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Does Economic Sanction Work? The Case of North Korea

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Do Economic Sanctions Work? The Case of North Korea

Based on the gravity model of international trade, this paper analyzes North Korea's international trade patterns, which tend to follow the predictions inherent in the gravity model: a positive relationship between trade and the GDP of a nation's trading partners, and a negative relationship between trade and distance. In spite of the economic sanctions that have been imposed by various countries, this pattern has been consistently preserved in recent years, implying that sanctions do not significantly change North Korea's trade environment, mainly due to the substitutability of goods among countries. For example, North Korea has traded increasingly more goods with China and Korea since Japan imposed sanctions against Pyongyang. Unless all countries strictly agree on imposing sanctions against a specific country, which is highly unlikely, imposing economic sanctions will be unsuccessful.

JEL Classification F15, F51, R10, R40

Keywords; International Trade; Gravity Model; Economic Sanctions; North Korea

1. Introduction

North Korea is surrounded by a wall of economic sanctions. Ever since the outbreak of the Korean War in 1950, the United States has imposed sanctions against the country. The level of sanctions has particularly risen since the beginning of the 21st century following Bush's "axis of evil" statement in January 2002, Pyongyang's nuclear

program reactivation in October 2002,¹ and its nuclear tests in October 2006² and May 2009.³ In particular, imports from North Korea are absolutely prohibited. Japan's policies are another example. Since the Prime Minister Koizumi's first visit to Pyongyang on September 2002 and Kim Jong-Il's acknowledgement about abducting Japanese people to his country, discussions regarding economic sanctions against the hermit kingdom have been raised.⁴ Actual sanctions, including lowering the number of remittances to North Korea, restricting trade volume, and selling luxury goods to North Korea have been imposed since the 2006 nuclear test. Another test in 2009 motivated Japan to decide to renew and strengthen its sanctions, and imports from North Korea are completely banned. Thailand and EU, which used to be relatively open toward trading with North Korea, also participated in economic sanctions against the country following the decision of the United Nations Security Council in 2006. As a result, North Korea suffers from food shortage (Han, 2005)

So, in the final analysis, do these sanctions work? In other words, do they succeed in isolating a country and drying up its economic contacts with other countries? Using the gravity model of international trade, this paper says "no" to the sanction question and will argue that economic sanctions against North Korea do not significantly change the country's trade environment because of the substitutability of goods among countries.

¹The crisis in October 2002 peaked when North Korea expelled International Atomic Energy Agency (IAEA) agents and declared that it would withdraw from the Non-Proliferation Treaty (NPT) (Rennack).

² Specifically, North Korea's account in Banco Delta Asia (BDA) was frozen, and the North Korean Nonproliferation Act was passed to minimize the country's contact with companies related with weapons of mass destruction (WMD). Not only the United States but also the United Nations Security Council imposed sanctions, including blocking trade on military and technological materials and luxury goods. These sanctions (1695 and 1718) were the first two sanctions imposed by the UN.

³ The third UN sanction was imposed after North Korea's second nuclear test, confirming the implementation of Sanction 1718. The contents of the bilateral sanction imposed by the United States are not yet reported. One reason for this may be that since there are almost no contact between the two countries, including exports and imports, some people are skeptical about the effect of the sanction. Another reason that can be considered is that the current Obama regime is more open to dialogue with North Korea than was the Bush administration.

⁴ Adding fuel to the fire, the North Korean government sent to Japan in November 2004 the remains of Yokota Megumi, one of the abductees, which a DNA analysis proved false. The Japanese government, which had been hesitant regarding economic sanctions against North Korea, stated in December 2004 that it would consider imposing sanctions.

2. Gravity Model

Along with globalization, many people assume that technology has lessened the importance of distance as a significant variable in international trade. Bell (1976) argued that distance has been “eclipsed,” and Maier (2000) said that “territorial age has passed.” A large volume of labor and capital mobility, free trade agreements, electronic based commerce, and widespread mobile communications all seem to support this claim. Moreover, based on this claim, it is likely that the gravity model of international trade, in which a country’s trade is positively related with its GDP and negatively related with its distance, loses its power.

Nevertheless, many studies in economics contradict this claim and show empirically that for several countries, trade patterns follow the prediction of the gravity model. Furthermore, a significant number of researchers obtained successful empirical results from additional variables including population, language, contiguity, colonial history, trading bloc, and others.⁵

This section examines North Korea’s trade patterns using the gravity model. To state the conclusion up front, Pyongyang consistently reveals a trade pattern based on the gravity model despite the many factors that affect the secluded kingdom’s trade with other countries. Thus, the outcome indicates that these factors, particularly economic sanctions, do not have a significant influence on North Korea’s trade environment. An enormous amount of literature exists about the economic sanctions that have been imposed against North Korea. Still, this research is new and worth investigating in the sense that the conclusion is based on quantitative results. Little is known about North Korea in the outside world, and it is very difficult to obtain data on the country. For this reason, there has been almost no *empirical* research done thus far on trade in North Korea. In this regard, even though Caruso (2003) conducted an excellent research on the gravity model investigating the impact of economic sanctions on trade by estimating trade

⁵ Language, contiguity, and colonial history were insignificant reasons; Korean is spoken only in South and North Korea, its contiguity matters only to China and South Korea, and Japanese colonialization is also insignificant as far as North Korea’s trade goes.

between the United States and its 49 “target” countries, North Korea was not included. Fortunately, this research overcomes the difficulty of obtaining North Korea’s data by the help of the Korea Trade Investment Promotion Agency (KOTRA) that has collected North Korea’s bilateral trade since the 1990s.

