Effects of Economic Sanctions on North Korea–China Trade:
A Dynamic Panel Analysis

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This study addresses whether North Korea–China trade dilutes the effectiveness of the unilateral sanctions imposed by South Korea and Japan, and if so, to what extent and in what way. The structural adjustment of North Korea's export pattern in size and trade type dilutes the effectiveness of the unilateral sanctions imposed by South Korea in particular. South Korea's economic sanctions significantly boost North Korea's exports to China, and the export increase has been substantial to cover the loss from the sanctions. North Korea has increased exports to the Chinese domestic market (by general trade) and those passing through China (by bonded trade). These findings show that North Korea has mitigated the economic damage of sanctions by employing various techniques for trade diversion. Changes occur because incentives for both North Korean regime and foreign firms are expedient particularly after South Korea's sanctions.

Keywords: Economic sanctions, North Korea–China trade, Dynamic panel model

JEL Classification: F51, P33, C23

I. Introduction

Economic sanctions are essential events in understanding North Korean economy in the 2000s. The United Nations Security Council Resolution (UNSCR) 1718 and 1874 were adopted in 2006 and in 2009,

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respectively, in response to the consecutive nuclear tests of North Korea. Multilateral sanctions included sanctions on weapon systems and sales of luxury goods to North Korea but did not sanctions on nonmilitary commercial trade (Haggard, and Noland 2009). In contrast, unilateral sanctions by North Korea's principal economic partners, South Korea and Japan, embodied much stronger measures.[1] In the aftermath of the sinking of the *Cheonan* battleship in March 2010, South Korea suspended all trade relations with North Korea except for the Kaesong Industrial Complex (KIC). North Korea's trade volume with Japan also sharply dropped to zero after the complete trade embargo of the latter caused by the bilateral tension over the abductions of Japanese citizens.[2]

Analyzing the effectiveness of the sanctions offers important implications to the South Korean government and international community for suggesting effective sanction strategies to stop North Korea from developing nuclear weapon programs that currently seem to progress considerably (Jeong 2013). Despite the implications, the effectiveness of the economic sanctions[3] on North Korean economy remains unclear. Noland (2008) and Jeong and Bang (2011) report that the economic sanctions by UNSCR 1718 did not significantly affect North Korea's exports and imports. Lee and Kim (2011) observes a negative relationship between the sanctions by UNSCR 1874 and North Korea's aggregate exports but no apparent relationship between the sanctions and North Korea's imports. Lee (2010) finds that Japan's economic sanctions diminished North Korea's export to Japan, but the size of export loss was mostly compensated by North Korea's increased exports to other countries. Lee and Lee (2012) argue that South Korea's sanctions may incur significant adjustment costs to the North Korean economy in increasing exports to China, because North Korea's exports

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[1] The US has also implemented a unilateral sanction against North Korea since the end of the Korean War. This long-term sanction restricts economic relations between the US and North Korea.

[2] Refer to Appendix Table 1 for a detailed list of sanctions.

[3] Van Bergeijk (1994) distinguishes between the effectiveness and success/ failure of economic sanctions. The former deals with (potential) damage that is to be inflicted on the target economy, whereas the latter deals with the target's behavioral changes as a consequence of diplomatic economic measures.

to South Korea are not easily transferable to the Chinese market.[4] Exporting strategic goods, such as coal and iron ores, may also deteriorate North Korea's domestic productions.

Despite differences in the effects of the sanctions North Korean trade, most studies have reached a consensus on the limited effect of the sanctions in damaging the North Korean economy as a whole, indicating that the expanded trade between North Korea and China, North Korea's largest trade partner, relieved a considerable amount of pressure imposed by both multilateral and unilateral sanctions (Mimura 2005; Whitty *et al.* 2006; Noland 2008; Haggard, and Noland 2009; CRS 2010; Lee, and Kim 2011; Jeong, and Bang 2011; Lee, and Lee 2012).
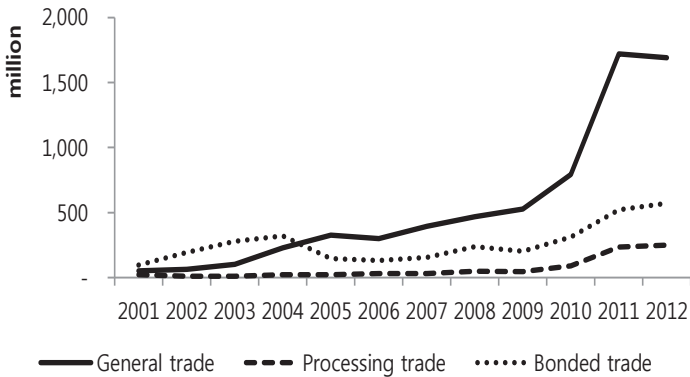
In this regard, this study addresses the question whether North Korea–China trade dilutes the effects of the sanctions, and if so, to what extent and in what way. For a clear analysis, this study focuses on changes in North Korea's exports caused by the unilateral sanctions applied by South Korea and Japan. Strengthening multilateral sanctions mainly targeting North Korea's import is difficult because of informal and illicit cross-border trades and the lack of Chinese cooperation in the border areas (Haggard, and Noland 2009; CRS 2010). From this perspective, evaluating the effects of the sanctions on North Korea's exports rather than imports is critical because the matter is directly related to the amount of cash flow blocked by the sanctions that may be used for military development.

