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Article

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Global Business & Finance Review (GBFR)

Provided in Cooperation with:
People & Global Business Association (P&GBA), Seoul

Suggested Citation: Choi, Jina; Kim, Hyoshin; Oh, Jinhwan (2017) : Effectiveness of economic sanctions against North Korea and role of China: Empirical approach, Global Business & Finance Review (GBFR), ISSN 2384-1648, People & Global Business Association (P&GBA), Seoul, Vol. 22, Iss. 2, pp. 8-15,
https://doi.org/10.17549/gbfr.2017.22.2.8

This Version is available at:
https://hdl.handle.net/10419/224367

GLOBAL BUSINESS & FINANCE REVIEW, Volume. 22 Issue. 2 (SUMMER 2017), 8-15
pISSN 1088-6931 / eISSN 2384-1648 | Http://dx.doi.org/10.17549/gbfr.2017.22.2.8

GLOBAL BUSINESS & FINANCE REVIEW

www.gbfrjournal.org

Effectiveness of Economic Sanctions against North Korea and Role of China: Empirical Approach

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A B S T R A C T

This study explores North Korea's trade patterns and the effectiveness of economic sanctions imposed on the hermit kingdom. Using a gravity model with a panel dataset of the country's 92 trading countries from the period of 1999 to 2014, this paper examines North Korea's trade patterns and compares the model-based estimated bilateral trade flows with actual trade ones. Main findings are: (1) North Korea's trade has been excessively skewed to China as a result of economic sanctions from the United Nations and international community, largely driven by the United States; (2) The U.S. - North Korea trade would not be seriously affected by the sanctions due to their low estimated trade flows; (3) The latter finding raises further questions over the effectiveness of the current sanctions and asks for active cooperation from China.

Keywords: North Korea, China, Trade Patterns, Economic Sanctions, Gravity Model

Ⅰ. Description

The news that North Korea (DPRK, Democratic People's Republic of Korea) had launched a long-range missile following a hydrogen bomb test once again shocked the world, calling the international community for tougher sanctions (Demirijian, 2016). In response, the United States Department of Treasury proposed the so-called secondary sanctions targeting not only North Korea itself but also those who do illegal businesses with the reclusive kingdom by freezing any banking transactions with Pyongyang (U.S. Department of the Treasury, 2016). In line with this, Japan agreed to impose punitive sanctions to deter further provocation (Pollmann, 2016) and South Korea decided to shut down the Gaeseong Industrial Complex, which was seen as the last link for economic engagements between the two Koreas and known to be profitable, effectively combining South Korean capital with North Korean labor (Oh, 2007). In March 2016, the United Nations Security Council adopted a new resolution on North Korea, UNSCR 2270 which contains more intensified and expanded measures than the previous ones; UNSCR 1718, UNSCR 1874, UNSCR 2087, UNSCR 2094 (UN, S/RES/2270, 2016). Major new measures include: (1) banning the sale of North Korean coal, iron, gold, rare earth minerals and aviation fuel; (2) a sweeping ban on North Korean bank branches abroad; (3)

Received: Nov 4, 2016; Revised: Jan 8, 2017; Accepted: Jan 16, 2017

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inspection of all exported North Korean cargo; (4) prohibiting any trade assistance; (5) the expulsion of North Korean diplomats participating in illegal activities (Nephew, 2016).

However, the effect of the sanctions is still questionable without China, which has been reluctant to impose strict sanctions. Although China agreed on the United Nations Security Council's sanctions on North Korea, UNSCR 2270, it is unsure whether China is willing to fully enforce the resolution given Beijing's past actions of not adhering to past agreements (Beauchamp-Mustafaga & Jun, 2013). For example, when the UN Security Council adopted the resolution prohibiting the export of luxury goods to North Korea right after the first nuclear test in 2006, the banned luxury goods were transported from Beijing to Pyongyang (Nanto & Manyin, 2010). Moreover, the resolution still allows China to export oil to North Korea and to trade at their border regions, which leaves room for the regime's survival (Lou, 2016). With an ambiguous stance on North Korean affairs, China seems to believe that preserving the North's nuclear program will eventually benefit themselves (Horowitz, 2015). Accordingly, the Council's sanctions on North Korea did not have a noticeable impact on its trade with China (Noland, 2009) and not much change has been observed in North Korea's hostile behavior. In this regard, South Korean government and the Obama administration continuously demand China be with them.

