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The (Non) Impact of UN Sanctions on North Korea

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Abstract

This study finds that North Korea's nuclear test and the imposition of UN Security Council sanctions have had no perceptible effect on North Korea's trade with its two largest partners, China and South Korea. Before North Korea conducted an underground nuclear test, it was widely believed that such an event would have cataclysmic diplomatic ramifications. However, beginning with visual inspection of data and ending with time-series models, no evidence is found to support the notion that these events have had any effect on North Korea's trade with its two principal partners.

In retrospect, North Korea may have calculated quite correctly that the direct penalties for establishing itself as a nuclear power would be modest (or, alternatively, put such a high value on demonstrating its nuclear capability that it outweighed the downside risks, however large). If sanctions are to deter behavior in the future, they will have to be much more enthusiastically implemented.

Keywords: Sanctions, North Korea, Nuclear, United Nations, Trade equations

JEL codes: F51, P2, D74

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INTRODUCTION

On October 9, 2006, despite warnings not to proceed by its principal economic benefactors, China and South Korea, North Korea conducted an underground nuclear test. Before the test, it was widely believed that such an event would have cataclysmic diplomatic ramifications in Asia, possibly even prefiguring war. On the day of the test, the South Korean stock market dropped, but it began rising the next day, and regained the lost ground the following week. The markets in the rest of Asia were largely unaffected.

Five days later on October 14, the United Nations Security Council (UNSC) unanimously adopted Resolution 1718 imposing economic sanctions, specifically imposing a ban on the exportation of large-scale arms-related goods, technology, and services, and luxury goods, as well as the importation of North Korean heavy arms (UN 2006).

These developments could have been expected to attenuate North Korea's trade with the rest of the world: The sanctions specifically prohibited the importation and exportation of certain products to North Korea, and the nuclear tensions might have been expected to raise the risk premium on economic interaction with the North, suppressing exchange, especially involving foreign partner private-sector entities, even with respect to activities not directly covered by the sanctions. Such reactions could have been motivated both by the firms' anticipation of possible restrictive actions or guidance by their home governments, as well as their own heightened assessments of risks regarding business with North Korean counterparties.

Whether or not these effects materialized is an important issue: If sanctions are toothless or major powers acquiesce in the face of such provocations, it makes deterring North Korea all the more difficult in future conflicts as well as establishes an unwelcome precedent for other countries contemplating emulation.

This paper examines the empirical evidence on North Korean trade both before and after the nuclear test with its two neighbors and principal trade partners, China and South Korea, which together account for nearly half of the country's merchandise trade (Haggard and Noland 2008, table 1). The results suggest that for better or worse, the North Koreans correctly calculated that the penalties of their nuclear action, at least in this primary sphere, would be trivial to the point of being undetectable, potentially establishing a very unwelcome precedent both with respect to their future behavior as well as that of potential emulators.

SANCTIONS BACKGROUND

During the 1993–94 nuclear crisis, the sanctions option was considered but ultimately not pursued. Policymakers in the United States, Japan, and South Korea all feared a violent and possibly preemptive North Korean response to the imposition of sanctions (North Korea repeatedly threatened a war that

would turn Seoul into “a sea of fire”).¹ Moreover, there were concerns about the possible ineffectiveness of sanctions, either due to Chinese (and Russian) unwillingness to support them in the Security Council or the unwillingness of provincial authorities in northeast China to implement a sanctions policy. Nevertheless, the United States, Japan, and South Korea discussed the possibility of pursuing limited sanctions outside UN purview in the event that China was unwilling to enforce sanctions, presaging the Proliferation Security Initiative a decade later (Sigal 1998).

By the time of the July 2006 missile tests, attitudes had hardened considerably. In 2003, in response to North Korean diplomatic recalcitrance, China allegedly cut off an oil pipeline to North Korea briefly (Funabashi 2007). China had also cooperated in the September 2005 investigation into North Korean assets at Banco Delta Asia located in Macau, one of China’s two special administrative regions, and subsequently allegedly froze North Korean accounts in a Chinese bank (Suh 2006).

Before the July missile firings, China publicly and privately warned North Korea not to proceed. When the North Koreans went ahead, China (and Russia) supported the adoption of UN sanctions (Resolution 1695—targeted sanctions on missile proliferators). Although China blocked more sweeping proposals from the United States and Japan, one observer characterized the erosion in North Korea’s diplomatic support as a “momentous move” (Hayes 2006). The sanctions were the strongest reprimand of North Korea by the Security Council since 1950, and clearly represented an escalating response on the part of the United Nations.

When in October 2006 North Korea announced its intention to test a nuclear device, the UNSC issued a vague warning, which could have been interpreted as alluding to the prospect of tightened sanctions (Choi and Lee 2007). One prominent observer predicted that such a test could lead to military action by the United States and possibly South Korea as well.² As it had in the case of the July 2006 missile tests, China cautioned North Korea not to proceed, warning of “grave consequences” if it did so.³

When North Korea once again defied Chinese wishes, Beijing described the act as “flagrant and brazen” and supported more robust sanctions—though as in the case of the July missile tests, with a less severe package than that proposed by the United States and Japan. Resolution 1718 was passed relatively quickly in six days. The resolution imposed an embargo on exports of heavy weapons, dual-use items, and luxury goods to North Korea, as well as the importation of heavy weapons systems from North Korea.

The administration of the sanctions was left up to the individual sanctioning countries. Russia, for

1. South Korea took some of these threats sufficiently seriously to put its military forces on alert in June 1994. See Sigal 1998 and Oberdorfer 1997.

2. Michael A. Levi in a Council on Foreign Relations Interview, “North Korea Nuclear Test Could Lead to Military Response from U.S.,” October 3, 2006, available at www.cfr.org (accessed on December 10, 2008).

3. Joseph Kahn, “North’s Test Seen as Failure for Korea Policy China Followed,” *New York Times*, October 9, 2006, available at www.nytimes.com (accessed on December 10, 2008).

example, defined “luxury goods” so narrowly (fur coats costing more than \$9,637, watches costing nearly \$2,000) that the sanctions’ bite was questionable (Choi and Lee 2007). Due to Chinese opposition, Article 42 of Chapter VII, which allows the use of military enforcement action, was not included despite US and Japanese support, and Chinese UN Ambassador Wang Guangya expressed hesitation about full implementation (Choi and Lee 2007, International Crisis Group 2006). South Korea announced that in addition to the sanctions it would suspend food and fertilizer aid, though it would continue with other economic cooperation projects. North Korean UN Ambassador Park Gil-yon called the resolution “gangster-like” and the Foreign Ministry released a statement reiterating that sanctions were an act of war and threatening “a merciless strike” against any implementer of the UN resolution.⁴

The chair of the UN sanctions committee, Italian Ambassador Marcello Spatafora, subsequently advised that 71 countries and the European Union had submitted reports on their implementation activities (UNSC 2007). China’s report was notable in its lack of detail, however, and some countries such as Iran and Ethiopia, with past histories of North Korean weapon systems procurement, did not submit reports.