This study extends the existing literature on the effectiveness of sanctions against North Korea in two aspects. First, we construct a unique panel dataset of North Korea's bilateral trade with China, South Korea, and Japan at Harmonized System (HS) 4 digit-commodity code level[5] from 2001 to 2012. Commodity-based trade panel data can capture the substitutional trade relationship between China and Korea or China and Japan after imposing sanctions at commodity level. The dataset includes detailed information on the trade types[6] between

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[4] Mining products and garments are the main exporting commodities of North Korea to China and South Korea, respectively.

[5] The Harmonized Commodity Description and Coding System, also known as the HS of tariff nomenclature, is an internationally standardized system of names and numbers to classify traded products (Wikipedia).

[6] The author divides North Korea's exports statistics with China into three basic trade types. Refer to Hammer (2006) and/or Korea Trade and Investment

Source: China Customs

FIGURE 1

TREND OF NORTH KOREA'S EXPORTS TO CHINA BY TRADE TYPE

North Korea and China; such information has been ignored in most previous studies. The dataset also provides new dimensions to identify how changes in North Korea's trade patterns mitigate the effects of the sanctions. The trends of the three trade types dynamically changed over the period (Figure 1). In the early 2000s, the bonded trade was the dominant trade pattern when North Korea exported to China. The share of the bonded trade plummeted from 2005 to 2009 because the South Korean government implemented strict inspection measures on imported goods passing through China and the Japanese government imposed strong sanctions. After South Korea imposed sanctions in 2010, the export volumes of all trade types surged, and the increase in general trade was the highest among trade types.

Promotion Agency or KOTRA (2006) for detailed information on trade types.

General trade refers to exports intended for the Chinese domestic market. North Korea's major exports are mining products.

Processing trade refers mainly to imports of raw material intended to be assembled or transformed in North Korea and subsequently re-exported (normally by subcontracting operations). North Korean firms only gain processing fees through this trade type. North Korea's major exports are clothing products.

Bonded (warehouse) trade refers to exports not intended for the Chinese domestic market; the exports are only transit to China and re-exported to third-party country. Bonded trade accounts for 30% of the total trade between North Korea and China. North Korea's major exports are clothing and mining products.

Second, this study uses dynamic models to reflect the adjustment or persistent effects of economic sanctions on North Korea–China trade over time. If North Korea increases trade volumes with China during a particular year in response to South Korea's or Japan's sanctions, then the trade volume in the succeeding year may be affected because the effects of the sanctions are growing. A dynamic setting is a plausible approach to investigate the dynamic interaction between sanctions and the North Korea–China trade relationship. Most previous studies on the effects of sanctions against North Korea have employed a static panel analysis (*e.g.* pooled OLS, fixed-effects and random-effects estimator); dynamic panel data analysis has yet to be used in empirical studies. In this dynamic setting, we apply the system generalized method of moments (GMM) estimator to deal with the endogeneity problem caused by the inclusion of lagged variables. The system GMM estimator is efficient because it employs a large set of instruments and uses instruments both in levels for equations in first differences and in first differences for equations in levels (Arellano, and Bover 1995; Blundell, and Bond 1998).

The results show structural adjustments of North Korea's export pattern in size and types for voiding the effectiveness of unilateral sanctions, especially those imposed by South Korea. South Korea's economic sanctions significantly boost North Korea's exports to China. The export increase is adequate to cover the loss from the sanctions. All trade types between North Korea and China are increased in response to South Korea's trade restrictions. The expansion in mining exports through general trade is the largest. Bonded trades transferred in China also effectively circumvent sanctions, because North Korea manages to evade foreign custom regulations. The findings support the argument that even severe sanctions against the commercial trade of North Korea exert minimal effect because North Korea mitigates the economic damage from the sanctions by employing various techniques for trade diversion.

The rest of the article is organized in five sections. Section II discusses the empirical model. Section III describes the data. Section IV presents the main results and discussions. Section V summarizes the core findings of this study and discusses policy implications.

TREND OF NORTH KOREA'S EXPORTS IN 2000S (UNIT: MILLION USD, %)

Year	Total Export Volume	Export Proportion by Country (%)				Note
		China	South Korea	Japan	Sum	
2001	826	20	21	27	69	
2002	1,007	27	27	23	77	
2003	1,066	37	27	16	81	Start of Japan's sanctions
2004	1,278	46	20	13	79	
2005	1,338	37	25	10	73	
2006	1,467	32	35	5	73	
2007	1,683	35	45	0	80	
2008	2,062	37	45	0	82	
2009	1,997	40	47	0	86	
2010	2,559	46	41	0	87	Start of South Korea's sanctions
2011	3,703	67	25	0	91	
2012	3,954	63	27	0	90	

Note: North Korea's total export volume was complied by adding KOTRA's statistics and inter-Korea trade volume.[7]

Sources: KOTRA, Korea International Trade Association (KITA), China Customs statistics, UN Comtrade database.

II. Empirical Framework

The gravity model of international trade has often been used to investigate the influence of political variables on normal bilateral trade flows (Van Bergeijk 1994; Caruso 2003). Following this approach, some scholars have also applied the model to analyze the effect of sanctions imposed on North Korea (Lee 2010; Jeong, and Bang 2011; Lee, and Kim 2011). However, the abnormality of North Korea's trade pattern casts doubt on the model's applicability.