As shown in Table 1, regardless of sanctions, Beijing has been always the number one trading partner with Pyongyang, with the portion of trade close to 90 percent in 2013. South Korea has been frequently ranked the second or the third since 1999, but its percentage has been drastically decreasing. Japan used to be another major trading partner but, its name has disappeared in the half of the table when it imposed sanctions since the first nuclear test in North Korea in 2006 (Wada, 2009). Thailand also joined the embargo, minimizing its contact with the North Korea.

Then, how extremely is North Korea's trade biased to China? Geographically and economically, it is natural to find that North Korea's trade tends to be skewed towards China, whose GDP is the world's second largest (allegedly the first if adjusting purchasing power parity) and geographically adjacent to Pyongyang. However, what we find from Table 1 is too extreme and we believe that the above-mentioned political context plays an important role. Against this backdrop, this study will measure the extreme degree beyond the normal circumstances. The gravity model will be the main tool, in which GDP and/or per capita GDP of trading countries, as well as distances between them, are major determining factors for bilateral trade flows. Based on the gravity-based analysis, this study compares the estimated bilateral trade flows with actual trade flows to measure what extent North Korea's export and import have been extremely skewed to few countries, like China, and have been abnormally frozen to sanction-imposing countries, especially the U.S. This will be eventually linked to the discussion of the effectiveness of the "containment policy" and the importance of China's role, which was argued by Oh and Ryu (2011). Using game-theoretic tools, they emphasized the importance of China's role in making the sanctions effective.

This study is to empirically confirm Oh and Ryu (2011)'s finding, with panel data of North Korea's 92 trading partners from 1999 to 2014. North Korean data is rare, which is the biggest obstacle in an empirical study for the country. However, Korea Trade-Investment Promotion Agency (KOTRA) publishes the annual report each year on North Korean trade statistics where we obtained data. Method-wise, this study is based on Montenegro and Soto (1996) who measured Cuba's trade pattern and compared the actual trade with the gravity-based estimates. Their major finding was that 70 percent of Cuba's entire trade flows will shift toward the U.S., given its world's largest GDP and geographical proximity between the two. North Korea is different from Cuba, as it is geographically much further. It is also different from Cuba, as it has another superpower, China.