In sum, in the face of repeated North Korean provocations and despite the apparent reluctance of some countries, the United Nations had adopted increasingly stringent sanctions—and the stage had been set for bolder future action. The widely respected International Crisis Group (2006) opined: “Should the North test again, the Security Council would likely pass a new resolution with more sweeping sanctions and perhaps language authorizing enforcement by military means.” The implication is that the activities of traders and investors in North Korea would be continually exposed to the vagaries of Pyongyang’s decision making, which, for whatever reason, has consistently elevated diplomatic over economic goals, as illustrated by the recent interference in the operation of the Kaesong Industrial Complex.

ASSESSING IMPACT

It is less clear how much of an impact on commerce the sanctions actually had, however.⁵ It goes without saying that South Korea does not export weapons to North Korea, and in recent years, China has not reported the export of heavy arms either.⁶ Luxury goods are a different story, however. China and South Korea did not publish detailed lists of sanctioned luxury goods, but a number of other countries did. As shown in table 1, these lists exhibit considerable consistency across countries.

In the absence of a Chinese list of sanctioned luxury goods, as an illustration figure 1 reports

4. BBC News, “Full Text: North Korea statement,” October 17, 2006, available at <http://news.bbc.co.uk> (accessed on December 10, 2008).

5. Data sources are documented in the appendix.

6. In 2007 China reported arms and ammunition exports to North Korea of \$20,000 consisting entirely of cartridges for shotguns.

Chinese exports of luxury goods to North Korea defined in three ways. The first variant (“Australian list—SITC”) takes the Australian list in table 1 and maps the verbal description of the sanctioned luxury products to Standard International Trade Classification (SITC) categories. (Australia was selected for this exercise as a middle power with diplomatic relations with North Korea; its list also has the virtue of being specified in simple terms, facilitating concordance to SITC categories). The second variant (“Japanese list”) is based on KOTRA (2006), which attempted to map the Japanese sanctions list to detailed product categories using the Harmonized System (HS) (Kim 2006). The third variant (“Australian list—HS”) reconstructs the Australian list using KOTRA’s HS codes, which tend to be more narrowly drawn than the SITC-based categories used to construct the Australian SITC list.

As can be seen in figure 1, Chinese exports of luxury goods to North Korea did not fall to zero in 2007 under any variant; indeed, luxury goods exports increased between 2006 and 2007 under all three definitions. Resolution 1718 appears to have had no impact on Chinese behavior.

Beyond the direct impact of the sanctions narrowly construed, it is plausible that the ratcheting up of political tensions and the prospect of tightening sanctions, or even military action should there be future provocations, would drive up the risk premium on exchange with North Korea and deter commerce in areas not directly subject to sanctions. Monthly data on bilateral trade between North Korea and China, and North and South Korea are shown in figures 2 and 3, respectively. The data exhibit significant month-to-month volatility and strong seasonal patterns—trade volumes drop off in the winter possibly due to slowdowns of economic activity or, particularly in the case of China, the impassibility of unpaved roads on the North Korean side of the border. It is not apparent from figures 2 and 3 that the imposition of sanctions had any impact on trade flows, particularly once the expected winter decline in activity is taken into account.

However, figures 2 and 3 also illustrate that North Korean trade was generally on an upward trend. It is possible that statistical models could detect an impact of the imposition of sanctions and the more general increase in political risk that might not be apparent to the eye. Simple models incorporating only a time trend, seasonal dummies, and a dummy variable for the post–nuclear test/sanctions period are reported in tables 2 (China) and 3 (South Korea).⁷ Two variants are reported: the first based on the original monthly trade data, and a second in which the data have been cumulated on a quarterly basis for use in subsequent models where other variables are available only on a quarterly basis. There are positive time trends in all of the regressions and some evidence of seasonality as well. In the monthly data there appear to be some declines in activity in the winter months.⁸

7. The equivalent exercise cannot be conducted on the luxury goods data because in contrast to the aggregate data reported in figures 2 and 3, the disaggregated product-specific data are only available for annual observations.

8. Not surprisingly, given the simplicity of these models, in some of the regressions there is evidence of autocorrelated residuals, which means that the estimated standard errors are likely to be biased downward, and as a consequence the

In most cases these models detect no significant change in trade flows following the nuclear test and the imposition of UN sanctions (i.e., the null hypothesis of a zero-valued coefficient on the test/sanctions dummy could not be rejected), and in regressions 2.1 (monthly Chinese exports to North Korea), 3.2 and 3.4 (South Korean imports from North Korea), the post-test period is actually associated with larger than expected trade volumes.⁹

A more complete characterization of trade behavior would take the level of economic activity explicitly into account; trade is not only a function of sanctions, but also of macroeconomic performance. North Korea can be considered a “small country” in that its imports are so small relative to the exports of either of its principal partners (less than 0.25 percent of total exports in both cases) that it is a “price taker” facing a perfectly elastic supply of exports at a parametrically given price (figure 4). This justifies the use of a single equation-reduced form in which observed variations in trade volumes (figure 4, $Q_0 \rightarrow Q_3$) reflect shifts in the demand curve tracing along a horizontal supply curve (figure 4, $Q_0 \rightarrow Q_1$), and price variations are solely due to shifts in the supply curve along the demand curve (figure 4, $Q_0 \rightarrow Q_2$). This model can be formulated algebraically as:

$$\log M_t^d = \alpha_0 + \alpha_1 \log(PM/P)_t + \alpha_2 \log Y_t$$

where

M_t^d	= quantity of imports demanded
PM/P	= relative price of imports
Y_t	= an index of domestic activity

The export case is more complicated: Trade with China and South Korea looms sufficiently large in the North Korean economy that China and South Korea presumably face an upward-sloping North Korean supply curve (i.e., the magnitude of their demands are such that external demand shifts actually affect North Korean internal prices). In modeling terms this possibility implies the need to estimate demand and supply simultaneously. Given this increase in analytical complexity, the fact that the UN sanctions were mainly on exports to North Korea, not imports from North Korea, and that there are no qualitative differences in the estimated results for export and import trade, for the sake of brevity, consideration of North Korean exports to China and South Korea has been set aside to focus on trade moving in the other direction.

reported level of statistical significance is exaggerated. For obvious reasons this is a bigger issue for the regressions on monthly data.

