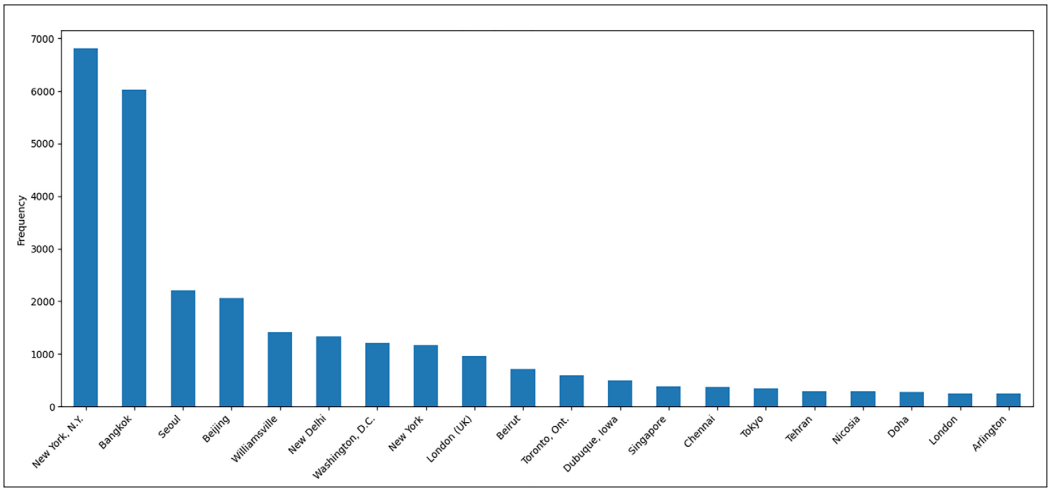

Figure 1. Most frequent place of publication
Note: The graph displays the top 20 place of publication of newspapers in total of 34,001 articles. / Data has been downloaded in ProQuest Database (https://www.proquest.com/). / For additional details on the metadata of the news data we gathered, please refer to Appendix A.

In total, we gathered 34,001 newspaper articles over the three-year period related to the U.S., China, and Korea. The dataset reflects three distinct relationships: U.S. and China (19,171 articles), China and Korea (8,548 articles), and Korea and the U.S. (6,282 articles).

Text Data to Numbers

For the econometric analysis involving trade statistics, it is essential to convert text data into numerical form. We employ a method known as Natural Language Processing (NLP) on the titles of newspapers. Following this, we utilize deep learning techniques, particularly transformer-based models (Vaswani et al., 2017), to quantify sentiment as numerical values. This approach enables us to automatically assess the economic sentiment between the two countries, providing valuable insights into the underlying perceptions and attitudes embedded in the textual data.

Gössi et al. (2023) developed Large Language Models (LLMs) to analyze complex financial texts, utilizing Federal Open Market Committee (FOMC) minutes that cover a broad range of economic topics. Building on this approach, Kim and Kim (2024) extracted sentiment scores related to China and Korea to detect economic issues in real-time. They also incorporated the concept of "Biased Word" introduced by Kim (2023), which is an efficient model for capturing negative narratives in news titles. Identifying negatively biased words becomes feasible through tokenization,[2] allowing for a more nuanced understanding of sentiment in the textual data.

Table 1 presents the frequency of the top 50 words in news titles. Based on these results, we identified biased words for each bilateral relationship. For example, in the context of U.S. and China relations, biased words include 'Taiwan,' 'War,' 'Military,' and 'Tensions.' These words are considered to have a negative impact on the sentiment analysis. Therefore, we adjust the results of FinBERT-FOMC (Gössi et al., 2023) by applying a negative impact equivalent to -1*standard deviation for each news title sentences.

Table 1. Most frequent words in newspaper (2021-2023)

United States and China				Korea and United States				China and Korea			
Keyword	Freq.	Keyword	Freq.	Keyword	Freq.	Keyword	Freq.	Keyword	Freq.	Keyword	Freq.
China	16,245	Japan	404	Korea	5,576	**Missiles**	**170**	China	5,815	**Military**	**225**
U.S.	7,288	Ukraine	372	U.S.	2,118	Market	168	Korea	4,574	Covid	221
Chinese	1,558	Business	357	North	1,957	Seoul	166	North	1,744	Asian	219
Taiwan	**1,507**	Trade	349	South	1,769	News	165	South	1,627	**Nuclear**	**199**
United	1,376	Asia	340	Republic	632	Jong	161	Japan	834	Amid	199
Korea	1,375	Global	337	United	628	Stock	160	Taiwan	456	**War**	**185**
States	1,294	Trade	331	States	576	Shares	154	Russia	381	Trade	181
Biden	1,114	U.S.-China	326	Japan	498	Test	151	Biden	380	Region	180
Beijing	1,021	Says	324	**Missile**	**334**	Ukraine	148	United	371	Global	175
Russia	802	Stocks	322	Biden	320	**Missile**	**140**	India	346	New	166
Foreign	800	Canada	312	Korean	309	Stocks	137	States	330	N.	162
Xi	777	Economic	307	Kim	298	New	136	Foreign	320	Visit	158
Says	753	Sea	299	N.	289	Un	134	Asia	312	Desk	153
News	746	President	299	Foreign	245	Iran	130	Republic	277	Jong	147
South	738	India	295	President	237	New	128	Korean	276	Test	144
Desk	691	Visit	284	S.	233	**Nuclear**	**126**	World	275	Seoul	143
World	636	Global	284	Says	210	Pyongyang	126	Says	272	World	142
North	633	Blinken	281	**Military**	**205**	Drills	125	Xi	271	):	141
New	576	World	278	World	200	Ballistic	124	Kim	264	Pelosi	139
Market	495	Amid	276	**Nuclear**	**191**	**Launch**	**124**	Ties	254	**Missiles**	**137**
---	484	**War**	**265**	Russia	185	Tests	124	New	241	Talks	130
Military	**480**	**War**	**262**	):	184	Secretary	106	Beijing	238	Summit	130
Stock	479	Republic	261	Desk	179	Minister	105	S.	235	Economic	128
New	462	Iran	261	**Fires**	**177**	Talks	104	**Missile**	**232**	**Threat**	**125**
Ties	425	**Tensions**	**245**	Yoon	173	Meeting	103	Chinese	226	Vietnam	125

Note: The table displays the top 50 most frequent words associated with each relationship among the three countries. / Bolded words (e.g., nuclear, military, tensions) indicate negatively biased terms found in news titles.

Numbers to Political Stability

We calculate the net political stability score daily. However, because most economic statistics are reported monthly, quarterly, or annually, this study averages the daily political stability data to match the monthly frequency. Figure 2 deficits political stability on a weekly and monthly basis, as determined by LLMs' sentiment scores. The realization of political stability is underscored by several critical observations. Firstly, media coverage predominantly focuses on negative news, which amplifies perceptions of stability. Secondly, when we aggregate daily data to a monthly frequency, this process normalizes the scores and filters out the noise from daily news fluctuations, thereby enhancing the accuracy of trend forecasting in international relations.

Finally, the significance of these scores extends beyond their numerical values; the changes observed from week to week or month to month offer valuable insights into evolving political dynamics.

The left graphs of figure represent average instable media sentiment between the United States and China from 2021 to 2023. The sentiment shows significant fluctuations over this period, with notable peaks and troughs, indicating periods of heightened and reduced tensions. The stability seems to decrease notably during mid-2022 and late 2022, with some sharp spikes in the sentiment score, which could correspond to specific political events or diplomatic incidents. In August 2022, the line shows that while US-China media sentiment reached its lowest point due to US House Speaker Nancy Pelosi's visit to Taiwan, the impact on US-Korea media sentiment was minimal, whereas Korea-China sentiment deteriorated significantly (see Figure 2). This indicates that media reactions to the same international event differ across bilateral relationships, demonstrating that South Korea's geopolitical position makes it more sensitive to relations with China in situations of US-China conflict.