The geographic composition of North Korea's export has transformed considerably (Table 1). Both South Korea and Japan were once the

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[7] North Korea's trade data often cause confusion because South Korea does not report its trade with North Korea to international authorities, considering it as inter-Korean rather than international.

top importing countries of North Korea, but their importance in North Korea's exports sharply decreased shortly after they imposed severe restrictions on trade inflow from North Korea. On the contrary, the Chinese share continuously increased up to almost 70% as the diplomatic climates around North Korea deteriorated. This shift shows the dominant influence of political factors on North Korea's exports and the limited explanatory power of the gravity model, which suggests GDP of exporting/importing country or geographic distance between exporting and importing countries as key variables.[8]

Noland (2008) assesses the effects of sanctions on trade based on the import demand equation. Macro variables (*e.g.* North Korean income, black market exchange rates) have been included in the trade equation to control for the level of economic activity and domestic price of North Korea. However, most North Korean macro data suffer from serious measurement errors during estimation (Lee 2007).

Given the lack of theoretically applicable models and macro data availability, our estimation strategy is to maximize the use of trade data. We construct bilateral trade panel data by commodity rather than by country to maximize the use of rich trade information ranging from price and quantity to the values of each commodity.

With the dataset, we identify the following variables to explain North Korea's export to China. First, the lagged variable of North Korea's export values is used as a repressor in the model. The model can then account for the dynamics in the underlying process of bilateral trade and North Korea's behavioral adjustment in response to the sanctions. In this dynamic setting, we apply the system GMM estimator to deal with the endogeneity problem (Arellano, and Bover 1995; Blundell, and Bond 1998).

Second, the price level of trade goods should be considered in the function. Kim (2013) indicates that the rising unit prices, particularly for mining products, contribute to North Korea's increased trade outflow to China. Given the limited information of the price index of North Korea's trade, we alternatively use unit prices of each export commodity

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[8] The bonded trade with China and its unusual large size, that is, 30% of the total trade between North Korea and China, can lead to biased results from the gravity model. The bonded trade is not an actual trade between North Korea and China. North Korea exports goods only through China, and information about the final destinations of these commodities is unavailable.

of North Korea to China to control price inflation effects of the exports
to China.

Third, we include export values of South Korea and Japan to reflect
trade linkage among countries. Regardless of the sanctions, the
countries may have enjoyed substitutive or complementary relationship
with North Korea in terms of exports. For example, if North Korea
exports more (less) to China, then it subsequently exports less (more) to
other countries because of its limited production capacity and internal
policy or trade type changes.

The basic model takes the following functional form. We use subscripts
i and t to denote HS 4-digit commodity code and year, respectively.

$$\ln C_{it} = \beta_1 + \beta_2 \ln C_{it-1} + \beta_3 \ln CP_{it} + \beta_4 \ln K_{it} + \beta_5 \ln J_{it}$$
$$+ \beta_6 \text{Kdummy}_t + \beta_7 \text{Jdummy}_t + \varepsilon_{it} \tag{1}$$

Where

  $\ln C_{it}$: log of North Korea's exports value to China of commodity i in
        year t

  $\ln C_{it-1}$: lagged log of North Korea's exports value to China of commodity
        i in year t

  $\ln CP_{it}$: log of unit price of North Korea's exports to China of commodity
        i in year t

  $\ln K_{it}$: log of North Korea's exports value to South Korea of commodity
        i in year t

  $\ln J_{it}$: log of North Korea's exports value to Japan of commodity i in
        year t

  Kdummy_t: South Korea's economic sanction dummy (if $t \geq 2010 = 1$,
          otherwise $= 0$)

  Jdummy_t: Japan's economic sanction dummy (if $t \geq 2003 = 1$,
          otherwise $= 0$)

To identify the variations of the effects of the sanctions by trade
types, we decompose North Korea's exports to China by trade types and
construct the three following equations. We use superscripts G, B, and
P to denote general, bonded, and processing trade, respectively.

$$\ln C_{it}^G = \beta_1 + \beta_2 \ln C_{it-1}^G + \beta_3 \ln CP_{it}^G + \beta_4 \ln K_{it} + \beta_5 \ln J_{it}$$
$$+ \beta_6 \text{Kdummy}_t + \beta_7 \text{Jdummy}_t + \varepsilon_{it}$$
$$\ln C_{it}^B = \beta_1 + \beta_2 \ln C_{it-1}^B + \beta_3 \ln CP_{it}^B + \beta_4 \ln K_{it} + \beta_5 \ln J_{it} \tag{2}$$

$$+ \beta_6 \text{Kdummy}_t + \beta_7 \text{Jdummy}_t + \varepsilon_{it}$$
$$\ln C_{it}^P = \beta_1 + \beta_2 \ln C_{it-1}^P + \beta_3 \ln CP_{it}^P + \beta_4 \ln K_{it} + \beta_5 \ln J_{it}$$
$$+ \beta_6 \text{Kdummy}_t + \beta_7 \text{Jdummy}_t + \varepsilon_{it}$$

Where

$\ln C_{it}^G$: log of North Korea's exports value to China by general trade of commodity i in year t

$\ln C_{it}^B$: log of North Korea's exports value to China by bonded trade of commodity i in year t

$\ln C_{it}^P$: log of North Korea's exports value to China by processing trade of commodity i in year t

Despite the merits of the commodity-based panel dataset, this empirical setting bears limitations. First, the model explicitly considers the effects of North Korea's trade diversion from South Korea and Japan to China but not the effects of trade reduction (increase) from third-party countries. To capture all the effects of trade reduction (increase) from third-party countries, a country-based panel data comprising the bilateral trade with North Korea must be constructed. However, the data contain information on the bonded trade with China, and most of North Korea's exports to China in this form are re-exported to third-party countries. Bonded trade data do not present exhaustively covered trade data with the third-party countries, but they may serve as good proxy. Data of North Korea's trade with other countries, excluding South Korea, China, and Japan, are inaccurate because the customs of some countries often confuse the origins of commodities between South and North Korea.