Using this KOTRA data on North Korea’s trade volume of its trading partners, this paper will show that North Korea’s trade pattern essentially follows what the gravity model predicts. The key research tool is the Ordinary Least Squares (OLS) method.⁶

2.1. Model

It has been shown that the gravity model successfully explains bilateral trade flows. This model states that trade flows (exports + imports) are positively related to the economic size of the two countries, often measured by GDP, and inversely related to the distance between them. That is,

$$T_{ij} = A(Y_i * Y_j / D_{ij}) \quad (1)$$

T_{ij} : bilateral trade volume between country i and j

Y_i, Y_j : GDP of country i and j , respectively

D_{ij} : Distance between country i and j

A : Constant of Proportionality

Originally derived from Newton’s theory, the gravity model has been applied to international trade theory since the 1960s, and has been successful in empirical research. At the same time, however, this model has been criticized because of its lack of theoretical foundations. It was not until the 1980s that the gravity model was supported by international trade theory. The first compelling theory came from monopolistic competition with *imperfect substitute* and *product differentiation*. Helpman and Krugman (1985), Helpman (1987), and Hummel and Levinsohn (1995) argued that the gravity model does a better job of capturing so-called intra-industry trade under monopolistic competition and increasing returns to scale than the traditional inter-industry trade models do. Extending the theoretical framework, Deardorff (1995) and Evenett and Keller (1998)

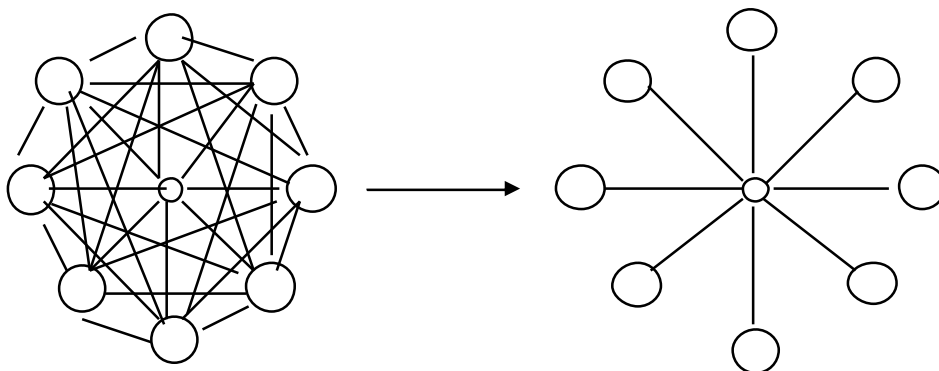
⁶ This paper assumes homoskedasticity of variance-covariance matrix for the OLS regression. A test for heteroskedasticity was conducted, but is not significant. However, White’s corrected estimator will be introduced due to robustness.

have shown that the gravity equation can also be derived from a Heckscher-Ohlin type of inter-industry trade.

2.2 Applying the Model to North Korea

Using the panel data on North Korea's trade with its 60–80 trading partners from 2002 to 2008⁷, this section tests whether North Korea's trade patterns follow the prediction of the gravity model. Unlike the typical analysis of the gravity model in which every possible kind of bilateral trade between all participating countries is considered, this paper, designed to test North Korea's trade patterns, focuses on bilateral trade flows between North Korea and its trading partners, as shown in Figure 1. This method was previously used by Wall (1999), and Sohn and Yoon (2001).

Figure 1. Original Gravity Model (Left) and Simplified Model (Right)



Based on this simplified method, each year's cross sectional regressions and panel regressions are run. The dependent variable is trade volume between North Korea and its trading partner, and the independent variables are the GDP of the partner country, the per capita GDP of the country, the Trade Freedom Index, and the distance between North Korea and the partner country. GDP and distance are the main variables, and others will be added and dropped, as shown in Box 1. This paper uses Ordinary Least Squares (OLS)^{8,9} regressions¹⁰.

⁷ Data is available since 1994. However, this paper is particularly interested in years since 2002 when economic sanctions against North Korea has been strengthened.

⁸ As usual, an OLS regression assumes linearity, full rank, and homoskedasticity. In the case of potential heteroskedasticity, White's corrected estimators are introduced for robustness.

Box 1. Regression Equations¹¹

* $LnT_{Ni} = a + bLnGDPi + cLnDISTANCE$

* $LnT_{Ni} = a + bLnGDPi + cLnGDP\ per\ capita + dLnDISTANCE$

* $LnT_{Ni} = a + bLnGDPi + cLnTFi + dLnDISTANCE$

* $LnT_{Ni} = a + bLnGDPi + cLnGDP\ per\ capita + dLnTFi + eLnDISTANCE$

2.3. Basic Results

Both cross sectional analyses for each year from 2002 to 2008 and panel regressions for the entire dataset were conducted. Detailed results are provided in Appendix 1. To summarize, this section provides signs of each variable to check whether explanatory variables affect trade volume positively or negatively.

Table 1. Signs from the OLS Regressions (Cross Sectional and Panel)

	2002	2003	2004	2005	2006	2007	2008	P	Fe(y)	Re(y)	Re(c)
GDP	***	***	***	***	***	***	***	***	***	***	***
pcG	-	-	-	+	+	+	**	*(+)	-	*(+)	+
TF	+	+	+	-	-	***	-	***	***	***	+
Dist	***	***	***	***	***	***	***	***	***	***	***
Obs	52	52	56	62	68	70	76	436	436	436	436

- ***, **, *: significant at 99%, 95%, and 90% level, respectively.
- GDP: Gross Domestic Product; pcG: per capita GDP; TF: Trade Freedom; Dist: Distance; Obs: the number of observation; P: pooled regression; Fe(y): Fixed Effect for year; Re(y): Random Effect for year; Re(c): Random Effect for country.
- When the signs are not consistent, both results are provided.
- The fixed effect for the country is not provided for technical reasons.¹²
- This result does not include IV regression.