Table 1. North Korea's Major Trading Partners

	1999			2003			2009			2013	
Rank	Country	Export	Import	Country	Export	Import	Country	Export	Import	Country	Export	Import
1	China	41,709	328,660	China	395,344	627,538	China	793,048	1,887,686	China	2,913,624	3,632,909
2	Japan	202,564	147,839	KOR	434,965	289,252	KOR	744,830	934,251	KOR	520,603	615,242
3	KOR	211,831	121,604	Japan	173,818	91,500	DEU	26,798	43,177	Russia	7,712	96,511
4	India	44,347	98,004	THA	50,706	203,611	Russia	20,628	41,060	India	34,911	63,074
5	HK	63,271	60,507	India	1,613	157,878	India	8,108	52,331	THA	10,608	84,973
6	DEU	23,703	32,557	Russia	2,792	115,575	SGP	1,860	55,385	SGP	1,515	59,326
7	SGP	2,723	48,061	NLD	6,525	93,486	HK	29,974	26,331	Taiwan	37,497	2,955
8	Russia	1,613	48,507	DEU	24,467	70,999	Brazil	19,406	33,316	HK	6,374	26,217
9	THA	3,242	34,705	SGP	1,148	60,067	THA	14,017	30,273	UKR	1,363	26,337
10	BGD	24,246	3,400	Italy	3,553	27,772	BGD	28,730	7,277	Brazil	10,973	16,459
11	UK	2,411	22,141	HK	16,537	12,128	NLD	21,804	5,302	BGD	26,463	261
12	Taiwan	569	11,713	Canada	65	25,612	Italy	1,219	23,106	DEU	10,836	15,106
13	France	10,575	1,566	Spain	8,419	11,297	Canada	114	22,766	PAK	24,042	47
14	AUT	2,578	9,280	BGD	18,523	182	GTM	248	22,278	PHL	1	22,926
15	USA	29	11,265	Taiwan	1,521	14,788	Taiwan	7,062	13,314	IDN	13,637	2,870
16	NLD	3,755	7,304	UK	1,930	14,175	DOM	18,347	22	Mexico	14,439	1,561
17	Poland	10,146	511	BEL	3,784	11,731	IDN	7,644	8,026	Egypt	13,323	0
18	Spain	9,519	0	DNK	2,074	12,349	MYS	203	10,911	Finland	68	11,186
19	ZAF	3,143	5,109	France	7,976	4,128	COL	10,562	106	ETH	10,533	197
20	MYS	2,395	5,407	AUS	6,698	3,160	ARG	2,598	7,847	Turkey	3,538	6,414
21	BEL	3,910	3,043	Poland	7,246	1,964	DZA	9,739	46	ARG	4,867	4,336
22	UKR	6,667	0	USA	59	7,977	Chile	634	8,926	VEN	9,165	0
23	AUS	4,139	1,093	ROU	2,794	4,668	Cuba	3,000	3,000	HND	2,972	5,971
24	Nigeria	4,987	0	MYS	245	7,168	ZAF	1,273	4,444	CHE	2,433	6,038
25	Turkey	4,888	0	ZAF	447	6,349	Mexico	4,651	927	Chile	637	7,785
26	IDN	891	2,331	CHE	859	5,765	BEL	706	4,826	NLD	6,416	1,572
27	SVN	3,204	0	SWE	397	6,131	Spain	3,226	1,957	USA	0	6,538
28	PAK	1,604	1,204	UKR	5,455	687	DNK	272	4,862	LKA	5,955	273
29	DNK	2,351	0	Cuba	3,000	3,000	PAK	2,716	1,906	Cuba	3,000	3,000
30	Canada	156	2,184	AUS	1,719	2,811	UKR	751	3,651	COL	4,822	0

Source: Korea Trade-Investment Promotion Agency (KOTRA), United Nations Statistics Division,
Note: 1) KOTRA does not consider South Korea as a trading partner to the North, as the two Koreas are not officially regarded as two different countries. As such, KOTRA calculates the two Korea's cases separately. This study combines those two different data altogether because South Korea is *de facto* a trading partner. 2) Country codes indicate; Australia(AUS), Austria(AUT), Argentina(ARG), Algeria(DZA), Bangladesh(BGD), Belgium(BEL), Colombia(COL), Denmark(DNK), Dominican Republic(DOM), Ethiopia(ETH), Germany(DEU), Guatemala(GTM), Honduras(HND), Indonesia(IDN), Malaysia(MYS), Netherlands(NLD), Pakistan(PAK), Philippines(PHL), Romania(ROU), South Korea(KOR), Singapore(SGP), South Africa(ZAF), Slovenia(SVN), Switzerland(CHE), Sweden(SWE), Sri Lanka(LKA), Thailand(THA), Ukraine(UKR), Venezuela(VEN). 3) List of all the countries can be provided upon request.