The bottom graph, showing the monthly average sentiment scores, presents a smoother trend. It highlights that while there were significant weekly fluctuations, the overall monthly sentiment still exhibits notable instability with several noticeable drops, particularly around early 2022 and again towards the end of 2023. On August 4, 2022, China's initiation of military exercises around Taiwan significantly heightened negative media sentiment between the two countries (see Appendix A).

The middle set of graphs focuses on the sentiment between Korea and the United States. The weekly sentiment scores, as shown in the top middle graph, indicate a more consistent trend compared to the U.S.-China relationship, also lower level of negativity, though there are still numerous fluctuations. The sentiment appears to stabilize somewhat throughout 2022 and into 2023, despite some intermittent spikes in both positive and negative directions. The monthly average sentiment, depicted in the bottom middle graph, confirms this instability, showing that while there are still minor variations, the overall trend is relatively steady, particularly when compared to the U.S.-China relationship. This might suggest fewer extreme events influencing the political relationship between Korea and the United States during this period.

The right set of graphs illustrates the sentiment between China and Korea. The weekly average sentiment (top right graph) exhibits frequent and somewhat erratic fluctuations, indicating a relationship marked by periodic tensions. While there are several peaks and troughs, the overall trend remains close to neutral with minor positive and negative sentiments dominating. The bottom right graph, showing the monthly averages, reflects a similar pattern with some stability but smoother and less pronounced than the weekly data. The bottom right graph, showing the monthly averages, reflects a similar pattern with some stability but smoother and less pronounced than the weekly data. This could suggest that while there are frequent short-term tensions between China and Korea, they tend to balance out over longer periods, maintaining a relatively stable but occasionally volatile relationship. The notable upward trend in the line from early 2023 corresponds with a more peaceful diplomatic climate, specifically when South Korea participated in trilateral talks with Japan and China, focusing on economic cooperation despite historical and territorial disputes. This positive shift in sentiment illustrates how diplomatic engagement can influence media sentiment despite underlying tensions, showing the responsiveness of the relationship to constructive multilateral initiatives.

In summary, the political instabilities between these countries over the 2021-2023 period display varying levels of volatility. The U.S.-China relationship appears the most unstable on a weekly basis, followed by China-Korea and then Korea-U.S., with monthly trends reflecting a slightly more stable but still fluctuating political landscape.

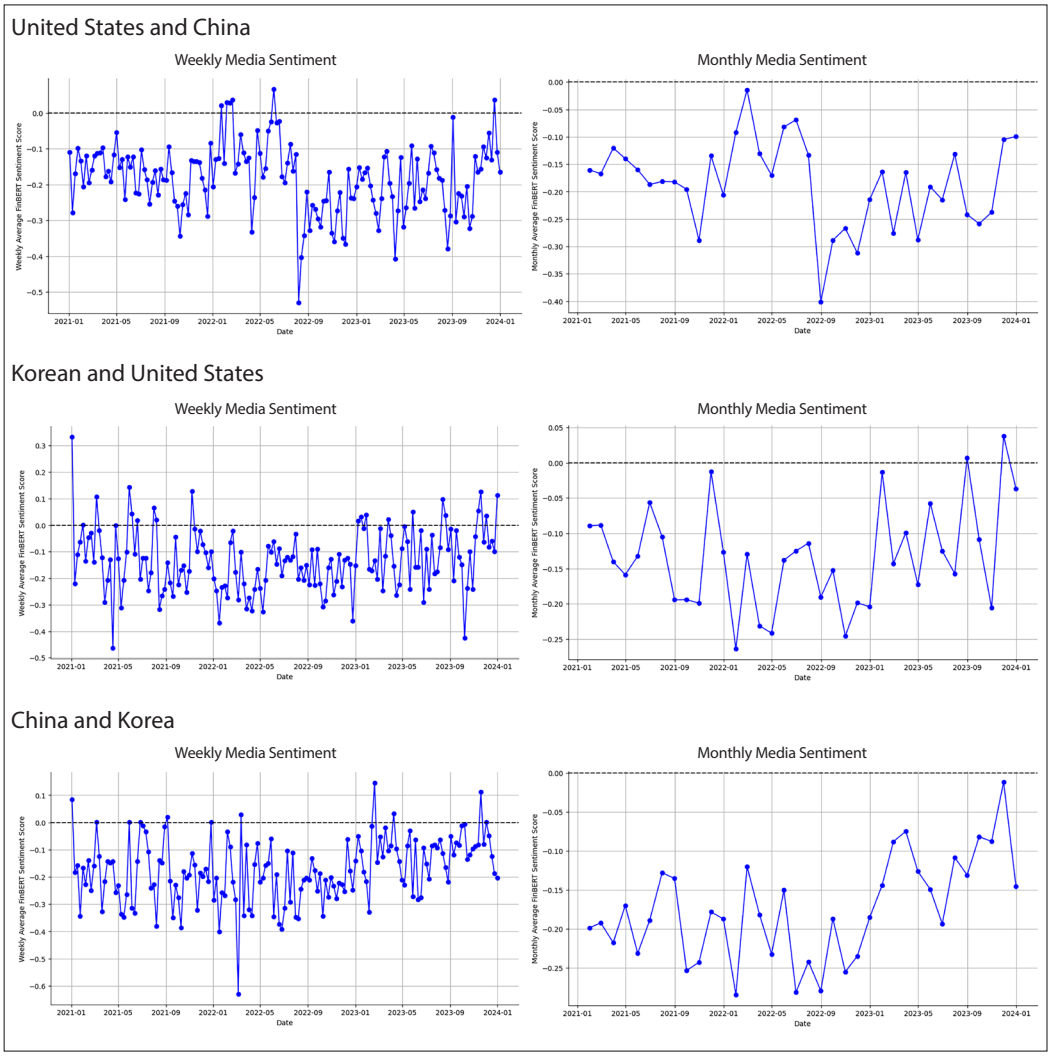

Figure 2. Political stabilities between countries (2021-2023)

Note: The figures display the sentiment scores of news titles generated by Large Language Models (LLMs). The original scores were calculated on a daily basis, but we aggregated them into weekly and monthly averages to better align with statistical analysis. The top three figures represent the weekly average scores, highlighting the weekly stability between the two countries. The bottom three figures, which are smoother, represent the monthly average scores, illustrating the monthly stability between the two countries. The sentiment scores range from -1 to 1, where -1 indicates extreme instability and 1 indicates extreme stability.

The Interaction of Media Sentiment and Trade

We explore political news sentiment with key economic indicators, focusing specifically on Korea's Trade Business Diffusion Index[3] (TBDI) and Balance of Payments[4] (BOP). TBDI serves to illuminate latent exploratory relationships with media sentiment, whereas BOP is analyzed

to establish a more robust statistical correlation. The rationale for integrating economic data is to lend credibility to the research objective of capturing the political influence on trade. As a strategically positioned middle power with high trade dependency, Korea's economic stability is intrinsically vulnerable to geopolitical tensions between dominant global actors. This analysis aims to examine how shifts in political relations between larger nations affect Korea's economic performance.

The TBDI is a comprehensive statistical measure designed to assess the overall trends in South Korea's trade economy. As globalization, multilateral WTO agreements, and the expansion of FTAs have heightened the significance of external trade, the TBDI provides essential data for analyzing and predicting trade conditions. This index is a crucial tool for economic analysis and the formulation of trade policies, offering valuable insights into the state and outlook of the trade economy.