⁹ The VIFs of each case are lower than 10, implying that multicollinearity is not a serious problem.

¹⁰ it will be argued that GDP is a problematic variable because of endogeneity problems, whose solution is to introduce instrumental variables (IV). As an instrumental variable for GDP, Wei (1995) uses population.

¹¹ Adding variables this way is the so-called simple-to-general approach. This approach has the potential problem of being tainted by biases caused by incomplete specifications at the early stages, and some econometrics textbooks, including Greene's (2003) recommend the general-to-simple approach. However, this paper maintains the simple-to-general approach because it is easier to understand and comments are not mandatory.

¹² This effect assumes that differences across units (country in this case) can be explained in differences in the constant term (Greene). However, distances between North Korea and a specific trading partners should be same over the years, so those "differences" cannot be captured and regression fails.

As shown in the table, in every single case, signs for GDP are all positive and signs for Distance are all negative at a 99% significance level, regardless of cross sectional and panel regressions, and regardless of year and regression method. This result suggests that North Korea's trade pattern strongly and consistently follows the prediction of the gravity model, in which trade volume is proportional to the GDP of participating countries and counter-proportional to their distances. In spite of North Korea's precarious relations with many countries, its trading patterns have been consistent for the past seven years. In other words, it can be concluded that many external economic and political factors, including economic sanctions, do not significantly affect or distort a country's trading patterns.

On top of these main variables, GDP and Distance, per capita GDP and Trade Freedom Index were also tested. While GDP measures a country's economic size, per capita GDP measures the country's income level, and this variable is often used in the gravity model. Wealthier countries usually trade more, so, it is expected that the sign of this variable should be positive, as the author has found in his research. Next, the trade freedom index¹³ is added. Both tariff and non-tariff barriers restrict world trade, so simply analyzing geographical distance is not very useful. In order to consider these barriers and to be closer to the actual trade distance, the trade freedom index is used. Deriving from the combination of the trade-weighted average tariff rate and non-trade barriers (NTB), trade freedom of a country *i* is,

$$TF_i = (\text{Tariff}_{\max} - \text{Tariff}_i) / (\text{Tariff}_{\max} - \text{Tariff}_{\min}) - (\text{NTB}) \quad (2)$$

where, according to Beach and Cane (2007), Tariff_{\max} and Tariff_{\min} represent the maximum and minimum tariff rates, and Tariff_i stands for the weighted average tariff rate in country *i*. A score of 100 implies perfectly free trade, and 0 implies the opposite.¹⁴ It

¹³ This index is from the Heritage Foundation of Index of Economic Freedom. On top of trade freedom, the foundation annually measures business freedom, monetary freedom, freedom from government, fiscal freedom, property rights, investment freedom, financial freedom, freedom from corruption, and labor freedom. Economic freedom is the equally weighted average of these 10 freedoms.

¹⁴ The highest score is 80 (Singapore), and the lowest one is 0 (Bangladesh and North Korea)

is expected that the coefficient of TFi will be positive; countries with more free trade policy tend to trade more.

Interestingly, the results in Table 1 are neither consistent with these expectations nor the same year by year. Negative signs¹⁵ might confirm economic sanctions, as it can be inferred that wealthy countries and countries with higher Trade Freedom Indices, again, mostly wealthier countries, are avoiding trade with North Korea. However, more than half of the results show a low significance level, and these two variables sometimes have opposite signs, reducing explanatory power. One trend worthwhile to note is that the two variables both showed negative signs for the first time in 2008. Conclusions cannot be drawn without further data, but at least this suggests the possibility of increasing the level of sanctions against an isolated country. The negative signs of these variables in three out of four different kinds of panel regressions also suggest, overall, that wealthier countries that have free trade tend to have lower levels of economic contact with North Korea.

2.4. Extended Results

Then, why do the signs for GDP and Distance firmly follow the prediction of the gravity model? In other words, why are North Korea's trade patterns basically consistent over the years irrespective of external factors, including economic sanctions? The answer lies in the reality that not all countries enforce sanctions against North Korea. Trading goods can be substituted, so even if a country imposes embargoes against North Korea, the country can still find other nations with which to export and import goods.

Japan is a prime example. Unlike the United States, in which economic sanctions have been imposed against North Korea since the Korean War, Japan has recently changed its trade policy toward North Korea. As shown in Table 2, also shown in the Appendices with more precise figures, Japan had been one of North Korea's top three trading partners, following China, but Japan disappears from the table in 2007 after it reportedly imposed a complete ban on importing North Korea's goods in reaction to

¹⁵ It is possible that this negative sign is due simply to technical problems, particularly multicollinearity. However, the Variance of Inflation (VIF) is not very high (1.5), so this technical concern can be discarded.

North Korea's nuclear test in 2006.

Table 2. North Korea's Top 10 Trading Partners

<i>Year</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>
1	China	China	China	China	China	China	China
2	S. Korea	S. Korea	S. Korea	S. Korea	S. Korea	S. Korea	S. Korea
3	Japan	Japan	Thailand	Thailand	Thailand	Thailand	Singapore
4	Thailand	Thailand	Japan	Russia	Russia	Russia	India
5	India	India	Russia	Japan	Japan	India	Russia
6	Germany	Russia	India	Singapore	India	Brazil	Thailand
7	Singapore	Netherlands	Germany	Germany	Germany	Singapore	Brazil
8	Russia	Germany	Singapore	Netherlands	Singapore	Germany	Germany
9	Hong Kong	Singapore	France	France	Netherlands	Netherlands	Netherlands
10	Netherlands	Italy	Sweden	India	Sweden	Taiwan	Hong Kong