Ⅱ. Basic Results

Export and Import flows between North Korea and its 92 trading partners for 16 years (1999 to 2014) are dependent variables in this study. Explanatory variables include; GDP, per capita GDP, and distance. A simple version of the regression equation is provided as follows:

$$Ln[EX \text{ or } IM] = B_0 + B_1 lnGDP_{it-1} + B_2 lnPGDP_{it-1} + B_3 lnDISTANCE_i + u_{it}$$

Where EX or IM (unit: thousands USD) are bilateral export and import flows from each country (i) given a specific time (t), which is log-transformed. Data is from the International Monetary Fund's Direction of Trade Statistics (DOTS). GDP (current prices, billions USD) is typically used in a gravity research as a measurement of "economic mass," which is expected to show a positive relationship with trade flows. In addition, this study uses per capita GDP (current prices, U.S. dollars) as well, to test the income effect of North Korean trade - whether it exports or imports more with higher income countries or not. Given that China, whose gap between aggregate GDP and its per capita term is huge, is an important country to deal with and that most of the sanction-imposing countries are from the high-income group, adding per capita GDP to aggregate one will be important in this study. Against this political backdrop (trading more with China and less with sanction-imposing-high-income countries), we unusually expect the coefficient of per capita GDP to be negative. Both aggregate GDP and per capita GDP are log-transformed and lagged by one year to minimize any potential endogeneity issues. They are all from World Bank's World Development Indicator and in current prices. DISTANCE is another major determining factor, which is measured by the Greater Circle distance between Pyongyang and major cities of the 92 countries.[1] Consistent with all other gravity studies, we expect this coefficient to be negative.

There are usually several other "controlling" variables in gravity studies in international trade, oftentimes used as dummy types; some of them are trade bloc, national borders, landlockedness, language, pre-colonial relationship, *etc*. We decided not to use them given special circumstances surrounding North Korea; it does not share borders with any other countries except China and all others are not very meaningful factors for this hermit kingdom. Instead, as a sensitivity check for robustness, this study later adds China dummy and the squared term of distance to the original equation and considers population as an instrumental variable for GDP.

Regarding methodology, this study uses the panel random effect, as fixed effect is unable to analyze the distance effect, which is one of the major variables in this study, yet time-invariant.

Table 2. Results for Basic Equation

	Log Export	Log Import
Lag of Log GDP	0.589***	0.654***
	(0.179)	(0.138)
Lag of Log Per Capita GDP	-0.775***	-0.552***
	(0.207)	(0.148)
Log of Distance	-0.766**	-1.135***
	(0.388)	(0.263)
Constant	1.654	3.069
	(5.377)	(4.095)
Num. Obs (Num. Countries)	923 (88)	846 (85)
Median Theta	0.760	0.694
R Square	0.321	0.355

Note: Panel Random Effect. White-corrected heteroscedasticity-robust standard errors, which are in parentheses, .01 - ***; .05 - **; .1 - *; Number of countries are reduced to 88 and 85, respectively, due to missing values.

Table 2 shows that all the coefficients are as expected, positive for GDP and negative for distance, which is consistent with what the gravity model predicts. Elasticities of exports and imports with respect to GDP are similar (0.589 vs. 0.654) but differ quite a bit for distance; import is far more elastic than export (-1.135 vs. -0.766[2]). Negative coefficients for per capita GDP is also expected, but an interesting observation is that export is more sensitive to per capita GDP (-0.775 vs. -0.552); higher income countries seem to restrict the export of North Korean goods to their countries more than import of their own goods to North Korea.

Based on the findings listed in Table 2, this study compares model-based estimated trade flows between

1) Mostly capital cities, with a few exceptions for larger countries in terms of geographical area, to which the shortest distance is applied (*e.g.* Vladivostok for Russia and Seattle for the U.S.)

2) A number of gravity studies have distance coefficients less than one in absolute value (McCallum, 1995).