Figure 3 titled "Trend of Political Instabilities and TBDI" presents two graphs that explore the relationship between political sentiment and the TBDI over time. Both graphs utilize 6-month moving averages to smooth out short-term fluctuations, thereby emphasizing long-term trends in the data. Additionally, the data have been normalized using min-max scaling, which adjusts all values to a common range of 0 to 1, allowing for easier comparison across different series. A key feature of the graphs is the gray shaded area surrounding the moving average lines, which represents the range of TBDI values, bounded by 110% of the upper moving average and 90% of the lower moving average. This shaded band highlights the variability and uncertainty within the TBDI data, providing a visual indication of how much the trade index can fluctuate around the central trend.

Notably, Korea's TBDI exhibits stronger synchronization with sentiment indices related to US-China relations (UC_sentiment) than with Korea-US (KU_sentiment) or China-Korea (CK_sentiment) relations. This suggests that geopolitical developments between the United States and China exert greater influence on Korea's trade patterns. In particular, export TBDI demonstrates a distinct correlation with media sentiment indices (especially UC_sentiment), indicating that export performance responds more sensitively to political stability and sentiment in US-China relations. In contrast, import TBDI shows a relatively weaker relationship, suggesting that import activities are influenced by various factors beyond geopolitical sentiment. This visualization clearly illustrates how, as a small open economy positioned between two major powers, Korea's economic performance is affected by changes in political relationships between larger nations. The dynamic correlation between TBDI and media sentiment indices offers critical analytical leverage for elucidating how geopolitical stability fluctuations cascade through international trade networks.

The BOPs are a comprehensive statistical record of all economic transactions between residents and non-residents of Korea within a specific period. This data serves as fundamental information for compiling the external account in the national accounts and is crucial for understanding the external economic activities of a country. The BOP captures various forms of transactions, including the supply and disposal of goods and services, income distribution, and capital accumulation, offering a comprehensive view of Korea's external economic interactions. By analyzing the trends in Korea's external transactions, the BOP provides essential data for formulating national economic policies and assessing their effectiveness.

The BOP is classified as processed statistics and adheres to the accrual principle, meaning all transactions between residents and non-residents are evaluated at actual market prices agreed upon by the parties involved. For instance, goods exports and imports are assessed at FOB (Free on Board) prices, excluding pure re-exports. Each transaction is recorded systematically according to the double-entry bookkeeping principle, where every transaction is entered

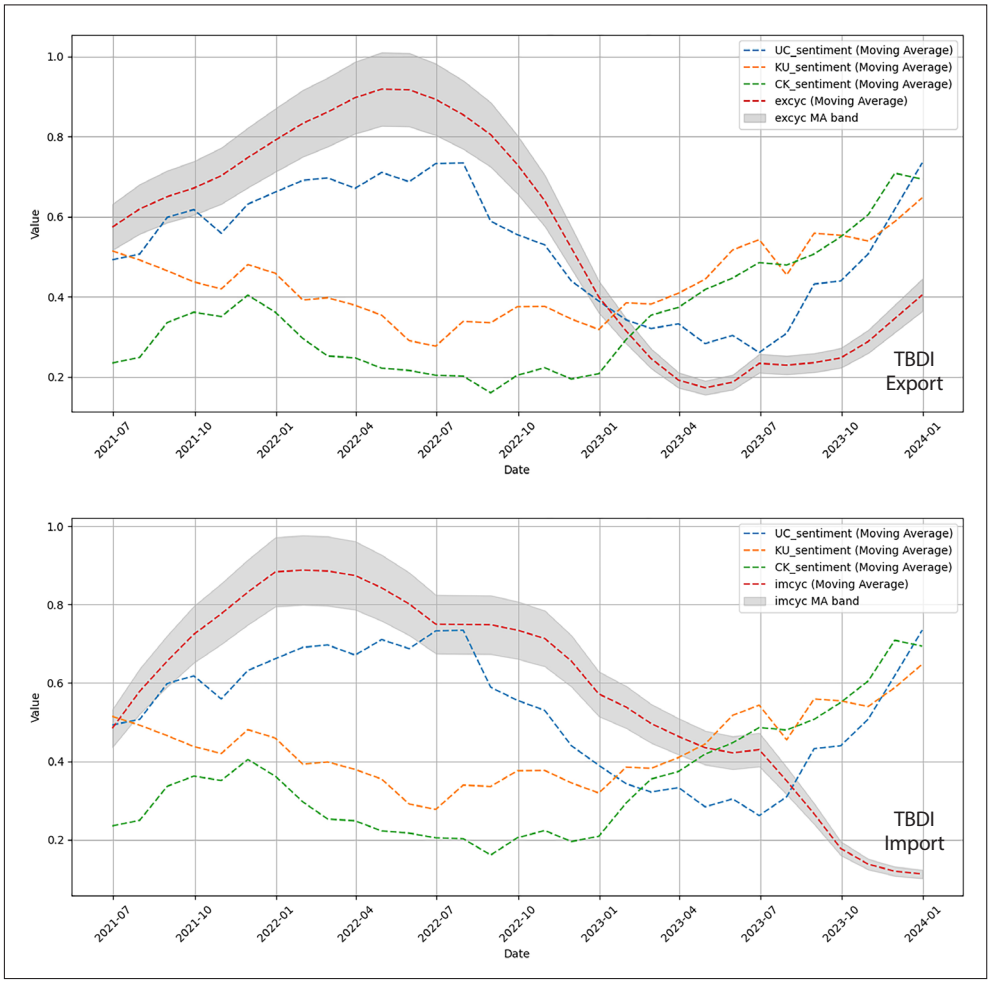

Figure 3. Trend of political instabilities and TBDI

Note: All time series data are presented as 6-month moving averages (seasonally adjusted), with min-max normalization applied to scale the values between 0 and 1 for comparison purposes. / The top graph illustrates media sentiment alongside the Trade Business Diffusion Index (TBDI) for exports, adjusted for cyclical factors through hp filter. / The bottom graph displays media sentiment in relation to the TBDI for imports, also adjusted for cyclical factors through hp filter. / The grey area in each graph represents the range of TBDI values, bounded by 110% of the upper moving average and 90% of the lower moving average.

simultaneously on both the debit and credit sides in the same amount. To ensure comparability between countries, Korea's BOP is structured according to the IMF's Balance of Payments Manual (BPM), specifically the sixth edition currently in use. When the raw data used for BOP compilation does not align with BOP standards, adjustments are made to match the timing, classification, and coverage according to the BOP criteria. The BOP is compiled using the U.S. dollar (USD) as the calculation currency.

Table 2. List of variables in the balance of payments for Korea

Variable	Name (English)	Name (Korean)
BC	**Current Account Balance**	**경상수지**
BP	**Trade Balance**	**상품수지**
BP1	Goods Exports	상품수출
BP2	Goods Imports	상품수입
BS	**Service Balance**	**서비스수지**
BS1	Service Exports	서비스수출
BS2	Service Imports	서비스수입
BS3	Processing Service Balance	가공서비스수지
BS4	Transport Balance	운송수지
BS5	Travel Balance	여행수지
BS6	Construction Balance	건설수지
BS7	Insurance Services Balance	보험서비스수지
BS8	Financial Services Balance	금융서비스수지
BS9	Telecommunications and Computer Services Balance	통신컴퓨터정보서비스수지
BS10	Intellectual Property Rights Usage Balance	지식재산권사용수지
BS11	Maintenance Services Balance	유지보수수지
BS12	Other Business Services Balance	기타사업서비스수지
BS13	Personal, Cultural, and Recreational Services Balance	개인문화오락서비스수지
BS14	Government Services Balance	정부서비스수지

Note: For detail information of BOP, please see online publication:
https://ecos.bok.or.kr/#/StatisticalResearchPublication/MainStatisticsPublication

Influence of Stability

Time series analysis in this study involves two primary investigations: first, examining the correlation between economic stability and the Balance of Payments (BOP), and second, employing multiple regression analysis to understand the relationship between variables in Table 2. Correation analysis aims to identify and quantify the degree to which fluctuations in economic stability are associated with changes in the BOP. This involves calculating correlation coefficients over time to observe patterns and trends, helping to understand how closely these two variables move together. The second part of the analysis utilizes multiple regression techniques to explore the impact of multiple independent variables on the BOP.