Source: KOTRA

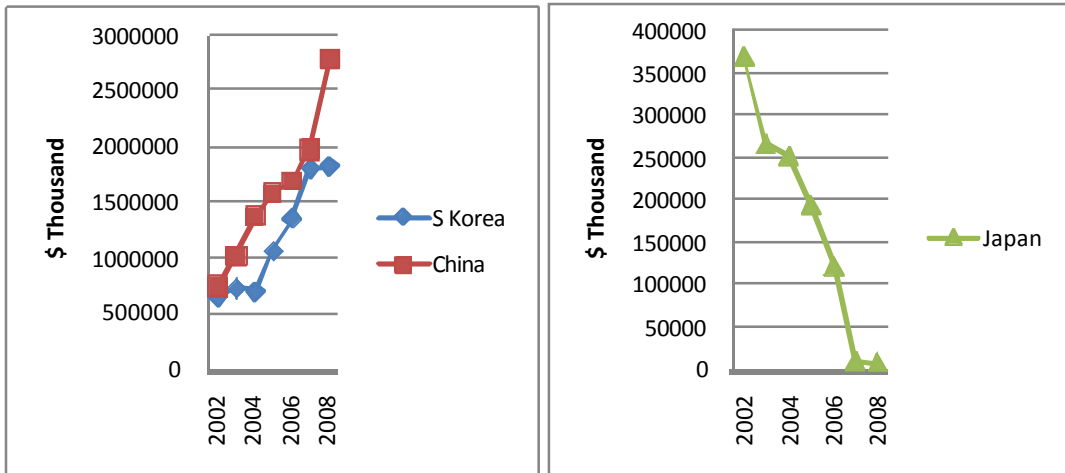
Note: KOTRA's report does not count South Korea because it regards trade between the two Koreas as intra-national trade instead of international trade. This paper simply assumes that South Korea is one of North Korea's international trading partners.

Still, Japan's sanctions against North Korea have not been very effective, for North Korea has increased its trade with China and South Korea as its trade with Japan has decreased (Figure 2). For example, as shown in Han (2005), since 1995 when North Korea requested food assistance, economic contact between two Koreas in terms of aid and trade has been increasing.

Figure 3 displays North Korea's four major exports to China and Japan. Korea was excluded in this figure because the South Korean government does not categorize trade between South and North Korea as "international" trade, and it uses different way of categorizing export and import goods.¹⁶ Again, this figure generally explains the same trend; trade with Japan is getting replaced by trade with China.

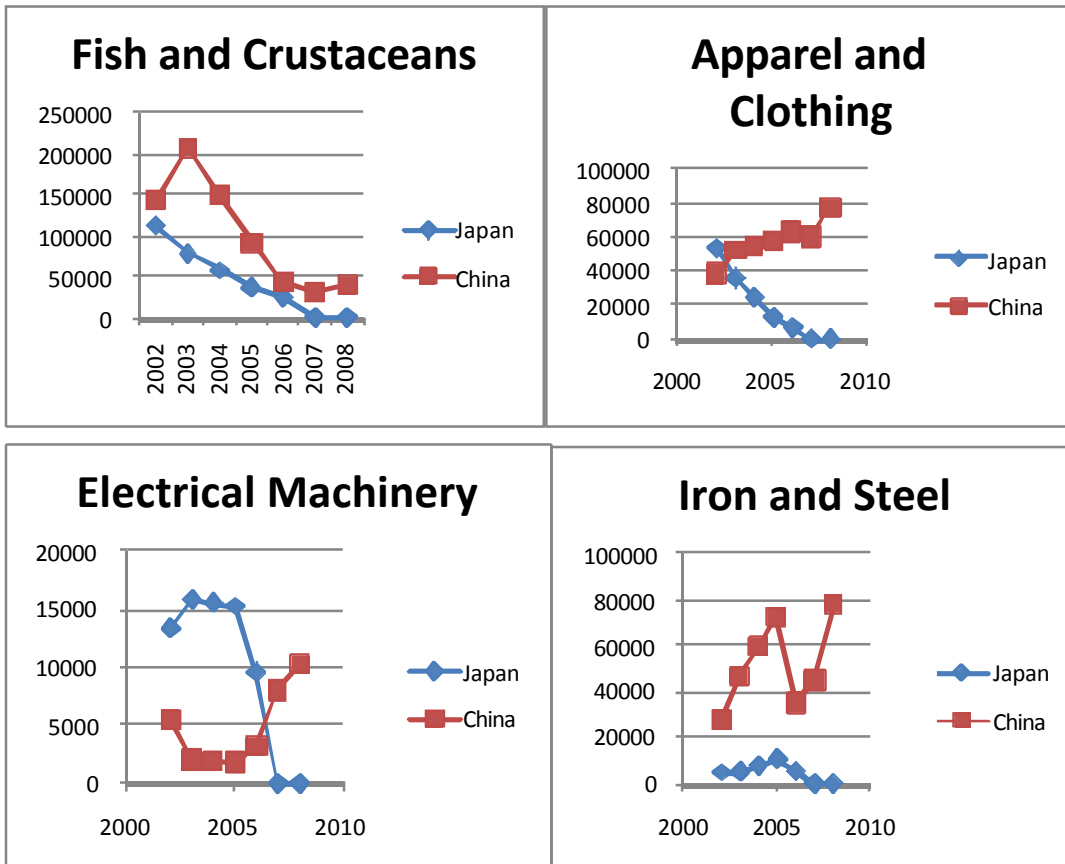
Figure 2. North Korea's Trade Volume with China, South Korea, and Japan

¹⁶ Total amount in "international" trade is categorized into goods-specific volume using the HS Code system, but trade between South and North Korea is categorized in a broader way. For example, one of North Korea's major exports is classified as "fish and crustaceans," but its counterpart in South and North Korea is "goods in agriculture, forest, and fishery," which makes direct comparison very difficult. Nonetheless, the appendix to this paper provides detailed information on North Korea's trade with South Korea.