9. In the case of the two regressions on monthly data (2.1 and 3.2) this is subject to the caveat regarding autocorrelated residuals and exaggerated statistical significance noted in footnote 8.

Tables 4 and 5 report regressions incorporating only the North Korean economic activity term, derived by quarterly interpolations of Bank of Korea annual GDP growth estimates. The inclusion of the activity renders the time trend insignificant and reduces the autocorrelation of the residuals to an acceptable level. The estimated income elasticities are extremely large (i.e., in terms of figure 4, the shift $Q_0 \rightarrow Q_1$). One possibility is that the impact of omitted variables is being misattributed to the activity term.

There are three obvious possibilities for the fact that changes in North Korean income appear to have a very large impact on the demand for imports. The first is that behavior of North Korean households and importing firms has been changing during the sample period; specifically, exposure to new products from China and South Korea has in effect boosted the demand for imports. Something quite similar to this was observed in Eastern Europe, particularly East Germany in the days following unification, when the suddenly enhanced availability of new Western products led to a massive shift in consumer preferences away from home goods (Dornbusch and Wolf 1994). As a consequence, an upsurge in demand may have swamped any impact of sanctions.

A second, related possibility, which also echoes the German experience, is that the development of new institutional channels of trade has greatly reduced transaction costs, and this secular decline in transaction costs, possibly together with a shift in consumer preferences, has led to an upsurge in the demand for imports, which in these regressions is being captured in the activity term. Again, such effects may have overridden the impact of sanctions.

The third possibility is that as a high-inflation economy with a fixed nominal exchange rate, North Korea is by definition experiencing real exchange rate appreciation. For North Korea, the relative price of imports is a function of foreign prices converted to North Korean won via an exchange rate, P^*E/P . With the nominal rate, E , unchanged, the movement in the real exchange rate, P^*E/P , would be a function of differential change in the foreign and local price levels, P^* and P , respectively. This real appreciation may have driven a growth in the demand for imports and has not been captured in the preceding specifications. The situation is complicated further by the existence of both an official nominal exchange rate and a parallel or black-market rate.

The problem is that we cannot observe P , North Korean prices, directly. Hence one solution would be to use movements in the black-market exchange rate as a proxy for changes in the unobservable domestic price level, P . This is not perfect: In a high-inflation environment, demand for foreign exchange as a relatively liquid “safe haven” investment may outstrip both domestic prices and the prices of imported goods, and as a consequence, movement in the black-market value of the won (which in fact depreciated continuously over the sample period) may be an upwardly biased measure of inflation.¹⁰

10. The classic reference is Bresciani-Turroni (1937).

In table 6, the log inverse black-market exchange rate is added to the specifications reported in tables 4 and 5 (i.e., an increase in the value is an appreciation and would be expected to be associated with a larger volume of imports). As can be seen in table 6, this variable is not statistically significant. In terms of figure 4, this indicates that the changes in trade volumes are driven by the income shift $Q_0 \rightarrow Q_1$ while price effects, $Q_0 \rightarrow Q_2$, are imperceptible. It could be that the black-market exchange rate is not a good proxy for the unobservable domestic price level. Another possibility is that trade is occurring contemporaneously at both the official exchange rate as well as the black-market rate. In such circumstances, real exchange rates calculated using either official or black-market rates will be a noisy proxy for the actual rate imbedded in the trade.

The models reported in tables 4, 5, and 6 assume that all adjustment to variations in activity and prices occurs within a single quarter; a large literature examines the issue of noncontemporaneous adjustment of trade to changes in the levels of economic activity and relative prices (Goldstein and Khan 1985). There are two basic approaches to estimating these relationships. The first is to estimate distributed lags of each explanatory variable directly. The second is to include a lagged dependent variable on the right hand side, imposing the same long-run geometric adjustment pattern on all of the independent variables.

The conventional wisdom is that variations in activity levels feed through to trade flows relatively quickly, while the impact of relative price changes takes longer to manifest. In the case at hand, the exchange rate term was never statistically significant either contemporaneously (table 6) or noncontemporaneously (not reported for the sake of parsimony). There is some evidence of lagged adjustment with respect to the income term, but permitting noncontemporaneous adjustment has no significant effect on the nuclear test/sanctions coefficient.

TIME-SERIES ANALYSIS EXTENSIONS

As shown in figures 2 and 3, North Korea's trade volumes have shown an upward trend. It is possible that these trends in the key trade and income series are so pronounced that the series are said to be nonstationary, and hence simple ordinary least squares estimates such as those reported in tables 2 through 6 are biased and inconsistent (Hamilton 1994). It is possible to test for and take into account the nature of nonstationarity; in particular that two series are cointegrated processes, and thus generate unbiased and consistent estimates. However, the relatively short time series makes implementation of modern time-series techniques problematic.

The first step is to test for the presence of so-called unit roots in the series. The Dickey-Fuller test assumes that such roots are present; the null hypotheses can be rejected at high levels of statistical confidence in the income series, but there is weak evidence of trend in the trade series. As a first pass, the quarterly series were differenced by four lags (to generate stationary series and take care of possible

seasonality) and the regressions estimated. As shown in table 7, there is no evidence that trade trends changed after the nuclear test and the imposition of sanctions, though there is evidence of increasing sensitivity of imports from China to the level of economic activity in North Korea.

Given that the evidence of unit roots both in the income and trade series is weak, it is unlikely that a cointegrating relationship is present. And indeed, in the Johansen test for cointegration, the null hypothesis of no cointegration cannot be rejected in the China regressions; however, in the South Korean regressions, the null can be rejected: There is evidence of cointegration. Given the small sample size and the possibly problematic nature of the data, this confounding result (a cointegrating relationship despite the absence of a unit root for one of the series) is presumably spurious.

CONCLUSIONS

Beginning with visual inspection and ending with the most sophisticated time-series models that can be implemented given the weakness of the data, no evidence has been found that economic sanctions by the UN Security Council have had any effect on either North Korea's trade in luxury goods with its largest trade partner, China, nor any indirect effect on North Korea's aggregate trade with its two principal partners.

From one perspective, the lack of robust results is perhaps unsurprising: The sanctions were limited to exports of military and luxury goods, with the definitions of these products and the administration of the sanctions left up to individual UN members. Perhaps some impact could be uncovered by focusing on narrow product categories, and restricting politically sensitive military and luxury products might have had some impact on regime behavior even if sanctions did not bite at the level of aggregate trade, but in the case at hand, even this modest result is questionable.