BOP has hierarchical structures 1st level of BC, BP, BS and 2nd level of BP (1~2) and BS (1~14). The Current Account Balance (BC) represents the overall net of a country's international transactions, encompassing trade in goods and services, net income from abroad, and net current transfers. The Trade Balance (BP) is divided into Goods Exports (BP1) and Goods Imports (BP2), reflecting the value of goods Korea trades with the rest of the world. The Service Balance (BS) is more granular, covering various aspects of the service economy, including exports and imports of services, such as transport (BS4), travel (BS5), and financial services (BS8). It also includes specialized categories like Intellectual Property Rights Usage (BS10) and Telecommunications and Computer Services (BS9). This detailed categorization helps to understand the different

components that contribute to Korea's overall balance of payments, offering insights into how different sectors influence the country's economic stability.

In Figure 4, the correlation matrix heatmap you've provided visualizes the relationships between several variables, indicated by color gradients ranging from blue (negative correlation) to red (positive correlation). The diagonal of the matrix represents perfect correlations (value of 1.00), as each variable is compared with itself. Off-diagonal cells display the strength and direction of the correlation between different variables, where values close to +1 suggest a strong positive correlation, and values close to -1 suggest a strong negative correlation.

Focusing on specific relationships, the heatmap reveals that UC_sentiment and BS9 have a moderate negative correlation of -0.31, indicating that as UC_sentiment increases, BS9 tends to decrease. Similarly, KU_sentiment shows a moderate positive correlation of 0.42 with BS4, suggesting they increase together, while it has a moderate negative correlation of -0.40 with BS8, indicating an inverse relationship. Additionally, CK_sentiment is moderately positively correlated with BS10 at 0.44, suggesting that as one increases, the other does as well.

Beyond these specific correlations, the heatmap shows that variables such as BC and BP generally do not exhibit strong correlations with other variables, with most values close to zero. This suggests little to no linear relationship between these variables and others in the dataset. The overall pattern indicates that while some variables are moderately correlated, many do not show significant linear relationships, which could imply more complex interactions or lack of association. Political instability may, therefore, be correlated with the service balance, particularly in sectors such as transport, finance, telecommunications, computer services, and intellectual property rights.

Before conducting regression analysis on your time series data, it's crucial to ensure that the data is stationary, as non-stationary data can lead to spurious regression results. Stationarity implies that the statistical properties of the series, such as mean, variance, and autocorrelation, are constant over time. To achieve stationarity, you've applied differencing to the time series data by calculating the percentage change. With the data now stationary, you can proceed with regression analysis with more confidence that the relationships you identify will be reliable and not artifacts of non-stationarity.

Media sentiment demonstrates a significant correlation with the Service Balance (BS), indicating its potential as a proxy for political and economic stability. An increase in sentiment scores typically reflects a reduction in perceived political stability, while a decrease suggests heightened instability. From an academic perspective, a positive coefficient aligns with established theories, such as those in behavioral economics and international finance, where stable sentiment fosters consumer and investor confidence, positively influencing the balance of payments. Conversely, unstable sentiment tends to exacerbate uncertainties, negatively impacting economic outcomes.

In Table 3, The regression analysis reveals a significant negative relationship between UC and BS9, with a coefficient of -6.3352. This indicates that an increase in UC is associated with a substantial decrease in BS9.[5] The relationship is statistically significant at the 10% level ($p < 0.1$), suggesting sensitivity but a weak level of significance. For KU, the analysis shows contrasting relationships with BS4 and BS8. The coefficient for KU with BS4 is 0.6802, marked as significant at the 5% level ($p < 0.05$), indicating a positive correlation, where increases in KU are associated with increases in BS4.[6] Conversely, the coefficient for KU with BS8 is -2.4276, significantly at the 5% level ($p < 0.05$), indicating a negative correlation, suggesting that higher KU sentiment values are linked to decreases in BS8.[7] Regarding CK, the results show a strong positive relationship with BS10, with a coefficient of 1.1275 and significance at the 1% level ($p < 0.01$), indicating that increases in CK are strongly associated with increases in BS10.[8] Additionally, CK

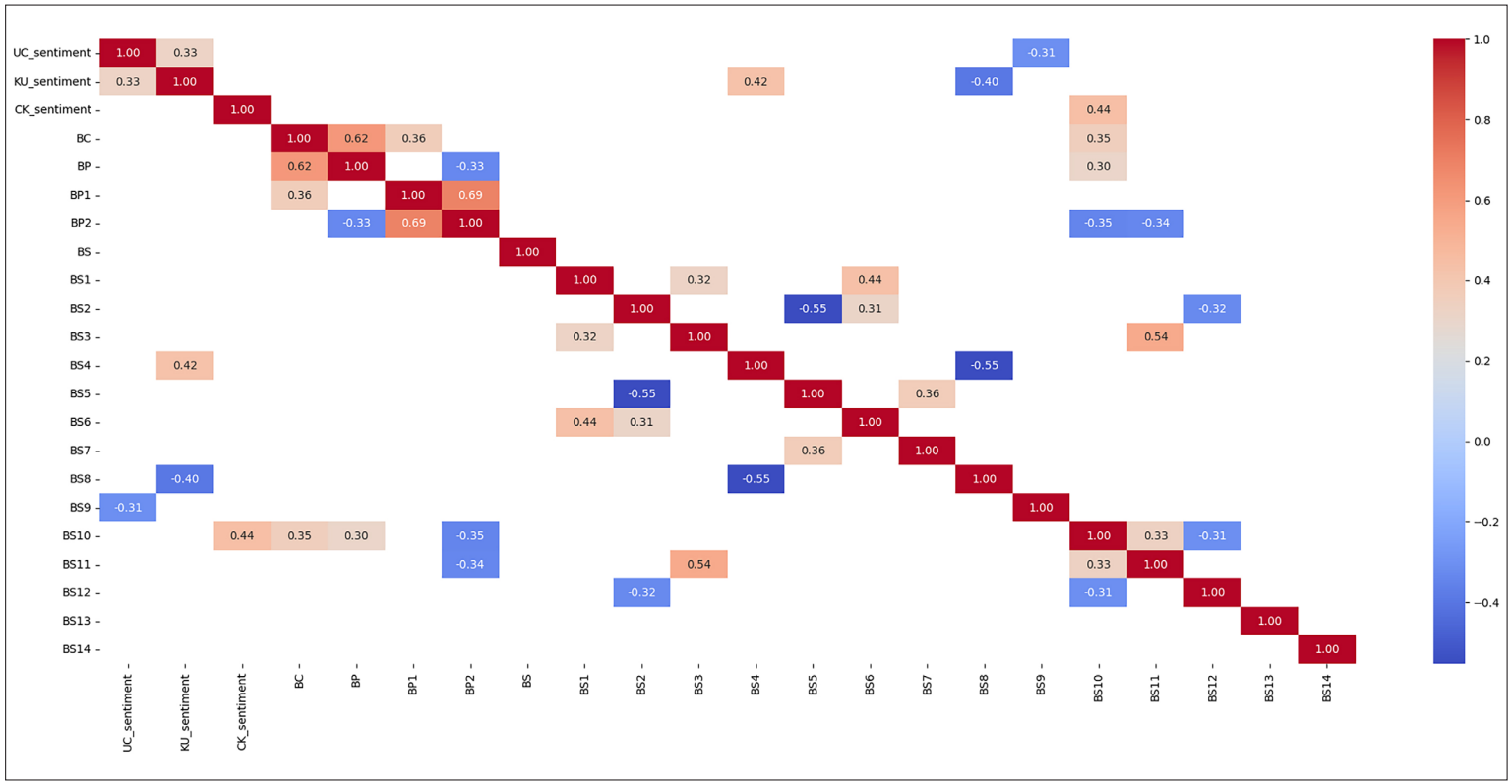

Figure 4. Correlation matrix heatmap

Note: To focus on the most significant correlations, a mask was applied to retain only those correlations with an absolute value greater than 0.3 (i.e., correlations stronger than 0.3 or weaker than -0.3).