Source: KOTRA

Figure 3. North Korea's Major Exports to China and Japan



Source: KOTRA

Note: Trade volume in 2004 is average of the volume between 2003 and 2005, as data for this year is currently not accessible.

Apparel and Clothing (HS Code 62)¹⁷ and Electrical Machinery (HS Code 85)¹⁸ are obvious examples describing North Korea's trade conversion from Japan to China. The figure showing Fish and Crustaceans (HS Code 3)¹⁹ is not easy to understand, as both China and Japan show a decreasing demand for these goods. A key reason for this change lies in the dropping prices of squid, octopus, and crab, North Korea's major export, as much as 40~60% (KOTRA). However, KOTRA revealed that the decrease in exporting fish and crustaceans to *Japan* is due rather to its extended economic sanctions against North Korea, which include prohibiting the entry of any North Korean vessels, implementing Catch-All Rules,²⁰ and imposing stricter customs for North Korean goods (KOTRA).

In this situation, North Korea is trying to diversify its trading partners. North Korea's traditional big four trading countries used to be China, South Korea, Japan, and Thailand, but, as displayed in Table 2, Japan and Thailand were replaced by Singapore and India in 2008. Also, Brazil recently emerged as one of North Korea's top ten partners. Given that Japan's sanctions against North Korea are getting stronger, and Thailand joined the embargo club in 2007, following the decision of the UN Security Council, this trend is expected to be continued in 2009 and onwards. Additionally, as shown in Tables 1 and 4, the total number of North Korea's trading partners has been increasing over the years.

At the same time, however, North Korea's trade is increasingly skewed to China and South Korea. As revealed in Table 3, North Korea's trade with these two countries explains over 80% of its entire trade. Even though the number of Pyongyang's trading partners has been rising, its trade is heavily dependent on these two neighbors.

Table 3. North Korea's Trade with Major Partners (Unit: Million USD)

¹⁷ The official title of HS Code 62 is "Articles of apparel and clothing accessories, not knitted or crocheted."

¹⁸ The official title of HS Code 85 is "Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sounds recorders and reproducers, and parts and accessories of such articles."

¹⁹ The official title of HS Code 3 is "Fish and crustaceans, mollusks and other aquatic invertebrates."

²⁰ This rule, proposed by the U.S. Department of Commerce, Bureau of Industry and Security (BIS), would require exporters to obtain licenses for certain goods, software, and technology that are related to military use (KOTRA).

	2002	2003	2004	2005	2006	2007	2008
China(1)	738.2 (25.4%)	1,022.9 (32.8%)	1,385.2 (39%)	1,580.3 (38.9%)	1,699.6 (39.1%)	1,974.0 (42.7%)	2,787.3 (49.5%)
S. Korea(2)	641 (22.1%)	724 (23.2%)	697 (19.6%)	1,055.8 (26%)	1,349.7 (31.1%)	1,797.9 (38.9%)	1,820.3 (32.3%)
(1)+(2)	1,379.2 (47.5%)	1,746.9 (56%)	2,082.2 (55.6%)	2,636.1 (64.9%)	3,049.3 (70.2%)	3,871.9 (81.6%)	4,607.6 (81.8%)
Japan	369.5 (12.7%)	265.3 (8.5%)	252.6 (7.1%)	193.6 (4.8%)	121.6 (2.8%)	9.3 (0.2%)	7.7 (0.1%)
Thailand	216.6 (7.5%)	254.3 (8.2%)	329.9 (9.3%)	329.2 (8.1%)	374.2 (8.6%)	228.7 (4.9%)	76.8 (1.4%)
Russia	80.7 (2.8%)	118.4 (3.8%)	213.4 (6%)	232.3 (5.7%)	210.6 (4.8%)	159.6 (3.4%)	110.5 (2%)

Source: KOTRA

What would happen if China and South Korea also imposed economic sanctions against North Korea? This paper examines this scenario by setting North Korea's trade volume with South Korea and China at zero. Although the latter is a purely imaginary scenario, it could answer the question of whether North Korea's trade patterns, based on the gravity model, will still be preserved when almost all of its trading partners impose economic sanctions against it. The same kinds of regression analyses were conducted, and, like Table 1, signs from the OLS regression are provided here (Detailed results are provided in Appendix 2). Unlike Table 1, however, the signs of Distance show no specific pattern: both inconsistent and insignificant. Indeed, China and South Korea's sanctions will take away more than 80% of North Korea's trade, and this will be a huge impact on the country's economy and its trading patterns will certainly be different from the current ones.

Table 4. Signs from the OLS Regressions (Cross Sectional and Panel)

	2002	2003	2004	2005	2006	2007	2008	<i>P</i>	<i>Fe(y)</i>	<i>Re(y)</i>
--	------	------	------	------	------	------	------	----------	--------------	--------------

GDP	****	****	****	****	**	****	****	****	****	****
pcG	-	-	-	+	+	+	-**	+	-	-
TF	+	+	+	-*	-*	****	-*	+	+	**
Dist	+	+	-	+	+	+	+	-	+	-
Obs	52	52	56	62	68	70	76	436	436	436

Notes:

- For some years, significance levels are different even though the sign itself is the same. In this case, this researcher used the results of full regressions that include entire variables.
- Neither fixed effect and random effect for country is used for technical reasons.