But sanctions were not the only channel through which the test could have affected trade flows: One would have thought that the test and sanctions would have generally increased the risk premium on all forms of economic engagement with North Korea, but the evidence does not bear this out. Enterprises in China and South Korea appear to have shrugged off the test, much as the financial markets did.

It is possible that the governments of China and South Korea undertook actions to offset or minimize the private risks faced by individual firms and enterprises. This is more plausible in the case of South Korea than China: There are a relatively limited number of South Korean firms engaged in trade or investment with North Korea and they operate through government-controlled programs that would facilitate the socialization of risk. Although the South Korean government did carry through on a threat to curtail humanitarian assistance, it did not impose sanctions on the nominally commercial trade associated with the Kaesong Industrial Complex—a decidedly mixed message that the critics of the Roh Moo-hyun government were quick to observe. It is less obvious that this explanation is plausible

with respect to China: Much of China's economic interaction with North Korea comes through small, largely self-financed and effectively private firms, and it is not at all obvious what kind of policy tools are available to socialize risk in this case. Indeed, survey evidence from other research suggests strongly that Chinese enterprises do not have recourse against losses in their North Korean business.

Even if the sanctions did not impede trade, counterfactually their existence may have deterred North Korea's partners from relaxing barriers further, in effect, blocking trade that would have otherwise developed.

It is also possible that the test and the subsequent ratcheting up of political tensions increased the risk premium on trade with North Korea but that the models are just too crude to capture them: The sample period under the sanctions regime is relatively short, and hence the power of the statistical tests comparing behavior before and after the test may be low. But the apparent steady growth in trade throughout the period in question does not suggest a major shift in behavior, regardless of the power of the statistical tests. More plausibly, it may also be the case that in light of the change of government in Seoul, South Korean behavior may change. Whether the current Lee Myung-bak government would react in a fashion similar to its predecessor is questionable. In some sense these considerations are subject to self-correction: As time goes by, more sanctions-period observations will become available, and eventually the sanctions may well be removed, generating additional sample variation for modeling.

Nor should these results be interpreted as suggesting that all economic sanctions are useless. In contrast to the UN trade sanctions, evidence suggests that the disruptions to financial flows associated with the Banco Delta Asia (BDA) case had economic and possibly political impact. Accounts at BDA were associated with missile proliferation (Pinkston 2008), unrecorded gold sales (Haggard and Noland 2007, appendix A), and allegedly Kim Jong-il's political slush fund (Chestnut 2007).¹¹ Apart from disrupting these activities, the financial shock led to a fall in the black-market value of the won, put a squeeze on legitimate commerce (Cowie 2006), and reportedly necessitated a scaling back of festivities associated with Kim Jong-il's birthday. More importantly, the accounts of the Six Party Talks reveal a strong North Korean interest in resolving the BDA issue and a willingness to make concessions to do so.

Nevertheless, the central message that emerges from this analysis is that the pre-test conventional wisdom that a North Korean nuclear test would resonate dramatically appears to have been misguided. Despite pre-test diplomatic warnings not to test, the post-test behavior of public- and private-sector actors in China and South Korea has been accepting of North Korea's nuclear status. The test and even the imposition of limited sanctions do not appear to have had a perceptible effect on the country's trade relationships with its two principal partners. If such warnings are to be heeded in the future, they must

11. Also see Stephen Mihm, "No Ordinary Counterfeit," *New York Times Magazine*, July 23, 2006, available at www.nytimes.com (accessed on December 10, 2008).

embody credible threats of penalty. In the present case, of course, a major problem appears to be that some of the permanent members of the Security Council, particularly China, displayed reluctance to fully embrace and implement sanctions.

North Korea may have calculated quite correctly that the direct penalties for establishing itself as a nuclear power would be modest indeed. Presumably this experience will condition North Korean policymakers' reactions in the future, making deterrence on this issue and other sources of conflict more difficult. Sanctions, fecklessly applied, may be worse than useless: They could actually encourage other states to pursue undesirable behavior. If trade sanctions are to deter behavior in the future, they will have to be much more broadly targeted and enthusiastically implemented.

One can question whether this was ever in the cards in the North Korean case. Clearly the United Nations had ratcheted up its response with each succeeding provocation, and Resolution 1695 established that China (and Russia) would no longer protect North Korea from sanctions in the Security Council. Yet it was also clear that they were less than enthusiastic in supporting the policy and would act as a brake on the United States and others. The real question then is less why sanctions were ineffective, but why US policymakers chose to go down a path that appears to have had little likelihood of reaching the desired outcome?

APPENDIX: DOCUMENTATION

Data and Data Sources

Sample periods: For South Korea, 2001Q1–2007Q2. For China, 2000Q1–2007Q3.

Trade: For South Korea: Ministry of Unification. For China: Ministry of Commerce of the People's Republic of China.

Income: For South Korea: International Monetary Fund (IMF), *International Financial Statistics*, May 2008. For China: IMF, *International Financial Statistics*, May 2008; CEIC, available at www.ceicdata.com (accessed on December 10, 2008). For North Korea: Bank of Korea.

Exchange Rate: Noland (2004); Good Friends, *North Korea Today*, various issues; NKNet, *NK Brief*, various issues; IMF, *International Financial Statistics*, May 2008.

Nuclear Sanctions: UN (2006).

Data Preparation

Trade data: Trade with North Korea is recorded from North Korea's trading partners' perspective, in this case either China or South Korea. Trade data were originally recorded in monthly increments and were

summed over quarters to get the quarterly numbers. Following conventional practice, the natural log of these quarterly totals is used as the dependent variable in the trade equations.

Income data: South Korea's quarterly real GDP data were calculated using nominal, quarterly, local-currency GDP and deflating it by South Korea's quarterly GDP deflator. A quarterly GDP deflator was unavailable for China, so real year-on-year quarterly GDP growth numbers from CEIC were applied to nominal quarterly GDP numbers to calculate real GDP for each quarter after the first year of the sample (2000). Chinese inflation in that year was negligible and does not distort subsequent observations. Both the nominal and real Chinese production data display strong seasonality. Annual observations on North Korea's real GDP were interpolated to generate quarterly data. Again, following normal procedures, once quarterly real GDP has been calculated, an index is formed in which the first observation is set equal to 100, and the natural log is used in the trade equations.

Exchange rate data: Exchange rate data come from various sources and are originally priced in either US dollars (US\$) or renminbi (RMB). We have found in the past that implied US\$–RMB exchange rates, in terms of relative won prices, tend to be very close to actual dollar–RMB rates and are therefore willing to use the NK won–US\$ exchange rate data to determine both RMB (where NK won–RMB data are not available) and NK won–SK won exchange rates. NK won is always in the numerator for our samples, and the exchange rate is indexed to 100 for the first observation of each sample. For use as an explanatory variable, in the absence of a relative price term, we take the natural log of this index used in the trade equation.