Table 3. OLS Regression results

Dependent	Coef. UC	Std err	t	R-squared	Coef. KU	Std err	t	R-squared	Coef. CK	Std err	t	R-squared
BC	**0.618**	0.718	0.861	0.022	**0.267**	0.369	0.724	0.016	**-0.010**	0.052	-0.183	0.001
BP	**0.638**	0.576	1.107	0.036	**-0.246**	0.298	-0.825	0.020	**-0.005**	0.042	-0.116	0.000
BP1	**0.006**	0.012	0.460	0.006	**0.004**	0.006	0.642	0.012	**0.000**	0.001	-0.430	0.006
BP2	**-0.012**	0.014	-0.825	0.020	**0.002**	0.007	0.231	0.002	**0.000**	0.001	-0.371	0.004
BS	**-0.766**	1.553	-0.493	0.007	**-0.343**	0.796	-0.430	0.006	**-0.033**	0.111	-0.292	0.003
BS1	**-0.003**	0.016	-0.206	0.001	**-0.007**	0.008	-0.894	0.024	**-0.001**	0.001	-0.626	0.012
BS2	**0.002**	0.017	0.141	0.001	**-0.007**	0.009	-0.836	0.021	**0.001**	0.001	0.419	0.005
BS3	**-0.091**	0.057	-1.576	0.070	**-0.036**	0.030	-1.189	0.041	**0.000**	0.004	-0.084	0.000
BS4	**0.407**	0.539	0.755	0.017	**0.6802****	0.252	2.696	0.181	**0.005**	0.039	0.116	0.000
BS5	**-0.024**	0.084	-0.285	0.002	**-0.028**	0.043	-0.654	0.013	**-0.004**	0.006	-0.605	0.011
BS6	**0.049**	0.146	0.339	0.003	**0.010**	0.075	0.135	0.001	**-0.011**	0.010	-1.111	0.036
BS7	**0.052**	0.334	0.156	0.001	**-0.126**	0.170	-0.739	0.016	**-0.005**	0.024	-0.191	0.001
BS8	**-1.310**	2.072	-0.632	0.012	**-2.4270****	0.981	-2.473	0.156	**0.031**	0.149	0.209	0.001
BS9	**-6.3352***	3.423	-1.851	0.094	**-1.035**	1.834	-0.564	0.010	**-0.018**	0.257	-0.068	0.000
BS10	**0.590**	0.693	0.851	0.021	**0.079**	0.359	0.220	0.001	**0.1275*****	0.045	2.838	0.196
BS11	**0.130**	2.099	0.062	0.000	**-0.194**	1.075	-0.180	0.001	**-0.019**	0.150	-0.125	0.000
BS12	**0.446**	0.732	0.609	0.011	**0.083**	0.377	0.221	0.001	**-0.016**	0.053	-0.309	0.003
BS13	**0.505**	0.674	0.750	0.017	**-0.362**	0.342	-1.056	0.033	**-0.070**	0.047	-1.477	0.062
BS14	**0.296**	0.566	0.523	0.008	**0.357**	0.285	1.256	0.046	**0.0699***	0.039	1.801	0.089

Note: Significance levels are marked as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. / Please refer to Appendix C for descriptive statistics.

shows a weaker but still significant positive relationship with BS14[9], with a coefficient of 0.0699 and significance at the 10% level ($p < 0.1$), suggesting a slight increase in BS14 as CK rises.

However, a negative coefficient, indicating a reversed effect, poses a theoretical challenge. Such results imply that stable media sentiment correlates with negative service balance outcomes, which contradicts established frameworks like the Keynesian theory of aggregate demand, where stability encourages positive economic behavior. This counterintuitive finding may result from omitted variable bias, measurement errors, or non-linear relationships that standard regression models fail to capture. To address these issues, additional tests such as interaction terms, sensitivity analyses, or advanced econometric models like structural equation modeling (SEM) or instrumental variable (IV) regressions are required. These methods can help disentangle potential endogeneity and provide a more robust understanding of the underlying relationship between media sentiment and service balance.

Conclusion

This study attempts to create a media sensitive-trade index, with a focus on the geopolitical dynamics between the Unities States, China, and Korea. Using advanced Natural Language Processing (NLP) techniques and Large Language Models (LLMs), the research quantifies media sentiment and links it to economic outcomes, such as Korea's Trade Business Diffusion

Index (TBDI) and Balance of Payments (BOP). The analysis shows that Korea's trade trends are more influenced by the broader U.S.-China relationship than by its direct relations with either nation. Notably, the study finds that media sentiment, particularly in the service sectors, plays a predictive role in economic trends, with positive sentiment correlating with improved performance in areas such as transportation and intellectual property services. The developed index in this study supplements ex-post indicators, with the characteristics of ex-ante indicators, regarding the short-term detection strategy for media sensitive economic system.

The analysis reveals that geopolitical tensions, particularly between the United States and China, exert a pronounced influence on trade performance, especially in export activities. The study finds that fluctuations in media sentiment are often smoothed out when viewed through the lens of monthly trends, offering a more stable perspective on the evolving dynamics of international relations. Additionally, the research highlights the correlation of media sentiment for trade trends, particularly in the service sectors, where positive sentiment is linked to improvements in areas such as transportation and intellectual property services.

The study highlights the critical role of media sentiment in forecasting trade trends, particularly in service sectors like transportation and intellectual property services. Positive media sentiment was found to correlate with improvements in these sectors, emphasizing the interconnected nature of political stability and economic outcomes. Korea's economic performance is not only influenced by its own bilateral relations but is also shaped by the broader hegemonic structure dominated by the U.S. and China.

In conclusion, the findings have significant implications for policymakers, economists, and business leaders. The developed index in this study supplements ex-post indicators, with the characteristics of ex-ante indicators, regarding the short-term detection strategy for media sensitive economic system. By recognizing the critical role of media with short-term detection linking to the specific economic sector, stakeholders can better anticipate economic trends and make informed decisions in response to the shifting landscape of international relations..

AI Acknowledgment

Generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete essential authoring tasks in this manuscript.

Conflicting interests

The author(s) declare that there is no conflict of interest (If there are conflicts of interest, list them in detail, specifying the nature of the conflict and the involved parties.).

Funding

1. This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2024S1A5B5A17037511).
2. This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2020S1A6A3A04064633).