Second, the model specification does not account for a possible trade volume difference between the sanction-affected and unaffected countries. Jeong and Bang (2011) and Lee and Kim (2011) use the difference-in-difference estimation method to control for the difference based on country panel data. Jeong and Hong (2001) choose socialist countries as control group, whereas Lee and Kim (2011) select the countries that have not submitted their national implementation reports to UNSCR 1874. However, Abadie *et al.* (2010) indicate that setting control groups on the basis of researchers' subjective measures leads to uncertainty in reproducing the counterfactual outcomes the treatment group may experience in the absence of the event of interest.

Finally, the price difference of imports between North Korea and

others is uncontrolled. The bargaining power of Chinese firms over
North Korea may result in the reduced price of major exporting
commodities of the latter (Koh 2008). Detailed commodity data, for
example HS 6- or 8- digit code level, can specify quality difference that
is unavailable for the full sample period.

III. Data

This study uses the data of North Korea's bilateral exports with
China, South Korea, and Japan from 2001 to 2012. North Korea does
not issue any official trade statistics; the data are constructed based
on the import statistics of the three other countries.[9] Given that each
original dataset uses different HS code levels, we aggregate the data into
panel HS-4 digit commodity code level in USD.[10] In particular, raw trade
statistics from China Customs contains trade types of each commodity's
transactions categorized into 19 custom regimes.[11] We reclassify North
Korea's main trade types into three groups—general, processing, and
bonded trade (Appendix Table 2). The main sources are China Customs
and KITA statistics database as well as UN Comtrade database.

It is worth noticing when the sanctions effectively initiated. In case of
Japan, the first measure was strengthening port state control inspection
on the Mangyongbong-92, a passenger ferry between North Korea and
Japan, in June 2003. In case of South Korea, the May 24 measures,
which suspended all commercial trades with the exception of KIC, were
introduced in May 2010. We cannot designate the specific point when
the sanctions began because of the intrinsic limitations of the annual
datasets. However, foreign trade partners may respond in advance, even

[9] The trade values are recoded as cost, insurance, and freight, not free on
board. The statistics overestimate the real export values of North Korea.

[10] Trade values are taken in logs; to deal with the issue of zeros, a very small
number is added to those to allow for log transformation. Silva and Tenreyro
(2006) point out that such approach can generate biased estimates in presence
of heteroskedasticity, and thus we run panel regressions with robust standard
errors to minimize possible bias.

[11] We mostly rely on China Customs sources to construct the data of Chinese
statistics. However, China Customs did not report trade statistics with North
Korea from August to November 2009 after North Korea's second nuclear test.
For 2009 data, we refer to UN Comtrade database and reconstruct the original
data from China Customs.

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TABLE 2

DESCRIPTIVE STATISTICS OF THE VARIABLES

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Variables	Observations	Min	Max	Mean	S.D.
Log of North Korea's exports value to China	2,417	1.08	20.91	10.80	3.32
Log of North Korea's exports value to China by general trade	1,413	1.10	20.84	10.49	3.34
Log of North Korea's exports value to China by bonded trade	1,412	2.18	18.45	10.53	3.17
Log of North Korea's exports value to China by processing trade	627	1.10	17.76	10.49	3.19
Log of North Korea's exports value to South Korea	2,417	0	18.50	6.95	6.39
Log of North Korea's exports value to Japan	2,417	0	18.09	1.50	4.08
Log of unit price of North Korea's exports to China	2,417	-6.73	13.81	0.89	2.64
Log of unit price of North Korea's exports to China by general trade	1,413	-6.73	13.82	0.20	2.89
Log of unit price of North Korea's exports to China by bonded trade	1,412	-5.30	11.92	1.09	2.15
Log of unit price of North Korea's exports to China by processing trade	627	-4.86	8.68	1.19	1.93
South Korea's economic sanction dummy	2,417	0	1	0.32	0.46
Japan's economic sanction dummy	2,417	0	1	0.92	0.26

before a sanction starts; starting discussions on imposing an economic sanction escalates political tensions and increases the risk premium on transactions with North Korea. Following, the data define the starting points of Japan's and South Korea's sanctions in 2003 and 2010, respectively. Table 2 presents the descriptive statistics of the variables.

IV. Empirical Results

A. Basic Model: Effects of Sanctions on Total Exports

Table 3 presents the estimation outcomes from pooled OLS as well

as fixed-effects and system GMM estimators for the basic model. In dynamic panel models, OLS estimator produces an upward biased and inconsistent estimate in the presence of individual-specific effects, and fixed-effects estimator generates a downward biased and inconsistent estimate in a short panel (Nickell 1981). A consistent estimate of the coefficient of a lagged dependent variable is expected to lie between the OLS and fixed-effects estimates (Bond *et al.* 2001). In this regard, the system GMM estimates in Table 3 are consistent and robust. The Hansen test of overidentification suggests that the set of instruments are valid, and the AR(2) test shows no second-order autocorrelation. Therefore, we interpret the results based on the system GMM estimator.

Regarding the effects of the sanctions, South Korea's economic sanctions increase North Korea's exports to China, whereas Japan's sanctions exert an insignificant effect. Our result on Japan's sanction is in line with that of Lee (2010), who reports that, based on Granger causality tests, North Korea mitigates the effects of Japan's sanctions not by increasing exports to China but by increasing exports to South Korea. However, after South Kore implemented the economic sanctions, North Korea cannot but expand exports to China because its export structure heavily relies on only two principal countries, China and South Korea. From this viewpoint, our estimated results reflect the reality of the changes in North Korea's trade patterns. After controlling for the effects of the unilateral sanctions, we observe a negative relationship between exports to China and those to South Korea. A substitutional trade relationship exists between the exports of the two countries to North Korea.

