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Abstract

This paper analyzes the future growth potential of the North Korean economy, conditional on economic reform and integration with South Korea. The growth projections based on cross-country evidence show that, if North Korea embarks on substantial policy reforms toward a market-oriented and open economy, it could achieve higher economic growth in the long run. Using an empirical gravity model of trade and direct investment, we forecast that, when the two Koreas pursue economic integration and cooperation without military conflicts, North Korea's trade with South Korea can increase significantly, that is, up to 36 percent of North Korea's gross domestic product (GDP) and its foreign direct investment (FDI) flows from South Korea up to 6 percent of GDP. Overall, by promoting trade and FDI integration with South Korea, North Korea can boost its GDP growth by about 3 percentage points per year. Combined with a market-oriented reform, which can bring an additional boost to GDP growth, the North Korean economy could grow by about 4.7 percent per year over the next decades. Conversely, if more rigid sanctions imposed on North Korea become effective, its trade and investment will decrease and its GDP growth rate is expected to fall by approximately 2 percentage points per year.

1. Introduction

Korea commemorated its 70th anniversary of liberation in 2015. However, unfortunately, at liberation, the nation was divided into South and North and experienced war over three years. However, the two Koreas have not yet established a firm foundation for peaceful closure to the 70 years of division in the Korean Peninsula.

The economic gap between South and North Korea has been widened since the 1970s, along with incessant military conflicts and political tensions. Moreover, North Korea's economy still remains the most centralized and closed system in the world today. As a result, North Koreans have suffered from devastating food shortages and recurrent economic decline.

Over all, it seems unlikely for North Korea recover from its plight and achieve strong future growth with the current policies of central planning and autarky. Wide-ranging economic reform and integration with regional and global markets will be required for economic take-off and sustainable growth. Indeed, North Korea's new regime has introduced some measures, such as market reform in agricultural sector and promotion of special economic zones, recently. However, there has been no evidence that the current reforms have brought about significant results.

One particular barrier to North Korea's economic development is its lack of economic cooperation with South Korea. The latter has shown a remarkable economic performance since the early 1960s, achieving per capita income of USD 34,600,[1] and becoming the world's eighth largest trading nation. Conversely, North Korea remains among one of the poorest countries in the world with per capita income of USD 1,800.[2] For North Korea, South Korea must be a natural trading partner and a primary source of capital and technology. Hitherto, the Kaesong industrial complex (KIC) operated as a collaborative economic development with around 53,000 North Korean workers under South Korean management, and is the only case of economic cooperation between the two Koreas. The inter-Korean trade volume was USD 2 billion in 2012, which amounted to only 0.2 percent of South Korea's total trade.

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[1] Gross national income per capita based on purchasing power parity (PPP), in 2014, from the World Bank's *World Development Indicators* (http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD).

[2] Gross national income per capita in 2013, adjusted by PPP, from the Central Intelligence Agency, *World Fact Book* (https://www.cia.gov/library/publications/the-world-factbook/geos/kn.html).

As peaceful reunification is one of the most important national agendas for South Korea, South Korean government is promoting initiatives to strengthen dialogue and economic cooperation with North Korea and prepare a unification that could benefit both Koreas. However, the situation has been in a stalemate. North Korea has continued its nuclear weapon programs. In January 2016, North Korea launched a rocket and claimed a hydrogen bomb test. On February 10, 2016, South Korea announced shutting down of the KIC in retaliation, suspecting that the North Korean regime had used hard currency earned from the joint venture to fund its nuclear and ballistic missile programs. The United States and the United Nations have toughened their sanctions as well. Nonetheless, the possibility of North Korea's denuclearization is small, at least in the immediate future.

In this study, we analyze the future growth potential of the North Korean economy conditional on its economic reform and integration with South Korea. We apply a framework of cross-country analyses of economic growth in order to investigate the major growth factors that determine long-term growth (Barro and Lee, 1994; Barro and Sala-i-Martin, 2004). Previous studies show that high growth performance requires good quality of institutions, well-educated human resources, greater openness to international trade, and strong long-term investments. The lack of market mechanisms and institutions, as well as international trade and economic cooperation, must seriously constrain North Korea's growth potential. Although North Korea has small and unproductive flatlands, it claims some geographical advantages—including natural seaports and rich mineral resources—that enable it to pursue export-led growth. Moreover, the relative abundance of well-educated labor implies low initial wages and the ability to compete internationally in labor-intensive manufacturing.