Table 3. Actual and Predicted Trade Portion of Selected Countries

Country	(1)Export Actual (%)	(2)Export Fitted (%)	Residual (1)-(2)	(3)Import Actual(%)	(4)Import Fitted(%)	Residual (3)-(4)
Russia	0.59059	30.43644	-29.84585	3.07014869	30.43644	-27.3663
China	51.89226	30.70983	+21.18234	58.8011889	30.70983	+28.09136
S. Korea	28.1254	19.31894	+8.80646	17.8076236	19.31894	-1.511317
USA	0.005632	2.323741	-2.318109	0.39731625	2.323741	-1.926424
Thailand	2.10808	0.423741	+1.684339	4.033602225	0.423741	+3.609861
Bangladesh	1.322194	0.328969	+0.993225	0.06020448	0.328969	-0.268764
Hong Kong	1.133017	0.43012	+0.702898	0.87524442	0.431031	+0.445125
Canada	0.006708	0.628777	-0.622069	0.42459387	0.628777	-0.204183
Germany	1.106651	0.485707	+0.622069	1.65867037	0.485707	+1.172963
Taiwan	0.620627	0	+0.620672	0.47182775	0	+0.471828
Philippines	0.000242	0.505755	-0.505513	0.14813134	0.505755	-0.357624
Japan	4.613431	5.075778	-0.462348	2.23573409	5.075778	-2.840044
Vietnam	0	0.431031	-0.431031	0.03851196	0.431031	-0.392519
Netherlands	0.597789	0.1813430	+0.416446	0.55884371	0.181343	+0.377501
Italy	0.102363	0.328057	-0.225694	0.426747	0.328057	+0.074617
Pakistan	0.472324	0.25789	+0.214434	0.08285493	0.25789	-0.175035
Malaysia	0.034803	0.245132	-0.210329	0.27832921	0.245132	+0.033197
Brazil	0.542541	0.381822	+0.160718	0.35720915	0.381822	-0.024631
UK	0.207843	0.368153	-0.16031	0.28214170	0.358154	-0.086012
Norway	1.89E-05	0.153093	-0.153075	0.00060726	0.153093	-0.152486

Note: Only 20 countries showing larger "residuals" are listed in this table. These are average percentages, which is why the portions in this table is different from those in Table 1 and may not reflect the most updated values. One important comment from the reviewer of this paper was that this interpreting result can be limited without further tests for the significance of the residuals, which can be a caveat for this study.

North Korea and its trading partners with actual ones, based on McCallum (1995), Montenegro and Soto (1996), and Sohn (2005). This is what econometricians call *residual*, which are actual values minus estimated ones. Table 3 shows the list of countries that show large residuals between actual values and fitted ones. This comparison is based on the average flows of export and import for a given time period. A positive sign means that actual values are greater than fitted ones and a negative sign means the other way around. For instance, the residual for Russia is close to -30%[3] for both export and import, which indicates Russia's substantially under-represented trade with North Korea, leaving room for further economic integration between the two. In contrast, in North Korea's trade with China, the residual is 21% for export and 28% for import. This is the degree of extreme biasedness toward China on top of natural skewness based on Beijing's economic size and geographical location. This residual demonstrates Pyongyang's dependencies on Beijing and which shows the importance of China's role in imposing economic sanctions. In a case of South Korea, exports from North Korea are over-represented by 8 percent but imports from the country are under-represented by 1.5 percent. It can be inferred from this mixed finding that the effect of sanctions imposed by South Korea against North Korea is somewhat limited.

An interesting finding is that the estimated export and import portions between North Korea and the

3) This result could be somewhat over-estimated, as we considered Vladivostok based on the shortest-distance rule. We may have a lower portion if Moscow is considered, instead. Therefore, this result should be interpreted with caution.