The magnitude of the coefficient of South Korea's sanctions should be given attention. The relatively large size implies that North Korea's exports to China after the sanctions are predicted to increase by 63.7% ($e^{0.493}$-1). Converting the effects to USD, the increased annual average exports caused by the sanctions is estimated to be around 319 million dollars.[12] The effects of North Korea's export diversion from expanded

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[12] We calculate this value by differencing "the expected average exports to China after sanctions" with "the actual average exports to China before sanctions." The expected exports volume is derived from the coefficient of South Korea's sanctions. Alternatively, the predicted values can be used for this conversion. However, applying them in practice is difficult because the predicted values by the model are far different from real observations as a result of the

TABLE 3

PANEL REGRESSION ESTIMATES OF BASIC MODEL

	Pooled OLS	Fixed Effect	SYS GMM t-3
Dependent Variables	Log of export values to China		
Log of lagged export values to China	0.452*** (0.011)	0.133*** (0.017)	0.202*** (0.035)
Log of unit price	0.013 (0.019)	0.235*** (0.065)	0.220 (0.168)
Log of export values to South Korea	0.031*** (0.007)	0.006 (0.013)	-0.071* (0.040)
Log of export values to Japan	0.091*** (0.012)	-0.008 (0.017)	0.056* (0.031)
South Korea's economic sanctions dummy	0.688*** (0.106)	0.777*** (0.106)	0.493*** (0.159)
Japan's economic sanctions dummy	-0.315* (0.182)	-0.155 (0.144)	-0.163 (0.164)
R2	0.53	0.16	
F-test		[0.000]***	
AR(2) test			0.43
Hansen test			0.13
Number of observations		2,417	

Note: *, **, *** refer to significance at 10%, 5%, and 1% level, respectively. Standard errors are in parentheses. All standard errors are calculated as robust to heteroskedasticity.

exports to China are larger than the loss from decreased exports to South Korea.[13] However, the actual average increase of North Korea's exports to China from before to after the imposition of South Korea's sanctions is more than 1.5 billion dollars. The estimates only partially explain the abnormal increase in North Korea's exports to China after South Korea's sanctions. The unidentified factors that are not

limitations of the model.

[13] Roughly, the estimate of the amount of exports loss from inter-Korean trade by the sanctions is 278 million dollars. It is calculated by differencing "the average of total exports to South Korea by general and processing trade (outside KIC) before the sanctions" with "the average of total exports to South Korea by general and processing trade (outside KIC) after the sanctions."

TABLE 4

CHANGES IN NORTH KOREA'S EXPORTS CAUSED BY SOUTH KOREA'S ECONOMIC
SANCTIONS (UNIT: MILLION USD)

	Effects of trade diversion to China	Loss from South Korea
General Trade	163	198
Bonded Trade	104	-
Processing Trade[1]	18	80
Total	319[2]	278

Note: [1] In South Korea's inter-Korean trade statistics, processing trade pertains to
        that outside KIC.
      [2] Discrepancy is observed between total value and each value by trade type
        in the first column, because the values are estimated from a single equation
        with different control variables.

considered in the model cause the rapid increase of North Korea's
exports. For example, the North Korean regime must obtain more hard
currency for the preparations of changing leadership.

The coefficient on lagged exports is also significant, indicating that
the dynamics of the interaction relationship between the sanctions and
bilateral trades is important.

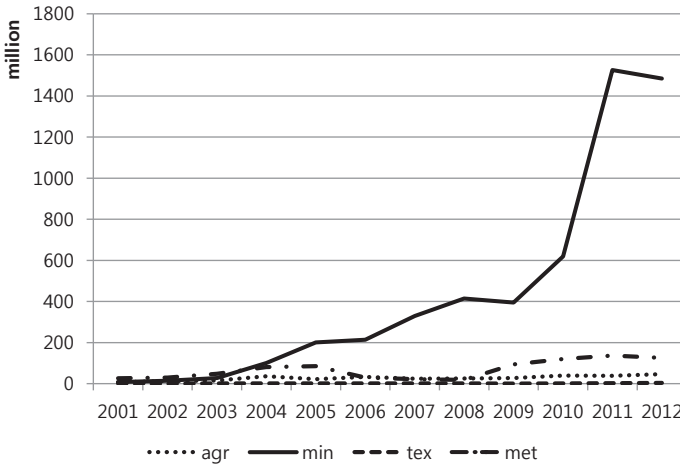## B. Extended Model: Effects of Sanctions by Trade Type

Table 5 lists the effects of economic sanctions on the three main
trade types of North Korea with China. The estimated results of the
coefficients of the sanctions are very similar to the previous findings.
Only South Korea's sanctions dummy is positively associated with
North Korea's exports through all trade types, whereas that of Japan
does not exert any effect across the models. In particular, the coefficient
of exports to South Korea is significantly negative in the bonded trade
equation, indicating that North Korea increases the bonded trade as
exports to South Korea decrease. Garments are the main exporting
commodities to China by bonded trade, and clothing accounts for
the major portion to South Korea (Figure 4); therefore, an increase in
garment exports through the bonded trade with China has compensated
the loss caused by decreased exports to South Korea.