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Notes

1. The search criteria in ProQuest database queries function as a form of grammar within the search prompt. For rigorous research, experimenting with various options can enhance the scientific validity of the results. However, when comparing the ex-ante method of using prompt grammar to the ex-post method of technical filtering, there is no single optimal approach. It is important to keep this debate in mind for future research.
2. "Tokenization" is the process of breaking down text into individual units called "tokens." These tokens could be words, phrases, symbols, or other essential elements. Tokenization is a vital step in natural language processing (NLP) and text analysis, as it converts raw text into a format that algorithms can more easily analyze and understand.
3. The TBDI is classified as a processed statistic, created by selecting representative continuous items that constitute exports and imports, collecting the necessary data, and then aggregating and compiling it to form the index. The index is included in the "Export-Import Trends" report, released between the 1st and 5th of each month for the previous month. Data collection for each component indicator occurs between the 15th and 16th, and the index is compiled using tools like Excel, eViews, SAS, and X13-ARIMA between the 19th and 25th. The results are published at the end of each month through a press release on the Korea Trade Statistics Promotion Institute website. / Data is accessible in Korean Statistical Information Service (KOSIS): https://kosis.kr/statHtml/statHtml.do?orgId=134&tblId=DT_134004_001&conn_path=I2
4. Data is accessible in Korean Statistical Information Service (KOSIS): https://kosis.kr/statHtml/statHtml.do?orgId=301&tblId=DT_301Y017&conn_path=I2 / Online publication: https://ecos.bok.or.kr/#/StatisticalResearchPublication/MainStatisticsPublication
5. Telecommunications and Computer Services Balance
6. Transport Balance
7. Financial Services Balance
8. Intellectual Property Rights Usage Balance
9. Government Services Balance

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Appendix A

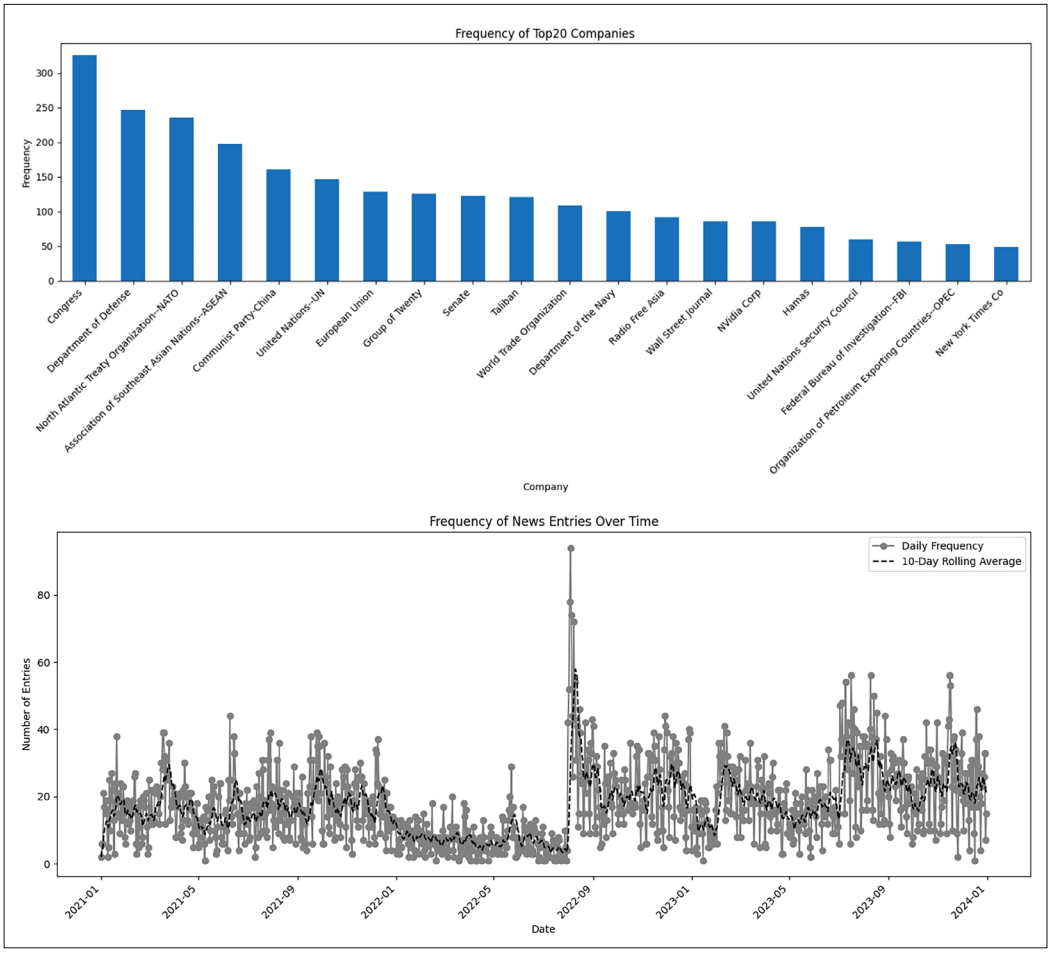

Figure A1. Newspapers regarding United States and China (2021-2023)

Note: The top bar graph displays the top 20 companies that publish newspapers related to 'U.S.' and 'China' out of a total of 2,510 companies. / The bottom-line graph illustrates the frequency of daily newspaper publications, with the dashed line representing a 10-day rolling average. / Data has been downloaded in ProQuest Database (https://www.proquest.com/).

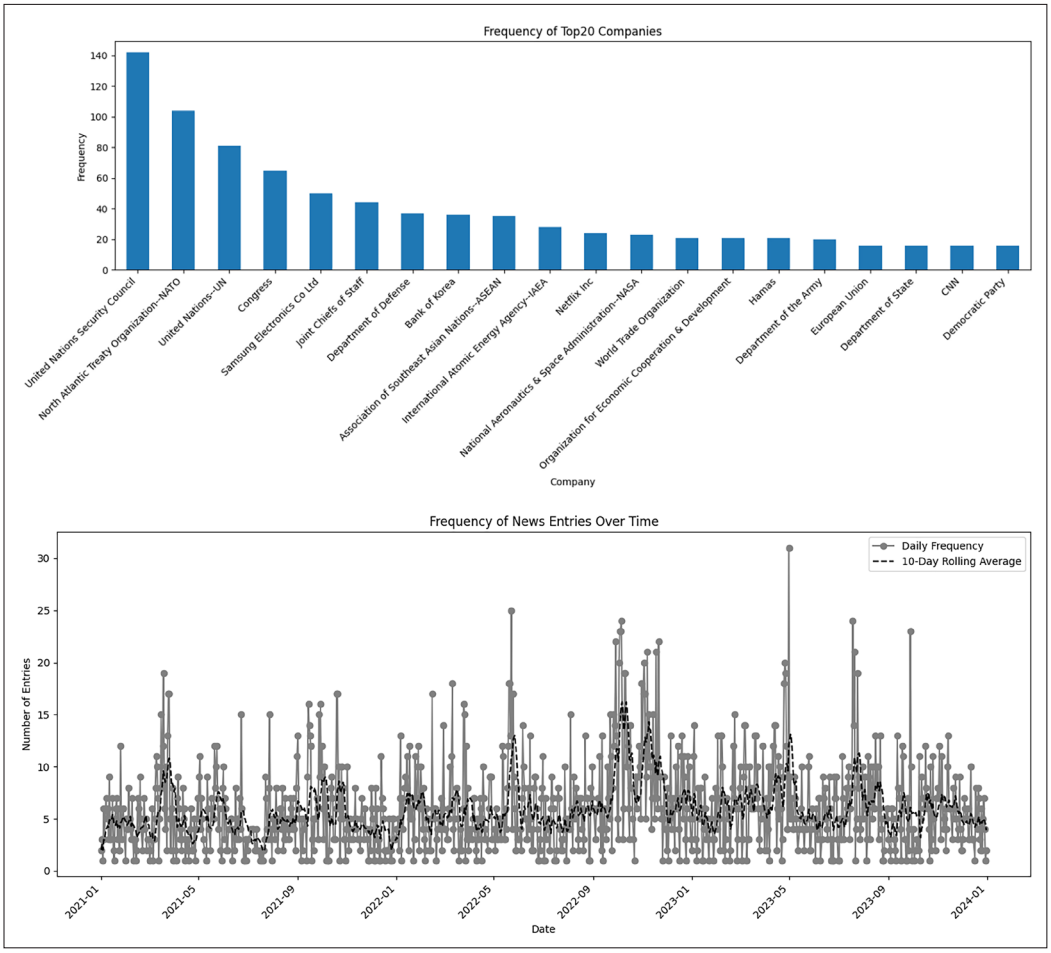

Figure A2. Newspapers regarding Korea and United States (2021-2023)

Note: The top bar graph displays the top 20 companies that publish newspapers related to 'Korea' and 'U.S.' out of a total of 733 companies. / The bottom-line graph illustrates the frequency of daily newspaper publications, with the dashed line representing a 10-day rolling average. / Data has been downloaded in ProQuest Database (https://www.proquest.com/).