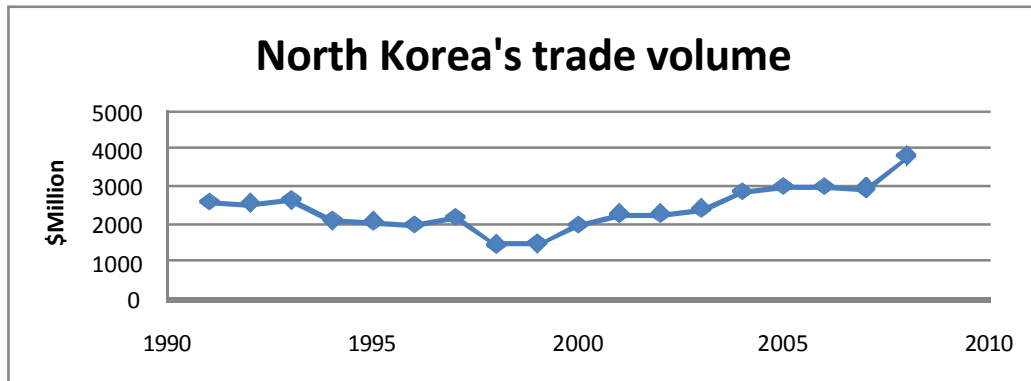
3. Conclusion and Policy Implications

Irrespective of precarious external factors, including economic sanctions, North Korea's trade patterns have been consistent under the gravity model. After having been abandoned by Japan, North Korea depends more than ever on trading with China and South Korea as well as pursuing trading with other countries. There is no evidence to support the claim that economic sanctions effectively worked in isolating North Korea. In fact, as described in Figure 4, North Korea's trade volume has actually been increasing for the past 10 years.²¹ As revealed in Table 4, economic sanctions might "successfully" distort North Korea's trade patterns and isolate the country if all of its trading partners, including China and South Korea, simultaneously shut down its doors to North Korea, which is not very likely to happen.²² This scenario is similar to the Prisoner's Dilemma Game in the sense that, usually, at least one country will have an incentive to trade with North Korea to pursue its own self-interests, which often makes cooperation among countries very difficult.

²¹ The lowest point in the late 1990s was the so-called "arduous march" in which 1.5 to 3 million people reportedly died of hunger.

²² Elegant (2006) argues that China fears that a cutoff in trade with North Korea would result in the collapse of the country, touch off civil unrest, and lead to an influx of millions of defectors crossing the border. He also says that trade with North Korea is also beneficial to China because the recent skyrocketing growth of border cities in China, including Dandong, is due to trade with North Korea.

Figure 4. Trend of North Korea's Trade Volume (1991–2008)



Economic sanctions against North Korea have been strengthened and extended in response to recent nuclear tests. However, those sanctions have not been made meaningful in “punishing” North Korea. Additionally, the more the international community tries to isolate this country, the more North Korea will depend on nuclear weapons as a bargaining chip.

In Appendix 3, the gravity model predicts that North Korea would benefit by \$125~172 million and \$281~\$411 million by trading with the United States and Japan, respectively, under normal conditions. In order to end the vicious circle of dependence on nuclear weapons, economic sanctions should be avoided²³. North Korea should give up its nuclear plan, and the international community should also help the country to normalize its economic activity and trade relations with other countries.

²³ In fact, there are many ways reducing conflicts in Korean Peninsula. While this paper argues that avoiding economic sanctions is a solution, Isard and Azis (1999) suggested the Cooperative Action Procedures (CAP) by withdrawing of North Korean troops from eastern DMZ instead of typical use by diplomats and negotiators.

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Appendix 1. North Korea's Trade Pattern: OLS Regressions

<i>Year</i>	<i>GDP</i>	<i>Per Capita GDP</i>	<i>Trade Freedom</i>	<i>Distance</i>
2002	1.400*** (0.169)			-1.429*** (3.631)
	1.596*** (0.264)	-0.356 (0.322)		-1.258*** (0.354)
	1.377*** (0.181)		0.615 (1.522)	-1.436*** (0.294)
	1.653*** (0.281)	-0.611 (0.368)	2.129 (1.346)	-1.157*** (0.365)
2003	1.433*** (0.176)			-1.269*** (0.287)
	1.450*** (0.280)	-0.035 (0.331)		-1.252*** (0.338)
	1.380*** (0.198)		0.802 (1.263)	-1.279*** (0.287)
	1.469*** (0.289)	-0.215 (0.388)	1.297 (1.330)	-1.178*** (0.350)
2004	1.044*** (0.164)			-1.480*** (0.265)
	1.047*** (0.262)	-0.005 (0.333)		-1.478*** (0.311)
	0.971*** (0.178)		1.497 (1.459)	-1.506*** (0.266)
	1.089*** (0.278)	-0.262 (0.380)	2.091 (1.475)	-1.385*** (0.329)
2005	1.131*** (0.174)			-0.955*** (0.270)
	1.072*** (0.246)	0.107 (0.291)		-1.007*** (3.198)
	1.177*** (0.184)		-1.209 (1.083)	-0.946*** (0.276)
	1.028*** (0.246)	0.333 (0.309)	-2.101** (0.921)	-1.102*** (0.327)
2006	0.764*** (0.247)			-1.153*** (0.308)
	0.566* (0.332)	0.372 (0.308)		-1.330*** (0.375)
	0.777*** (0.253)		-0.640 (1.701)	-1.135*** (0.326)
	0.414 (0.337)	0.806** (0.372)	-4.124** (1.767)	-1.426*** (0.376)
2007	1.200*** (0.184)			-1.020*** (0.315)
	1.067*** (0.247)	0.247 (0.310)		-1.137*** (0.345)
	1.147 (0.192)		1.323*** (0.219)	-1.095*** (0.324)
	1.130*** (0.248)	0.034 (0.319)	1.292*** (0.277)	-1.109*** (0.355)
2008	0.924*** (0.154)			-1.018*** (0.207)
	1.176*** (0.148)	-0.568*** (0.185)		-0.775*** (0.237)
	0.937***		0.607*** (0.127)	-0.973*** (0.206)
	1.165*** (0.151)	-0.534*** (0.204)	-0.203 (0.151)	-0.774*** (0.238)
pooled	1.156*** (0.070)			-0.419*** (0.065)
	1.281*** (0.094)	-0.239** (0.108)		-0.400*** (0.065)
	1.167*** (0.069)		-0.784*** (0.144)	-1.007*** (0.123)
	1.146*** (0.099)	0.039 (0.121)	-0.810*** (0.164)	-1.029*** (0.146)