For a clear comparison among trade types, we summarize the
changes in dollar-denominated North Korea's exports in response to

TABLE 5

PANEL REGRESSION ESTIMATES OF EXTENDED MODEL

Estimator	Pooled OLS	Fixed Effect	SYS GMM t-3	Pooled OLS	Fixed Effect	SYS GMM t-2	Pooled OLS	Fixed Effect	SYS GMM t-2
Dependent Variable	Log of export values to China by general trade			Log of export values to China by bonded trade			Log of export values to China by processing trade		
Log of lagged export values to China by General trade	0.456*** (0.013)	0.101*** (0.020)	0.190*** (0.068)						
Log of lagged export values to China by banded trade				0.331*** (0.012)	0.103*** (0.014)	0.132*** (0.024)			
Log lagged export values to China by processing trade							0.309*** (0.017)	0.082*** (0.020)	0.195*** (0.040)
Log of unit price by general trade	0.030 (0.021)	0.135 (0.117)	-0.246 (0.211)						
Log of unit price by bonded trade				0.034 (0.031)	0.323*** (0.077)	0.031 (0.211)			
Log of unit price by processing trade							-0.124** (0.053)	0.343*** (0.075)	-0.328 (0.299)
Log of export values to South Korea	-0.015 (0.010)	-0.006 (0.013)	-0.022 (0.064)	0.039*** (0.011)	0.012 (0.014)	-0.074* (0.045)	0.076*** (0.014)	-0.013 (0.021)	0.008 (0.057)
Log of export values to Japan	0.057*** (0.015)	-0.025 (0.021)	0.086** (0.043)	0.083*** (0.015)	-0.014 (0.018)	0.057 (0.031)	0.050** (0.021)	0.074*** (0.027)	-0.015 (0.036)
South Korea's economic sanctions dummy	0.580*** (0.138)	0.626*** (0.118)	0.467*** (0.200)	0.609*** (0.148)	0.843*** (0.119)	0.426** (0.179)	0.837*** (0.214)	0.822*** (0.222)	0.527* (0.281)
Japan's economic sanctions dummy	0.603*** (0.214)	0.647*** (0.182)	-0.248 (6.919)	-0.697*** (0.241)	-0.648*** (0.207)	-0.3389 (0.240)	0.010 (0.352)	-0.668* (0.344)	-0.199 (0.3672)
R2 / F-test / AR2 test / Hansen test	0.55	0.14 [0.000]***	0.237 / 0.132	0.43	0.19 [0.000]***	0.769 / 0.283	0.43	0.24 [0.000]***	0.403 / 0.188
Number of observation	1,413			1,412			627		

Note: *, **, *** refer to significance at 10%, 5%, and 1% level, respectively. Standard errors are in parentheses. All standard errors are calculated as robust to heteroskedasticity.

Note: HS code is converted to ISIC code. Conversion table is obtained from Jon
     Haveman's Industry Concordances at www.macalester.edu/research/
     economics/page/haveman/trade.resources/tradeconcordances.html
agr: Agriculture, Hunting, Forestry and Fishing (ISIC code 1)
min: Mining and Quarrying (ISIC code 2)
tex: Textile, Wearing Apparel and Leather Industries (ISIC code 32)
met: Basic Metal Industries (ISIC code 37)
Source: China Customs

FIGURE 2

TREND OF COMMODITY COMPOSITION OF NORTH KOREA'S EXPORTS TO CHINA BY
GENERAL TRADE

the sanctions in Table 4. The first column reports the export expansion
with China, which is estimated in the regression model. The second
column reports the loss from South Korea's sanctions, which is the
actual average difference in North Korea's exports to South Korea before
and after the imposition of the sanctions. In terms of volume, general
trade and then bonded trade between North Korea and China are the
most positively affected by the sanctions.

Each trade type features varying commodity compositions (Figures 2,
3, and 4).[14] Particularly, after imposing the sanctions, mining exports

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[14] To draw the figures, the HS code of each trade value is converted to
International Standard Industrial Classification of All Economic Activities (ISIC)
code, and aggregates the value by industrial level. The ISIC code was developed
by the UN as a standard classification of economic activities. The ISIC code
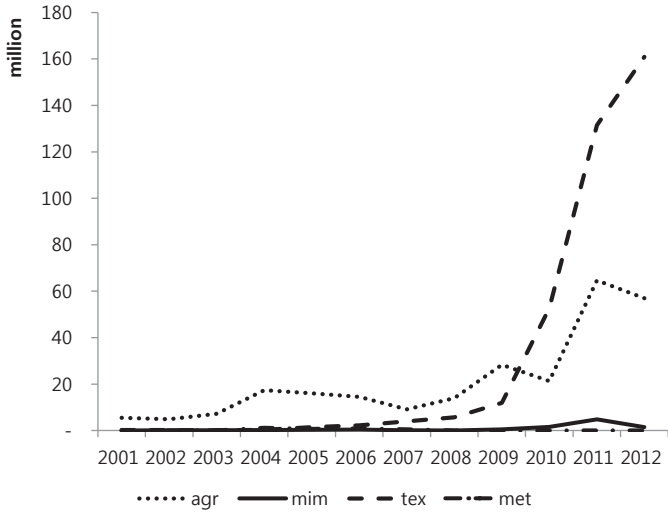
FIGURE 3
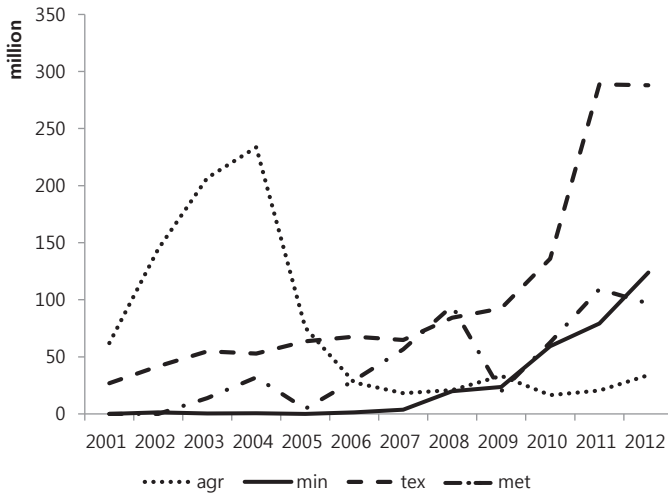TREND OF COMMODITY COMPOSITION OF NORTH KOREA'S EXPORTS TO CHINA BY PROCESSING TRADE