Nuclear sanctions: UN Resolution 1718 (UN 2006) went into effect in October 2006. This dummy variable is equal to zero from the beginning of the sample through the second quarter of 2006 and equal to one from the third quarter of 2006 through the end of the sample period.

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Table 1 Luxury goods ban lists

Luxury good	United States	European Union	Australia	Canada	Japan
Food items		Caviar and caviar substitutes Truffles and preparations thereof	Caviar Crustaceans (all), e.g., rock lobsters, abalone Molluscs and aquatic invertebrates, e.g., oyster in any form	Gourmet foods and ingredients Lobster	Caviar and caviar substitutes prepared from fish eggs Meat of bovine animals, frozen (beef) Fish fillets, frozen (tuna)
Tobacco	Tobacco and tobacco products	High-quality cigars and cigarillos	Tobacco products	Cigarettes	Tobacco
Beverages	Alcoholic beverages: wine, beer, ales, and liquor	High-quality wines (including sparkling wines), spirits, and spirituous beverages	Wine & spirits (all kinds)	Alcoholic beverages	Alcoholic beverages
Cosmetics	Perfumes and toilet waters Cosmetics, including beauty and makeup	Luxury perfumes, toilet waters and cosmetics, including beauty and make up products	Perfumes and toilet waters Cosmetics (all)	Perfume	Perfumes and toilet waters Cosmetics (beauty and makeup)
Apparel	Leather articles Silk articles Designer clothing: Leather apparel and clothing accessories	High-quality garments, clothing accessories, and shoes (regardless of their material)		Designer clothing	
Fur	Fur skins and artificial furs		Furs	Furs	Fur skins & artificial fur products
Fashion accessories	Leather travel goods, vanity cases, binocular and camera cases, handbags, wallets, silk scarves		Leather travel goods, apparel, and clothing accessories	Clothing accessories	Leather bags, clothes, and others
Transportation	Luxury automobiles (and motor vehicles): automobiles and other motor vehicles to transport people (other than public transport), including station wagons Racing cars, snowmobiles, and motorcycles Personal transportation devices (stand-up motorized scooters)	Luxury vehicles for the transport of persons on earth, air, or sea, as well as their accessories and spare parts	Automobiles and other vehicles to transport people		Motorcars Motorcycles
Aquatic vehicles	Yachts and other aquatic recreational vehicles (such as personal watercraft)		Yachts and pleasure craft		Motorboats, yachts, and others

table continues next page

Table 1 Luxury goods ban lists *(continued)*

Luxury good	United States	European Union	Australia	Canada	Japan
Flooring	Rugs and tapestries	Hand knotted carpets, hand-woven rugs, and tapestries	Carpets		Carpets and other textile floor coverings
Jewelry	Jewelry with pearls, gems, precious and semi-precious stones (including diamonds, sapphires, rubies, and emeralds), jewelry of precious metal or of metal clad with precious metal	Pearls, precious and semi-precious stones, articles of pearls, jewellery, gold- or silversmith articles Cutlery of precious metal or plated or clad with precious metal	Jewelry Precious and semi-precious stones (including diamonds and pearls) Silver and gold Precious metals	Jewelry Gems Precious metals	Jewelry Natural or cultured pearls, precious or semi-precious stones Precious metals & metal work
Electronic items	Flat-screen, plasma, or LCD panel televisions or other video monitors or receivers (including high-definition televisions), and any television larger than 29 inches; DVD players Personal digital assistants (PDAs) Personal digital music players Computer laptops	High-end electronic items for domestic use	Consumer electronics (televisions, videos, DVD players, PDAs, laptops, MP3 players, and any other relevant exports)	Televisions Computers Other electronic devices	Televisions Portable, digital automatic data processing machines
Photographic equipment		High-end electrical/ electronic or optical apparatus for recording and reproducing sound and images	Photographic equipment		Cinematographic cameras and projectors Apparatus for recording and reproducing sound and images
Watches/clocks	Luxury watches: Wrist, pocket, and others with a case of precious metal or of metal clad with precious metal	Luxury clocks and watches and their parts	Watches & clocks	Watches	Wrist watches & other watches
Works of art	Works of art (including paintings, original sculptures, and statuary), antiques (more than 100 years old), collectible items, including rare coins and stamps	Works of art, collectors pieces, and antiques Coins and banknotes, not being legal tender	Works of art (all)		Works of art, collectors' pieces, and antiques
Musical instruments	Musical instruments	High-quality musical instruments			Musical instruments; parts and accessories of such articles

table continues next page

Table 1 Luxury goods ban lists *(continued)*

Luxury good	United States	European Union	Australia	Canada	Japan
Sports equipment	Recreational sports equipment	Articles and equipment for skiing, golf, diving, and water sports	Sports equipment	Sporting goods	
Fountain pens	Fountain pens		Fountain pens		Fountain pens
Drinking glasses	Items of lead crystal	High quality lead crystal glassware	Drinking glasses (lead crystal)		Drinking glasses (lead crystal)
Others	Tableware of porcelain or bone China	High-quality tableware of porcelain, china, stone- or earthenware, or fine pottery Pure bred horses Articles and equipment for billiard, automatic bowling, casino games, and games operated by coins or banknotes	Electronic entertainment / software	Private aircraft	

Table 2 China–North Korea trade, time trend, seasonal dummies, and nuclear sanctions

(2.1) Log Chinese exports to North Korea		(2.2) Log Chinese imports from North Korea	
Nuclear sanction (Dummy variable)	0.33** (0.11)	Nuclear sanction (Dummy variable)	-0.09 (0.16)
Logged time trend	0.35*** (0.04)	Logged time trend	0.98*** (0.06)
Month 1	-0.31 (0.17)	Month 1	-0.53* (0.26)
Month 2	-0.58** (0.17)	Month 2	-0.65* (0.26)
Month 3	-0.04 (0.17)	Month 3	-0.33 (0.26)
Month 4	0.07 (0.17)	Month 4	-0.16 (0.26)
Month 5	0.04 (0.17)	Month 5	-0.42 (0.26)
Month 6	-0.06 (0.17)	Month 6	-0.27 (0.26)
Month 7	-0.04 (0.17)	Month 7	-0.29 (0.26)
Month 8	-0.05 (0.18)	Month 8	-0.15 (0.26)
Month 10	-0.02 (0.17)	Month 10	-0.06 (0.26)
Month 11	-0.06 (0.17)	Month 11	0.02 (0.26)
Month 12	0.14 (0.18)	Month 12	0.21 (0.26)
Constant	9.79*** (0.20)	Constant	6.66*** (0.30)
N	93	N	93
r ²	0.67	r ²	0.81
F	12.18	F	26.29
p	0.00	p	0.00
Durbin–Watson d–statistic	1.238272	Durbin–Watson d–statistic	.6775941
Durbin’s alternative test for autocorrelation, Prob > chi2	0.0008	Durbin’s alternative test for autocorrelation, Prob > chi2	0.0000
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.0006	Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.0000