fixed effect (year)	1.138*** (0.071)			-1.208*** (1.586)
	1.151*** (0.922)	-0.026 (0.110)		-1.195*** (0.157)
	1.167*** (0.069)		-0.784*** (0.144)	-1.007*** (0.123)
	1.148*** (0.935)	-0.015 (0.119)	-0.074 (0.312)	-1.198*** (0.158)
random effect	1.154*** (0.073)			-0.506*** (0.088)
	1.263*** (0.092)	-0.210** (0.107)		-0.512*** (0.093)
	1.164*** (0.072)		-0.748*** (0.155)	-1.018*** (0.132)
	1.146*** (0.094)	0.034 (0.118)	-0.749*** (0.180)	-1.044*** (0.148)

Note:

- ***, **, *: significant at 99%, 95%, and 90% level, respectively.
- Figures inside the bracket are standard error in White's correction for robustness.
- Results of fixed effect for country are not provided due to technical reason.
- Random effect for year and country has the same result.
- The signs for per capita GDP in random effect are different (-0.210 and 0.034), which is the only case in the entire regressions.

Appendix 2. OLS Regression: North Korea's Trade Pattern When North Korea's Trades with China and South Korea are assumed to be zero

<i>Year</i>	<i>GDP</i>	<i>Per Capita GDP</i>	<i>Trade Freedom</i>	<i>Distance</i>
2002	1.230*** (0.193)			-0.558 (0.756)
	1.467*** (0.315)	-0.413 (0.388)		0.143 (0.800)
	1.220*** (0.209)		0.510 (1.796)	-0.061 (0.764)
	1.524*** (0.337)	-0.673 (0.457)	2.178 (1.720)	0.246 (0.807)
2003	1.264*** (0.198)			0.131 (0.731)
	1.315*** (0.330)	-0.089 (0.92)		0.176 (0.773)
	1.231*** (0.228)		0.522 (1.469)	0.125 (0.740)
	1.331*** (0.339)	-0.237 (0.466)	1.070 (1.594)	0.236 (0.781)
2004	0.876*** (0.198)			-0.064 (0.741)
	0.908*** (0.313)	-0.057 (0.386)		-0.035 (0.779)
	0.815*** (0.214)		1.231 (1.637)	-0.085 (0.911)
	0.946*** (0.331)	-0.289 (0.457)	1.885 (1.744)	0.048 (0.787)
2005	0.956*** (0.184)			0.485 (0.671)
	0.932*** (0.280)	0.044 (0.342)		0.464 (0.716)
	1.013*** (0.196)		-1.519 (1.104)	0.496 (0.672)
	0.884*** (0.381)	0.291 (0.384)	-2.299 (1.162)	0.360 (0.717)

2006	0.586** (0.243)			0.300 (0.663)
	0.425 (0.343)	0.301 (0.365)		0.156 (0.716)
	0.611** (0.245)		-1.319 (2.026)	0.336 (0.673)
	0.248 (0.359)	0.808 (0.507)	-4.812 (0.259)	0.446 (0.719)
2007	1.013*** (0.189)			0.453 (0.655)
	0.923*** (0.274)	0.170 (0.358)		0.372 (0.692)
	0.972*** (0.194)		1.062*** (0.301)	0.393 (0.680)
	0.975*** (0.282)	-0.005 (0.381)	1.066*** (0.370)	0.396 (0.709)
2008	0.675*** (0.145)			0.625 (0.632)
	0.956*** (0.186)	-0.662 (0.259)		0.897 (0.666)
	0.692*** (0.145)		-0.884 (0.220)	0.687 (0.637)
	0.934*** (0.195)	-0.592** (0.283)	-0.425* (0.237)	0.898 (0.668)
pooled	0.941*** (0.079)			-0.094 (0.084)
	0.923*** (0.121)	0.034 (0.136)		-0.097 (0.083)
	0.936*** (0.079)		0.409* (0.228)	0.212 (0.228)
	1.007*** (0.114)	-0.137 (0.146)	0.500** (0.253)	0.290 (0.253)
fixed effect (year)	0.944*** (0.083)			0.152 (0.171)
	0.966*** (0.107)	-0.041 (0.127)		0.173 (0.182)
	0.924*** (0.083)		0.680 (0.332)	0.133 (0.170)
	1.006*** (0.108)	-0.164 (0.137)	0.844 (0.359)	0.210 (0.182)
random effect	0.941*** (0.082)			-0.086 (0.089)
	0.926*** (0.104)	0.029 (0.120)		-0.079 (0.095)
	0.935*** (0.082)		0.416 (0.171)	0.209 (0.150)
	1.006*** (0.107)	-0.140 (0.135)	0.517*** (0.199)	0.285* (0.169)

Appendix 3. North Korea's Actual Trade Volume and Fitted Values Based on Regressions