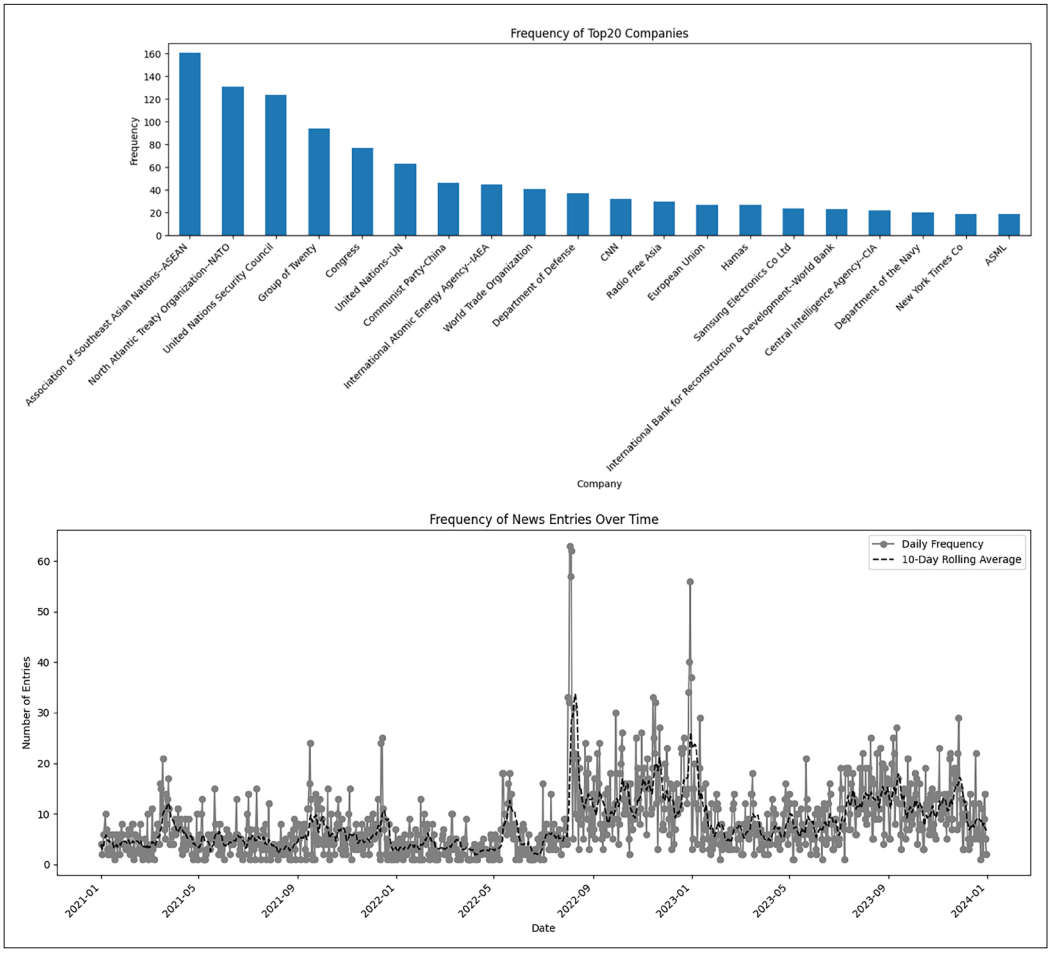

Figure A3. Newspapers regarding China and Korea (2021-2023)

Note: The top bar graph displays the top 20 companies that publish newspapers related to 'China' and 'Korea' out of a total of 792 companies. / The bottom-line graph illustrates the frequency of daily newspaper publications, with the dashed line representing a 10-day rolling average. / Data has been downloaded in ProQuest Database (https://www.proquest.com/).

Appendix B

Table B1. Main Political Issue between United States and China (2021-2023)

Month	Issue	Description
Jan-21	Biden administration takes office	U.S. President Joe Biden assumes office, continuing tough policies on China, especially on trade and human rights.
Ar-21	Alaska meeting	Senior U.S. and Chinese officials meet in Alaska, exchanging sharp criticisms, reflecting strained relations.
Apr-21	Climate cooperation	U.S. and China agree to cooperate on climate change, showing potential for collaboration despite broader tensions.
Jun-21	G7 summit	G7 leaders, including the U.S., criticize China on human rights and trade practices; China accuses G7 of interference.
Jul-21	China's 100th communist party anniversary	Xi Jinping warns foreign powers against "bullying" China; the U.S. continues criticism on human rights issues.
Feb-22	Winter olympics in beijing	U.S. leads a diplomatic boycott of the Beijing Winter Olympics due to China's human rights abuses.
Apr-22	Taiwan relations	The U.S. increases support for Taiwan, causing heightened tensions with China over sovereignty concerns.
Aug-22	Nancy pelosi's visit to taiwan	U.S. Speaker Nancy Pelosi visits Taiwan, leading to Chinese military exercises and heightened regional tensions.
Oct-22	U.S. Export controls on semiconductor technology	U.S. imposes strict export controls to limit China's access to advanced technology, escalating economic rivalry.
Feb-23	Spy balloon incident	U.S. shoots down a Chinese balloon suspected of espionage; China claims it was a civilian balloon, leading to a diplomatic fallout.
Apr-23	Tiktok hearings	U.S. lawmakers scrutinize TikTok for potential national security threats, intensifying debates over data privacy and Chinese influence.
Jun-23	Biden's statements on taiwan	President Biden affirms U.S. military support for Taiwan in case of a Chinese invasion, prompting strong reactions from China.
Aug-23	BRICS summit	China participates in BRICS discussions on reducing U.S. global financial influence, signaling a challenge to U.S. dominance.

Note: The authors manually organize Google News articles online to empirically assess their alignment with political instability.

Table B2. Main Political Issue between Korea United States (2021-2023)

Month	Issue	Description
May-21	U.S.-South Korea summit	South Korean President Moon Jae-in meets with U.S. President Joe Biden, reaffirming the U.S.-South Korea alliance and discussing cooperation on North Korea, China, and global issues.
Jun-21	Vaccine cooperation	The U.S. agrees to provide COVID-19 vaccines to South Korea, strengthening bilateral cooperation during the pandemic.
Aug-21	U.S.-South Korea military drills	The U.S. and South Korea conduct joint military exercises despite North Korea's warnings, emphasizing the strength of their defense alliance.
Sep-21	End of War declaration talks	The U.S. and South Korea discuss the possibility of an official end to the Korean War, a move aimed at reducing tensions with North Korea.
Feb-22	Winter Olympics and North Korea	South Korea coordinates with the U.S. on North Korea policy during the Beijing Winter Olympics, emphasizing the need for denuclearization and peace on the peninsula.
May-22	Yoon Suk-yeol's election	Yoon Suk-yeol is elected as South Korea's president, signaling a potential shift towards a stronger alliance with the U.S. and a more assertive stance on North Korea and China.
Jun-22	Extended deterrence talks	The U.S. and South Korea engage in discussions to strengthen extended deterrence against North Korea's nuclear and missile threats, including the potential deployment of U.S. strategic assets.
Aug-22	THAAD Deployment discussion	South Korea and the U.S. discuss the deployment of additional THAAD missile defense systems, which China opposes, reinforcing the U.S.-South Korea security alliance.
Sep-22	Indo-Pacific strategy cooperation	South Korea aligns more closely with the U.S. Indo-Pacific strategy, which is seen as a move to counter China's influence in the region.
Mar-23	South Korea-Japan-U.S. trilateral talks	The U.S. facilitates trilateral talks between South Korea and Japan, focusing on regional security, North Korea's threats, and cooperation against China's growing influence.
Apr-23	Biden's visit to Seoul	President Joe Biden visits South Korea, reaffirming the U.S. commitment to South Korea's defense and discussing economic cooperation, including supply chain resilience.
Jul-23	Joint military exercises	The U.S. and South Korea conduct large-scale joint military drills, a show of force intended to deter North Korean aggression and reassure allies of U.S. commitment.
Sep-23	South Korea's participation in Quad+	South Korea participates in discussions with Quad members (U.S., Japan, India, Australia), focusing on security and economic cooperation in the Indo-Pacific region, further strengthening ties with the U.S.