* p<0.05, ** p<0.01, *** p<0.001

Note: Standard errors in parentheses. Month 9 was omitted.

table continues next page

Table 2 China–North Korea trade, time trend, seasonal dummies, and nuclear sanctions
(continued)

(2.3) Log Chinese exports to North Korea		(2.4) Log Chinese imports from North Korea	
Nuclear sanction	0.16	Nuclear sanction	−0.39
(Dummy variable)	(0.18)	(Dummy variable)	(0.29)
Logged time trend	0.47***	Logged time trend	1.21***
	(0.07)		(0.12)
Quarter 1	−0.24	Quarter 1	−0.50
	(0.16)		(0.26)
Quarter 2	0.05	Quarter 2	−0.31
	(0.16)		(0.26)
Quarter 3	−0.16	Quarter 3	−0.37
	(0.16)		(0.26)
Constant	10.94***	Constant	8.29***
	(0.22)		(0.35)
N	32	N	32.00
r ²	0.72	r ²	0.83
F	13.06	F	25.20
p	0.00	p	0.00
Durbin–Watson d–statistic	1.720628	Durbin–Watson d–statistic	1.159076
Durbin’s alternative test for autocorrelation, Prob > chi2	0.6032	Durbin’s alternative test for autocorrelation, Prob > chi2	0.0801
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.5586	Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.0616

* p<0.05, ** p<0.01, *** p<0.001

Note: Standard errors in parentheses. Quarter 4 was omitted.

Table 3 South Korea–North Korea trade, time trend, seasonal dummies, and nuclear sanctions

(3.1) Log South Korean exports to North Korea		(3.2) Log South Korean imports from North Korea	
Nuclear sanction	0.23	Nuclear sanction	0.59***
(Dummy variable)	(0.18)	(Dummy variable)	(0.10)
Logged time trend	0.43***	Logged time trend	0.34***
	(0.07)		(0.04)
Month 1	-1.02***	Month 1	-0.18
	(0.27)		(0.15)
Month 2	-0.93**	Month 2	-0.40*
	(0.27)		(0.15)
Month 3	-0.59*	Month 3	-0.14
	(0.27)		(0.15)
Month 4	-0.50	Month 4	-0.35*
	(0.27)		(0.15)
Month 5	-0.03	Month 5	-0.35*
	(0.27)		(0.15)
Month 6	-0.30	Month 6	-0.36*
	(0.27)		(0.15)
Month 7	-0.40	Month 7	-0.26
	(0.27)		(0.15)
Month 8	-0.38	Month 8	-0.15
	(0.27)		(0.15)
Month 10	-0.54	Month 10	0.20
	(0.28)		(0.16)
Month 11	-0.45	Month 11	0.16
	(0.28)		(0.16)
Month 12	-0.48	Month 12	-0.21
	(0.28)		(0.16)
Constant	9.44***	Constant	9.08***
	(0.30)		(0.17)
N	80	N	80
r ²	0.60	r ²	0.78
F	7.68	F	17.54
p	0.00	p	0.00
Durbin–Watson d–statistic	1.196735	Durbin–Watson d–statistic	.9131134
Durbin’s alternative test for autocorrelation, Prob > chi2	0.0005	Durbin’s alternative test for autocorrelation, Prob > chi2	0.0000
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.0004	Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.0000

* p<0.05, ** p<0.01, *** p<0.001

table continues next page

Note: Standard errors in parentheses. Month 9 was omitted.

Table 3 South Korea–North Korea trade, time trend, seasonal dummies, and nuclear sanctions
(continued)

(3.3) Log South Korean exports to North Korea		(3.4) Log South Korean imports from North Korea	
Nuclear sanction	0.01	Nuclear sanction	0.48**
(Dummy variable)	(0.25)	(Dummy variable)	(0.15)
Logged time trend	0.48***	Logged time trend	0.37***
	(0.10)		(0.06)
Quarter 1	–0.33	Quarter 1	–0.31*
	(0.22)		(0.13)
Quarter 2	0.29	Quarter 2	–0.42**
	(0.22)		(0.13)
Quarter 3	0.22	Quarter 3	–0.25
	(0.22)		(0.13)
Constant	10.44***	Constant	10.55***
	(0.29)		(0.17)
N	27.00	N	27
r ²	0.67	r ²	0.82
F	8.48	F	18.78
p	0.00	p	0.00
Durbin–Watson d–statistic	1.787388	Durbin–Watson d–statistic	1.788646
Durbin’s alternative test for autocorrelation, Prob > chi2	0.8418	Durbin’s alternative test for autocorrelation, Prob > chi2	0.6713
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.8168	Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.6235

* p<0.05, ** p<0.01, *** p<0.001

Note: Standard errors in parentheses. Quarter 4 was omitted.

Table 4 China–North Korea trade, activity variable included

Log Chinese exports to North Korea	(4.1)	(4.2)
Nuclear sanctions	0.21 (0.16)	0.21 (0.16)
Log North Korean GNI index	9.76** (3.41)	10.16*** (1.27)
Logged time trend	0.02 (0.17)	
Quarter 2	0.36* (0.14)	0.37* (0.14)
Quarter 3	0.20 (0.15)	0.20 (0.14)
Quarter 4	0.45** (0.16)	0.45** (0.14)
Constant	-33.89* (15.59)	-35.72*** (5.95)
<hr/>		
N	31	31
r ²	0.80	0.80
F	15.63	19.53
p	0.00	0.00
Durbin–Watson d–statistic	2.17094	2.174953
Durbin’s alternative test for autocorrelation, Prob > chi2	0.6252	0.6166
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.5726	0.5713

* p<0.05, ** p<0.01, *** p<0.001

Note: Standard errors in parentheses.