Table 4. Sensitivity Tests: Specification Issues

	Export					Import				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Lag of Log GDP	0.557*** (0.176)	0.586*** (0.168)	0.558*** (0.167)	0.839*** (0.112)	0.786*** (0.148)	0.608*** (0.136)	0.648*** (0.132)	0.607*** (0.132)	0.773*** (0.120)	0.756*** (0.128)
Lag of Log Per Capita GDP	-0.741*** (0.210)	-0.769*** (0.190)	-0.739*** (0.196)	-0.857*** (0.117)	-0.182 (0.159)	-0.505*** (0.155)	-0.550*** (0.147)	-0.507*** (0.154)	-0.628*** (0.128)	0.113 (0.115)
Log Distance	-0.650 (0.441)	-11.228*** (2.135)	-10.941*** (1.819)	-0.642*** (0.215)	-0.665* (0.386)	-1.030*** (0.288)	-7.662*** (2.159)	-7.335*** (1.836)	-1.068*** (0.229)	-1.100*** (0.252)
Log Distance		0.690*** (0.145)	0.678*** (0.129)				0.431*** (0.146)	0.415*** (0.129)		
China	2.834** (1.215)		2.343*** (0.887)			2.822*** (0.732)		2.520*** (0.565)		
Constant	1.288 (5.491)	40.542*** (9.123)	39.564*** (7.784)	-4.542 (3.225)	4.805 (3.901)	3.055 (4.230)	27.407** * (8.220)	26.535** * (6.784)	0.096 (3.466)	8.341*** (2.842)
Num. Obs (Num. Countries)	923 (88)	923 (88)	923 (88)	979 (88)	924 (88)	846 (85)	846 (85)	846 (85)	879 (85)	847 (85)
R Square	0.327	0.365	0.373	0.328	0.323	0.362	0.362	0.370	0.369	0.359

Note: Panel Random EffectWhite-corrected heteroscedasticity-robust standard errors, which are in parentheses, .01 - ***; .05 - **; .1 - *; Equations are specified as follows:
(1) Adding China dummy (1 for China and 0 elsewhere)
(2) Adding square term of Log of distance
(3) (1)+(2)
(4) Log of population used as an instrument variable for log of GDP
(5) Log of population replacing log of GDP

U.S. are around 2 percent, which is not significantly higher than the actual values. This finding implies that the effect of the U.S. sanctions against North Korea could be negligible unless China cooperates. This result is very different from Montenegro and Soto's (1996) who found that Cuba's trade portion with the U.S. would drastically increase to 70% from the actual portion of almost zero percent.

Ⅲ. Robustness Checks

Table 4 sets out further regressions to deal with econometric issues and confirm the robustness of findings made in Table 2. In particular, Equation (4) and (5) deal with the reverse causality problem arising from the fact that exports and imports may affect GDP as parts of its components. McCallum (1995) tackled this endogeneity issue by using population as either an instrumental variable or a replacement, and this study adopts this approach.

As shown in the table, all the results are consistent. In Equation (1) and Equation (3) (both export and import) where China was added as a dummy variable, the coefficients are significantly positive in both cases with a similar level (2.834 for export and 2.822 for import in Equation (1), and 2.343 and 2.520 in Equation (3)). Holding other things constant, North Korea's trade with China is approximately 10-17[4] times larger on average than the North's trade with other countries, confirming the finding from Table 3 where North Korea is excessively tied to China.

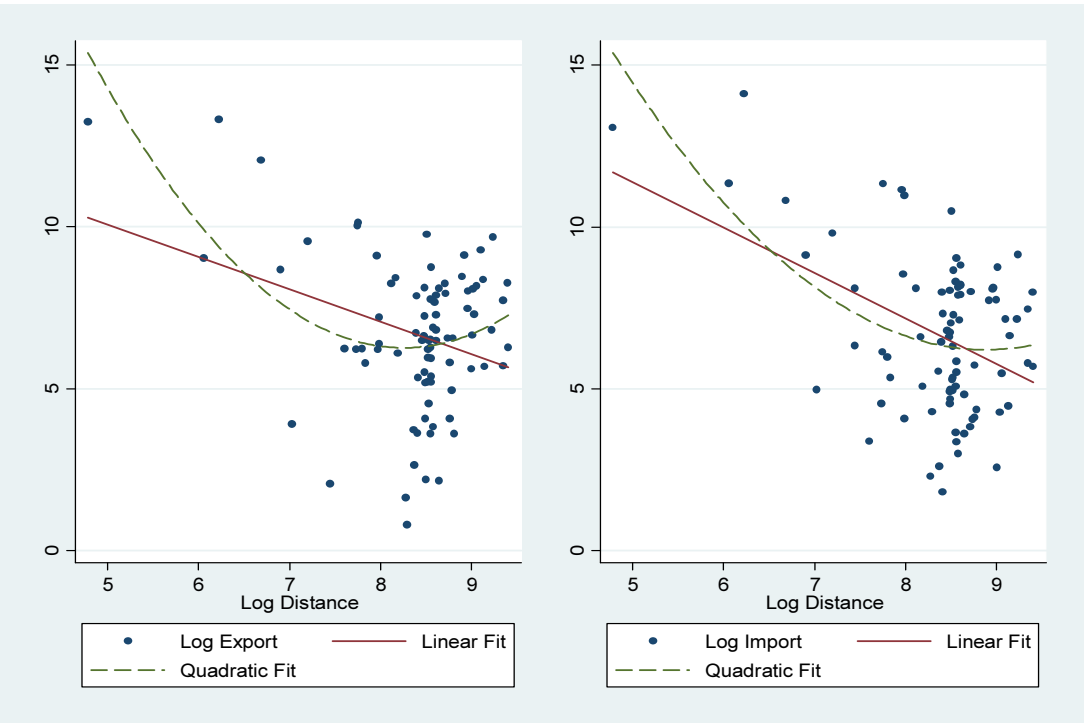
Equations (2) and (3) add the square term of log distance. The only difference between (2) and (3) is that the latter has China dummy while the former does not. In all of the four cases (two for export