FIGURE 4
TREND OF COMMODITY COMPOSITION OF NORTH KOREA'S EXPORTS TO CHINA BY BONDED TRADE

groups enterprises together if they produce the same type of goods or service or if they use similar processes (*i.e.* same raw materials, production process, skills or technology).

have become dominant in general trade, and clothing exports have become dominant both in processing and bonded trade.

These distinct features of each export channel enable us to extend our analysis to the industrial level in North Korea. The increased exports through general trade are interpreted as the increased production of the mining industry. Similarly, the increased production of the clothing industry implies rapid growing exports both in bonded and processing trade.

Combining trade types with their main export commodities gives us insight into knowing how the effects of sanctions are diluted. First, North Korea has generated the biggest trade increase from general trade, through which mining exports have entered into the Chinese domestic market. A considerable amount of mine exports are driven by the investment of Chinese firms (CRS 2011; OSC 2012). In general, Chinese firms have imported mining products in exchange for providing North Korea with mining equipment.

Second, although a ban on inter-Korean business connections outside KIC is one of the main targets of South Korea's sanctions, the increased garment exports through bonded and processing trade with China have compensated the loss from South Korea. Especially, bonded trade is an effective expedient to circumvent the sanctions. Foreign partners possibly import North Korean garment products through bonded trade and reship the goods with "Made in China" labels.[15] These goods may enter any country including South Korea, Japan, and US without proper authorization as well as receive preferential tariff rates in the most advanced markets and ASEAN countries.

North Korea has adjusted its industrial structures and trade types to minimize economic damages from the sanctions. Lee and Lee (2012) indicate the industrial adjustment may be costly to North Korea because North Korea's exports to South Korea are not easily transferrable to the Chinese market. The adjustment costs, however, are likely minimal because Chinese firms, not the North Korean government, may bear much of the cost to develop and export mining products to China, and North Korean firms can continue to export garments to third-party countries by bonded trade.

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[15] Japanese authorities arrested some garment importers for importing goods originating in North Korea. The foreign traders also changed the country of origin of imported products to China (*Yomiuri*, May 11, 2011).

V. Conclusion

This study finds that increased North Korea–China trade virtually dilutes the effect of the unilateral sanctions by South Korea. Using the panel data on North Korea's exports from 2001 to 2012, we show that South Korea's sanctions significantly boosted North Korea's export to China, whereas Japan's sanctions exerted an insignificant effect. The effect of the latter was weakened by the expansion of inter-Korean economic cooperation in the mid 2000s. As North Korea's export exhibited a high degree of dependence on China and South Korea, North Korea had to raise exports to China in response to South Korea's sanctions. South Korea's sanctions increased North Korea's average exports to China by 63.7%, compared with the volume before the imposition of the sanctions. This amount was substantial to cover the loss from the sanctions.

This study suggests that trade types matter when analyzing the dynamics of North Korea's export patterns. Our findings on the positive effects of South Korea's sanctions on general and bonded trade indicate that North Korea strengthens both the exports to the Chinese domestic market (by general trade) and those passing through China (by bonded trade). Considering specific export commodities at industrial level, North Korea has sold mining products by general trade and clothing products by bonded trade after the imposition of the sanctions. Especially, we observe a substitutional trade relationship between exports to China and those to South Korea by bonded trade, which is the main trade channel for North Korean garment products. As bonded trade is expedient for circumventing the sanctions, strengthening the monitoring for bonded trade between China and North Korea is crucial for designing effective sanction measures.

North Korea has mitigated the economic damage from sanctions by employing various techniques for trade diversion. Chinese private entities actively involved in business with North Korea have also exploited the opportunities of the policy changes in North Korea. This interaction has eventually weakened the effects of the sanctions. This finding is consistent with those in previous political studies. For example, Pape (1997) and Ripsman and Blanchard (2002) argue that the effect of any economic threat is limited because of the capacity of states to adjust to the welfare losses that are imposed by economic sanctions.