Table 5 South Korea–North Korea trade, activity variable included

Log South Korean exports to North Korea	(5.1)	(5.2)
Nuclear sanctions	−0.03 (0.26)	0.00 (0.25)
Log North Korean GNI index	9.55 (4.97)	12.73*** (2.38)
Logged time trend	0.15 (0.20)	
Quarter 2	0.68** (0.20)	0.70** (0.20)
Quarter 3	0.66** (0.22)	0.70** (0.21)
Quarter 4	0.47* (0.22)	0.53* (0.21)
Constant	−33.95 (22.93)	−48.55*** (11.15)
N	26	26
r ²	0.71	0.70
F	7.87	9.56
p	0.00	0.00
Durbin–Watson d–statistic	2.199694	2.222466
Durbin’s alternative test for autocorrelation, Prob > chi2	0.5528	0.5593
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.4798	0.4984

* p<0.05, ** p<0.01, *** p<0.001

Note: Standard errors in parentheses.

Table 6 Activity and exchange rate variables included**(6.1) Log Chinese exports to North Korea**

Nuclear sanctions	0.22 (0.16)
Log North Korean GNI index	11.02** (3.61)
Log inverse exchange rate index (export price proxy)	0.03 (0.13)
Quarter 2	0.37* (0.14)
Quarter 3	0.21 (0.14)
Quarter 4	0.46** (0.15)
Constant	-39.57* (16.16)
N	31
r ²	0.80
F	15.68
p	0.00
Durbin–Watson d–statistic	2.189263
Durbin’s alternative test for autocorrelation, Prob > chi2	0.5850
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.5287

* p<0.05, ** p<0.01, *** p<0.001

table continues next page

Note: Standard errors in parentheses.

Table 6 Activity and exchange rate variables included
(continued)

(6.2) Log South Korean exports to North Korea	
Nuclear sanctions	-0.08 (0.24)
Log North Korean GNI index	1.20 (7.40)
Log inverse exchange rate index (export price proxy)	-0.34 (0.21)
Quarter 2	0.68** (0.19)
Quarter 3	0.65** (0.20)
Quarter 4	0.43 (0.21)
Constant	3.44 (33.47)
<hr/>	
N	26
r ²	0.74
F	9.08
p	0.00
Durbin–Watson d–statistic	2.143525
Durbin’s alternative test for autocorrelation, Prob > chi2	0.6886
Breusch–Godfrey LM test for autocorrelation, Prob > chi2	0.6316

* p<0.05, ** p<0.01, *** p<0.001

Note: Standard errors in parentheses.

Table 7 Differenced regressions

	(7.1)	(7.2)
Differenced log exports to North Korea	China	South Korea
Differenced log North Korean GNI index	10.17** (4.333)	0.948 (8.050)
Nuclear sanctions	0.122 (0.206)	-0.272 (0.349)
Differenced log inverse exchange rate index	0.0296 (0.138)	-0.187 (0.246)
Constant	0.0317 (0.125)	0.150 (0.200)
Observations	27	22
R-squared	0.203	0.108

*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parentheses.

Figure 1 Chinese luxury goods exports to North Korea, 2000-07

millions of US dollars

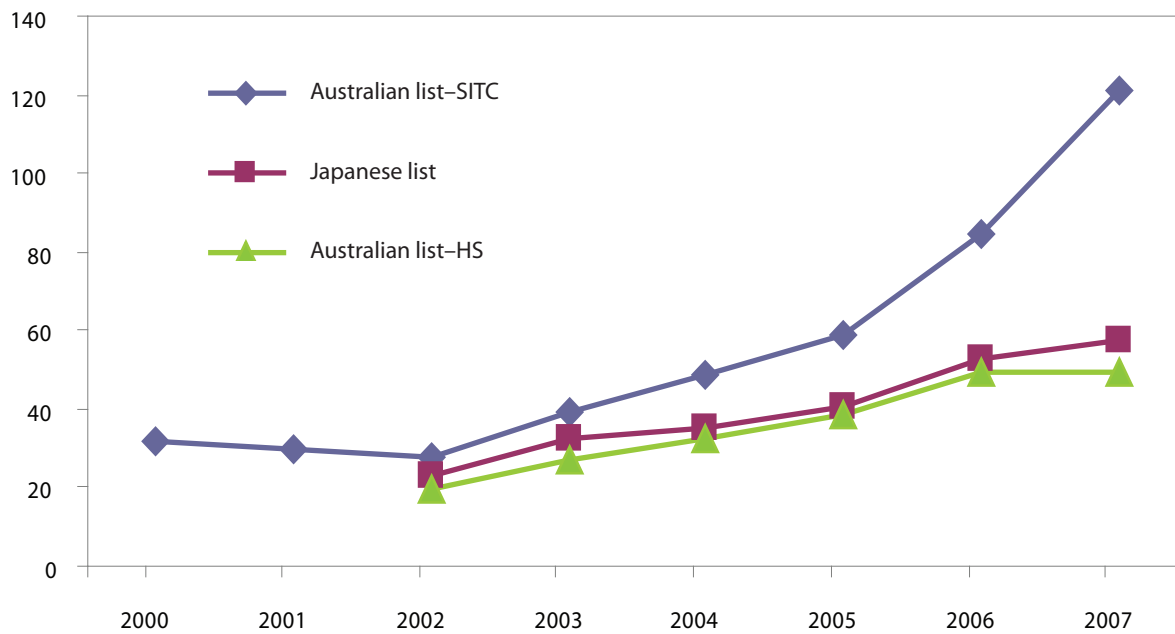
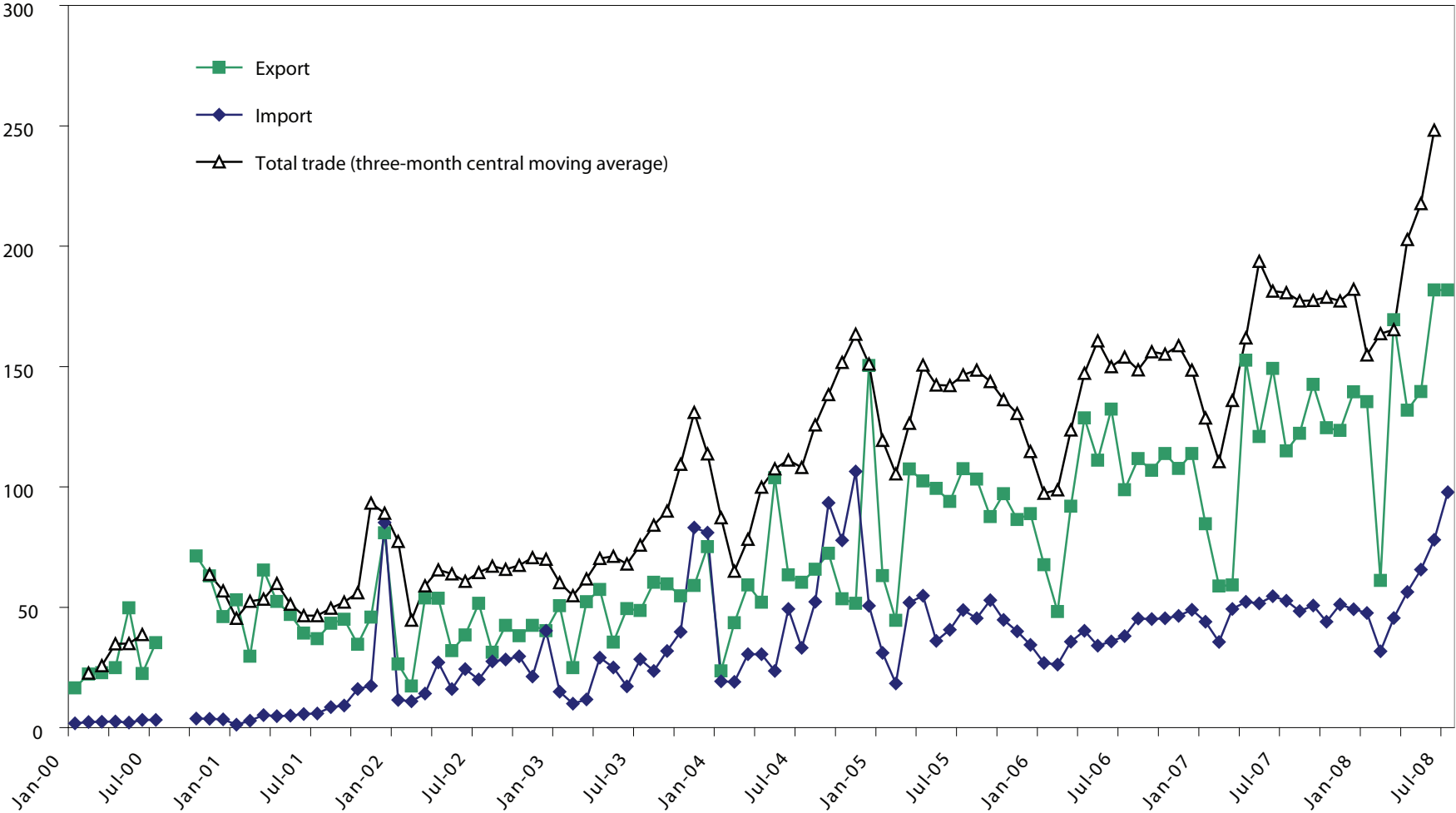