4) Equation (1): exp (2.834) = 17.01 and exp (2.822) = 16.81; Equation (3): exp (2.343) = 10.41 and exp (2.520) = 12.43
$iny = a + bX + cChina.$ *if* $China = 1$, $lny_1 = (a+c) + bX$ *and if* $China = 0$, $lny_0 = a + bX$. So, $lny_1 - lny_0 = \ln\left(\frac{y_1}{y_0}\right) = c$. *Therefore*, $y_1 = e^c y_0$

Table 5. Distance Thresholds

	Export		Import	
	Equation (2)	Equation (3)	Equation (2)	Equation (3)
Log Threshold	8.1362319	8.0685841	8.8886311	8.8373494
Actual Threshold	3,416 miles	3,193 miles	7,249 miles	6,887 miles

Note: Log thresholds are obtained by calculating coefficients for - [LogDistance/ 2*coefficients for $LogDistance^2$] from Table 4. Actual threshold are exponential values for log thresholds.



Note: This figure is based on the average values by each country from 1999 to 2015, so may not reflect the most updated values. However, this is better illustrated than the actual panel data, in which the time-invariant distance produces multiple circles in a row for each country.

Figure 1. Scatter Plot and Fitted Lines of Export and Import with Respect to Distance

and two for import), square terms are positive and linear terms are negative, suggesting the convex shape of the fitted curve. Table 5 summarizes the thresholds where distance is minimized and Figure 1 visually illustrates the findings.

In both exports and imports, distance has the negative relationship with trade only up to certain degrees and has upward sloping after the thresholds. One possible explanation of this non-monotonous trend is that the geographical location of China;[5] the finding that North Korea trades more with neighbor countries is dominantly determined by China, whose effect fades away as the distance becomes larger. This explanation can be supported by Equation (1) where distance coefficient is not statistically significant when China effect is controlled by a dummy variable. More interestingly, Table 5 show that, given the thresholds, the distance effect

5) Korea is also geographically close to North Korea and used to be one of North Korea's major trading partners, but, as Table 1 reveals, China is currently the only dominant commercial tie for the reclusive regime.

fades away around twice more quickly in export (approximately 3,200-3,400 miles) than in import (approximately 6,900-7,200 miles).

Ⅳ. Conclusion

After more than fifty years of sanctions, the diplomatic relationship between the U.S. and Cuba was finally normalized. Political situation surrounding North Korea is precarious and unpredictable, but academic studies on the country may possibly reduce the unpredictability and identify any future potential risks. Obtaining data is the biggest obstacle in empirical attempts for the reclusive regime, but we can at least get its trade data, indirectly from the partner countries, like the mirror. Data reliability can be an issue (Wall Street Journal, 2014) but, it would still be worth trying. In the process of discussions and negotiations, international coordination and cooperation, particularly with China are crucial and this study provides empirical grounds to confirm this.

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