Appendix

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APPENDIX TABLE 1

SOUTH KOREA'S AND JAPAN'S ECONOMIC SANCTIONS ON NORTH KOREA

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South Korea (May 24 measure, 2010)	Japan
Direct economic sanctions	**Direct economic sanctions**
- Suspension of general and processing trade with the exception of the KIC - Ban on new investment in North Korea - Prohibition on entry into South Korea ports and strait of North Korean ships	- Stoppage of remittances - Total cessation of trade - Prohibition on entry into Japanese ports of North Korean ship
Measures equivalent to economic sanction	**Measures equivalent to economic sanction**
- Stoppage of food and fertilizer aid with the exception of infant aid - Prohibition on entry into North Korea and contact with North Korean with the exception of the area of the KIC	- Stoppage of food aid - Port state control inspection on the Mangyongbong-92 - Tightening of supervision of *Chosen Soren*[1]-affiliated institutions

Note: [1] Credit union of Chogiin

Sources: Ministry of Unification, Hughes (2006)

APPENDIX TABLE 2
TRADE TYPES (CUSTOMS REGIMES) AND CODES OF CHINA CUSTOMS

This Article's Category	Original Category	Codes
General Trade	Ordinary trade	10
	Border trade	19
Processing Trade	Process & assembling	14
	Process with imported materials	15
Bonded Trade	Bonded warehousing trade	33
	Entrepot trade by bonded area	34
Others	International aid	11
	Donation by Overseas Chinese	12
	Compensation trade	13
	Goods on consignment	16
	Equipment for processing trade	20
	Goods for foreign contracted project	22
	Goods on lease	23
	Equipment/Materials investment by foreign-invested enterprise	20
	Outward processing	27
	Barter trade	30
	Duty-free commodity	31
	Equipment imported into Export Process Zone	35
	Other trade	39

Source: China Customs

References

Arellano, M., and O. Bover. "Another Look at the Instrumental Variable Estimation of Error-components Models." *Journal of Econometrics* 68 (No. 1 1995): 29-52.

Blundell, R., and S. Bond. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87 (No. 1 1998): 115-43.

Bond, S. R., A. Hoeffler., and J. Temple. GMM Estimation of Empirical Growth Model. CEPR Discussion Paper No. 3048, 2001.

Caruso, R. "The Impact of International Economic Sanctions on Trade: An Empirical Analysis." *Peace Economics, Peace Science and Public Policy* 9 (No. 2 2003): 1-34.

CRS. *Implementation of U.N. Security Council Resolution 1874*. CRS report for Congress, 8 October, 2010.

_____. *Imports from North Korea: Existing Rules, Implication of the KORUS FTA, and the Kaesong Industrial Complex*. CRS report for Congress, 2011.

Hammer, A. B. The Dynamic Structure of U.S.-China Trade, 1995-2004. USITC Working. Paper No. 2006-07A, 2006.

Haggard, Stephan, and Marcus Noland. "Sanctioning North Korea: The Political Economy of Denuclearization and Proliferation." *Asian Survey* 50 (No. 3 2010): 539-68.

Hughes, C. W. "*The Political Economy of Japanese Sanctions towards North Korea: Domestic Coalitions and International Systemic Pressures.*" *Pacific Affairs* 79 (No. 3 2006): 455-81.

Jeong, H. G., and H. K. Bang. "An Analysis of Effectiveness of International Economic Sanctions against North Korea." *The Northeast Asia Studies* 41 (No. 2 2011): 205-36.

Jeong, H. G. "Initial Conditions, Economic Performance, and Reform Prospects in North Korea." *Seoul Journal of Economics* 26 (No. 4 2013): 433-52.

Kim, S. J. "The Reasons for Trade Expansion between North Korea and China and Its Implication for North Korean Economy." *KDI review of the North Korean Economy* (2013): 93-118 (in Korean).

KOTRA. *Trend of Trade between North Korea and China and Its Implication*. Seoul: Korea Trade and Investment Promotion Agency, 2006 (in Korean).

Lee, J. H., and S. K. Kim. *The Impact of UN Economic Sanctions on North Korea*. Policy Study Series, Seoul: Korea Development Institute, 2011 (in Korean).

Lee, S. *The North Korean Statistics: availability and Creditability*. Seoul: Korea Institute for National Unification, 2007 (in Korean).

_____. "Economic Sanction and DPRK Trade: estimating the impact of Japan's sanction in the 2000s'." *KDI Journal of Economic Policy* 32 (No. 2 2010): 97-143 (in Korean).

Lee, S., and J. H. Lee. "Changes in Inter-Korean Trade and Sino-North Korean Trade after 5.24 Measurement: Data and Implications." *KDI review of the North Korean Economy* (2012): 3-31 (in Korean).

Mimura, M. *An Analysis of the Economic Effects of Japan's Economic Sanctions against North Korea.* Seoul: KIEP, 2005 (in Korean).

Nickell, S. "Biases in Dynamic Models with Fixed Effects." *Econometrica* 49 (1981): 1417-26.

Noland, Marcus. "The (non-) Impact of UN Sanctions on North Korea." *Asia Policy* 7 (No. 1 2009): 61-88.

OSC. *North Korea—Characteristics of Joint Ventures With Foreign Partners, 2004-2011.* Open Source Center Report, 2011.

Pape, R. A. "Why Economic Sanctions Do Not Work." *International Security* 22 (No. 2 1997): 90-136.

Ripsman, N. M., and J. M. Blanchard. "Lightning Rods Rather Than Light Switches: Arab Economic Sanctions Against Canada in 1979." *Canadian Journal of Political Science* 35 (No. 1 2002): 151-74.

Silva, J. M. C., and S. Tenreyro. "The Log of Gravity." *The Review of Economic and Statistics* 88 (No. 4 2005): 641-58.

Van Bergeijk, P. *Economic Diplomacy, Trade, and Commercial Policy: Positive and Negative Sanctions in a New World Order.* Cheltenham: Edward Elgar Publishing Company, 1994.

Whitty, M., S. Kim, and T. Crick. "The Effectiveness of Economic Sanctions: The case of North Korea." *North Korea Review* 2 (No. 1 2006): 50-65.