Figure 2 China–North Korea trade, 2000–08

millions of US dollars

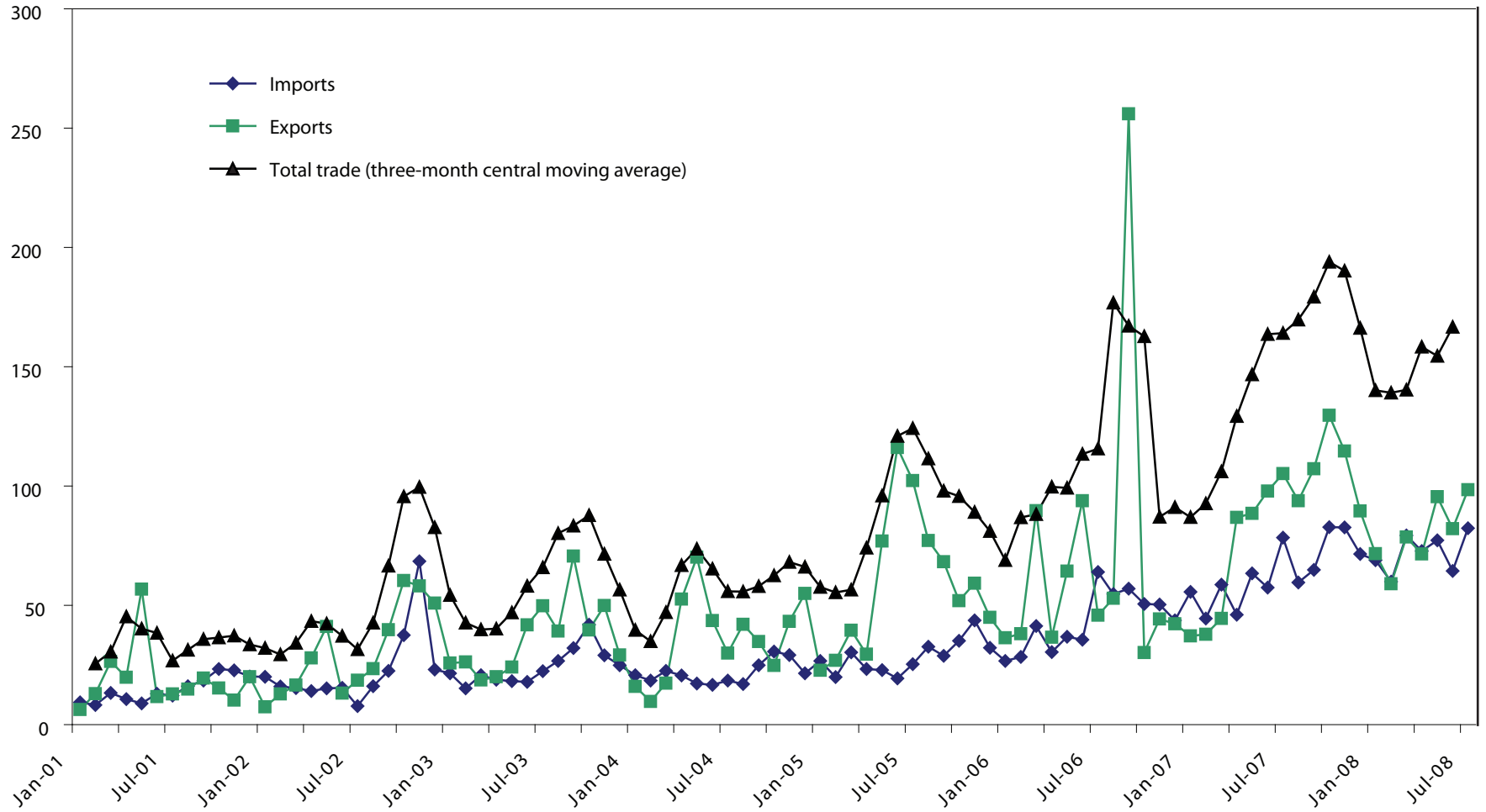


Source: Ministry of Commerce of the People's Republic of China, 2007.

Figure 3 South Korea–North Korea trade, 2001–08

millions of US dollars

28



Source: Ministry of Unification, Monthly North-South Trade Data.

Figure 4 Small-country demand for imports