<i>Country</i>	<i>Actual</i>	<i>Case 1</i>	<i>Case 2</i>	<i>Case 3</i>	<i>Case 4</i>	<i>Comparison</i>
S. Korea	1820366	364917.7	175715.5	339071.4	178867.1	O
Argentina	15861	2848.878	4316.441	3010.373	4292.054	O
Australia	6342	19327.47	11686.68	17817.46	11721.23	U
Austria	3101	4367.917	2397.685	4035.231	2421.807	B
Bangladesh	21807	2249.169	9135.968	29284.88	19831.3	O
Belgium	9532	4498.452	2788.69	4194.962	2805.158	O
Brazil	67500	12256.27	27588.65	13078.37	26866.98	O

Bulgaria	459	19.75525	67.7043	16.83047	59.73727	O
Canada	21315	15832.75	12438.14	14708.89	12314.85	O
Chile	7957	1616.115	1826.785	1527.988	1781.383	O
China	2787279	3397726	5432006	3004060	5057334	U
Colombia	16327	2159.855	4019.519	2249.304	3929.049	O
Costa Rica	12218	438.9068	380.4938	401.5057	372.9565	O
Croatia	687	877.5191	587.6561	781.5211	579.6627	B
Cyprus	34	388.0304	127.8935	355.5976	132.9137	U
Czech Rep	1666	1928.247	1550.422	1783.538	1531.689	B
Denmark	5350	2962.081	1435.535	2755.296	1464.408	O
Estonia	4	235.1026	121.3973	211.601	122.107	U
Fiji	210	110.7575	64.19992	101.9344	64.61117	O
Finland	406	2294.389	1181.444	2132.519	1200.62	U
France	7877	24408.63	23230.76	24047.11	23186.57	U
Germany	52353	27181.83	28816.86	26044.19	28311.99	O
Greece	1188	4324.948	2859.719	4111.993	2884.002	U
Guatemala	9746	620.7574	904.3011	582.1315	866.3312	O
Hong Kong	40314	19218.89	7168.373	15111.42	7015.053	O
Hungary	431	1770.373	1476.849	1614.881	1449.006	U
India	120200	26189.74	142207.7	32515.14	138143.3	O
Indonesia	14907	17326.6	44066.27	16824.43	41262.46	U
Ireland	4	2566.174	1164.816	2373.052	1190.604	U
Italy	12446	22817.69	21913.55	22288.63	21797.56	U
Japan	7664	411469.3	284911.5	371158.1	281054.3	U
Kazakhstan	647	5519.668	4568.873	4738.467	4392.161	U
Laos	16	374.1917	477.5385	390.9504	478.0335	U
Lebanon	7612	384.4927	312.0916	365.272	311.0405	O
Lithuania	71	461.8882	319.2287	490.5072	333.4246	U
Luxembourg	123	650.6301	136.2952	608.113	146.4876	U
Malaysia	19200	8669.529	8439.992	9705.518	8780.115	O
Malta	9	128.6734	43.28656	112.0793	44.18867	U
Mexico	10294	15039.17	23878.95	14746.88	23079.35	U
Mongolia	60	603.08	422.0153	571.7889	423.8343	U
Nepal	1779	665.3188	1582.232	626.192	1473.405	O
Netherlands	42750	7336.525	4937.127	7169.469	5019.236	O
Nigeria	1440	2069.595	7428.319	1971.735	6776.402	U
Pakistan	13720	3243.296	11218.56	3198.949	10373.54	O
Peru	3010	1471.107	2370.633	1389.872	2262.591	O
Poland	4978	4293.889	5502.899	4792.175	5628.247	B
Romania	577	2407.617	2806.542	2233.324	2713.936	U
Russia	110524	631302.7	464604.2	597002.9	463726.7	U
Singapore	120355	7557.652	2842.002	7348.02	2985.68	O
Slovakia	2224	1128.245	772.6704	1018.015	764.4202	O
Slovenia	794	701.2684	323.5086	627.0903	326.7716	O
South Africa	22478	3473.028	5720.855	3479.992	5559.742	O
Spain	3670	15461.11	14526.56	15563.4	14616.58	U

Sri Lanka	215	1134.679	1777.562	1095.711	1711.73	U
Sweden	830	3928.573	2309.272	3576.716	2311.834	U
Switzerland	4082	5109.357	2474.73	4730.865	2520.215	B
Taiwan	28792	41393.5	23865.54	35635.25	23448.37	B
Tanzania	134	386.3286	1226.88	338.0708	1096.26	U
Thailand	76770	11044.75	16485.35	10887.48	16018.96	O
Turkey	3621	8161.294	12251.67	10027.68	12815.08	U
UK	6400	20863.69	20522.52	19800.75	20190.48	U
Ukraine	10478	2147.128	3995.733	2157.646	3859.258	O
USA	52151	124835.9	170049.4	137266.4	172252.9	U

Source: KOTRA and author's calculations

Note:

- Used the most recent year's date (2008).
- $\text{LnCase 1} = \text{const} + 0.924 * \text{LnGDPi} - 1.018 * \text{LnDISTANCE}$
- $\text{LnCase 2} = \text{const} + 1.176 * \text{LnGDPi} - 0.568 * \text{LnGDP per capita} - 0.775 * \text{LnDISTANCE}$
- $\text{LnCase 3} = \text{const} + 0.937 * \text{LnGDPi} - 0.607 * \text{LnTFi} - 0.973 * \text{LnDISTANCE}$
- $\text{LnCase 4} = \text{const} + 1.165 * \text{LnGDPi} - 0.534 * \text{LnGDP per capita} - 0.203 * \text{LnTFi} - 0.774 * \text{LnDISTANCE}$
- O: Actual volume is *over* the all 4 fitted values (countries with friendly trade policy toward North Korea).
- U: Actual volume is *under* any of the 4 fitted values.
- B: Actual volume is *between* lower and upper end.