Note: The authors manually organize Google News articles online to empirically assess their alignment with political instability.

Table B3. Main Political Issue between China and Korea (2021-2023)

Month	Issue	Description
Mar-21	COVID-19 Vaccine diplomacy	China extends its vaccine diplomacy efforts to South Korea, providing vaccines and seeking closer cooperation during the pandemic.
May-21	U.S.-South Korea summit	South Korea strengthens ties with the U.S., discussing China's influence in the region, which raises concerns in Beijing.
Jun-21	North Korea-China relations	North Korea expresses appreciation for China's support amid international sanctions, emphasizing strong bilateral ties.
Dec-21	South Korea's stance on taiwan	South Korea cautiously balances its relations with China and the U.S., avoiding direct support for Taiwan to maintain economic ties with China.
Feb-22	Winter Olympics in Beijing	South Korea participates in the Beijing Winter Olympics, maintaining a neutral stance despite international calls for a boycott.
Apr-22	North Korea missile tests	North Korea conducts missile tests, leading to increased regional tensions. China urges restraint but maintains its support for Pyongyang.
May-22	Yoon Suk-yeol administration	The election of Yoon Suk-yeol as South Korea's president signals a potential shift towards a more U.S.-aligned policy, causing unease in China.
Aug-22	South Korea THAAD deployment	South Korea and the U.S. discuss the deployment of additional THAAD missile defense systems, which China strongly opposes, citing security concerns.
Sep-22	China-North Korea trade resumption	China and North Korea resume limited trade as part of efforts to alleviate North Korea's economic hardships amid ongoing sanctions.
Mar-23	South Korea-Japan-China relations	South Korea participates in trilateral talks with Japan and China, focusing on economic cooperation despite historical and territorial disputes.
May-23	China's influence in North Korea	China continues to assert its influence in North Korea, providing economic and diplomatic support amid increasing international isolation of Pyongyang.
Jul-23	South Korea-U.S. military drills	South Korea conducts joint military exercises with the U.S., which China views as provocative and destabilizing to regional security.
Oct-23	China's Stance on Korean Peninsula	China reiterates its call for stability and denuclearization on the Korean Peninsula, urging dialogue between North and South Korea.

Note: The authors manually organize Google News articles online to empirically assess their alignment with political instability.

Appendix C

Table C1. Descriptive Statistics

index	News sentiment (U.S.-China)	News sentiment (Korea.-U.S.)	News sentiment (U.S.-China)	경상수지	상품수지	상품 수출	상품수입 (FOB)
	UC_sent.	KU_sent.	CK_sent.	BC	BP	BP1	BP2
Raw dataset							
Count	36	36	36	36	36	36	36
Mean	-0.19	-0.13	-0.17	4070.69	3484.53	55245.76	51761.23
Std	0.07	0.07	0.07	3367.01	3407.41	3449.38	4772.02
Min	-0.33	-0.28	-0.28	-4092.3	-3813.5	49128.8	40272.6
25%	-0.23	-0.18	-0.22	1662.55	869.75	52686.25	48909.45
50%	-0.19	-0.14	-0.17	4971.2	4562.9	54290.65	52282.05
75%	-0.14	-0.1	-0.13	6453.58	6051.48	58420.28	54672.32
Max	-0.07	0.04	0	10238.7	8856.2	62048.5	61848
Differenced dataset							
Count	35	35	35	35	35	35	35
Mean	-0.079	-0.272	-1.197	-0.27	-0.194	0.005	0.007
Std	0.519	1.012	7.253	2.163	1.749	0.037	0.043
Min	-1.749	-3.933	-42.828	-8.468	-6.743	-0.063	-0.1
25%	-0.353	-0.441	-0.236	-0.342	-0.199	-0.015	-0.014
50%	0.045	-0.04	0.023	-0.113	0.003	0.007	0.016
75%	0.242	0.226	0.246	0.556	0.456	0.024	0.034
Max	0.634	1.205	1.108	2.842	3.986	0.1	0.092

Table C1. Descriptive Statistics (continue)

index	서비스 수지	서비스 수입	서비스 지급	가공 서비스 수지	운송 수지	여행 수지	건설 수지	보험 서비스 수지	금융 서비스 수지	통신컴퓨터 정보서비스 수지	지식재산권 사용료 수지	유지보수 서비스 수지	기타사업 서비스수지	개인문화 여가 서비스수지	정부 서비스 수지
	BS	BS1	BS2	BS3	BS4	BS5	BS6	BS7	BS8	BS9	BS10	BS11	BS12	BS13	BS14
Raw dataset															
Count	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Mean	-1061.1	10446.44	11507.53	-531.16	678.5	-775.6	378.15	-16.75	109.02	194.49	-280.09	-126.12	-717.34	64.9	-39.11
Std	952.75	746.47	1050.15	60.39	691.74	259.9	127.11	67.17	82.42	175.12	267.82	58.83	307.64	43.97	30.88
Min	-3050.7	8867.9	9030.3	-671.7	-410.1	-1304.9	200.8	-115.1	-120.3	-219.5	-1257.2	-246.6	-1351.1	-16.1	-86.3
25%	-1791.85	10005.85	10799.72	-552.22	27.32	-961.03	274.12	-64.95	81.58	99.28	-408.72	-163.22	-908.18	34.45	-58.53
50%	-838.7	10515.05	11519.95	-524.4	762.6	-736.15	358.8	-38.6	124.95	225.85	-257.9	-133.5	-790.2	61.2	-41.5
75%	-353.4	10993.98	12322.25	-486.5	1247.38	-580.58	438.18	50.42	154.8	286.72	-163.15	-87.65	-535.1	79.32	-30.48
Max	623.2	11710.1	13025.9	-408.4	1871.7	-326.4	650.3	96.1	276.4	532.1	382.1	1.5	121	196.5	68.7
Differenced dataset															
Count	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Mean	-1	0.007	0.011	-0.025	-0.468	-0.068	0.108	0.088	1.462	2.046	-0.768	-1.41	-0.586	0.805	-0.315
Std	4.644	0.048	0.051	0.178	1.62	0.252	0.435	0.996	6.212	10.717	2.088	6.256	2.194	2.025	1.694
Min	-26.772	-0.111	-0.134	-0.636	-6.535	-0.511	-0.616	-2.199	-3.378	-7.672	-6.977	-36.733	-10.042	-1.551	-6.719
25%	-1.002	-0.025	-0.019	-0.091	-0.339	-0.267	-0.215	-0.197	-0.333	-0.702	-1.459	-0.488	-0.554	-0.441	-0.545
50%	0.006	0.004	0.014	0.003	-0.095	-0.068	0.079	0.069	0.063	-0.198	-0.195	0.005	0.048	-0.043	0.134
75%	0.336	0.035	0.039	0.056	0.147	0.108	0.437	0.248	0.481	1.665	0.565	0.234	0.297	1.195	0.408
Max	2.865	0.119	0.111	0.229	1.53	0.477	1.307	3.439	33.695	62.345	2.017	0.929	1.12	7.462	3.535