Using an empirical gravity model of trade and foreign direct investment (FDI) flows between country pairs, we analyze how North Korea's trade and FDI dependence on South Korea are affected under different hypothetical scenarios, such that two Koreas end military conflicts and pursue economic integration and cooperation or that military confrontations continue and sanctions against North Korea increase. Subsequently, we quantify the effects of the change in trade and FDI dependence based on the different scenarios on North Korea's potential growth rates.

Our analysis shows that, if North Korea embarks on substantial and extensive policy reforms toward a market-oriented economy and openness, its trade and FDI with South Korea would increase significantly and so would the gross domestic product (GDP) over the next decade. Conversely, if North Korea continues to pursue nuclear weapon program and harsh

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sanctions on North Korea become effective, the economy will experience significant decrease in both trade and FDI, facing even lower economic growth.

It is difficult to judge whether North Korea can embrace fundamental reforms and economic opening in an attempt to reverse its economic decline or not. While the probability that North Korea reforms itself into a complete market economy and integrates into the global market is presently low, our analysis, based on conditional projections, illustrates North Korea's economic potential for long-run growth.

Previous studies have shown that the economic reform of North Korea and economic integration between the two Koreas would benefit each other, particularly North Korea. A number of studies have discussed the performance of the North Korean economy in response to political or social demand for peaceful relationships between the two Koreas and the possibility of reunification.

Noland et al. (1997, 2000a, 2000b), using a computational general equilibrium (CGE) modeling approach, estimate the potential gains from North Korea's reform and show North Korea benefits greatly from free trade, especially inter-industry trade, and military demobilization. Estrada and Park (2008) analyze the effect of the Korean reunification using the global dimension of the regional integration model and assert that reunification incurs losses for South Korea in political, social, economic, and technological development. Kwon (2009) maintains that economic integration benefits the two Koreas because North Korea has growth potential, such as rich human capital and natural resources. Lee et al. (2009), exemplifying the case of Fujian Province in China, which has achieved economic catch-up mainly due to Taiwanese investments, argue that North Korea can accomplish economic catch-up through FDI from South Korea. Brown et al. (2012) and Choi and Brown (2015) analyze total factor productivity (TFP) catch-up between the two Koreas based on the experience of the German unification. Using a growth model of productivity catch-up, they show that, when the two Koreas are unified, a slowdown in TFP growth is predicted to have persistent negative effects on South Korea, although North Korea would benefit from more rapid income growth. Kang et al. (2014) provide estimates on potential benefits from gradual economic integration in trade and FDI on the two Koreas, as well as from joining a region-wide economic cooperation framework involving China and Japan.

Since there are limited data on North Korea, which lack credibility, many previous studies tend to use theoretical models based on possible parsimonious parameterizations or estimate the benefits by referring to a specific historical incidence, such as the German unification.

Their results are often sensitive to the model's assumptions. This study implements a new empirical-based approach by relying on historical cross-country data, including both North and South Korea data. We directly estimate the effect of peaceful integration and economic cooperation on trade and FDI of the North Korean economy and subsequently derive the quantitative estimates of North Korea's potential economic growth rate with increased trade and FDI integration. We presume our predictions on North Korea's trade and growth are less sensitive to any assumptions on North Korea's economic structure or resource allocation, whereas they depend on the average pattern of historical experiences across all other economies, globally. We consider our empirical approach complementary to previous CGE modeling approaches in the estimation of economic and political shocks, such as international sanctions and demilitarization on trade and FDI, and, finally, economic growth.

The remainder of the paper is organized as follows. In Section 2, we introduce cross-country regression to determine the main factors of economic growth and discuss the role of institutional reform and opening policy in future growth. In Section 3, we adopt an empirical gravity model for trade and FDI, and forecast North Korea's trade and FDI, conditional on its market-oriented and opening policies. In Section 4, we provide quantitative estimates for North Korea's growth rates and discuss its growth prospects. Concluding remarks follow in Section 5.

2. Sources of Economic Growth and North Korea's Growth Potential

In this section, we investigate the determinants of the growth rates of output per worker for the last four decades. The analysis is based on a general framework of cross-country regressions, which puts the experience of individual countries in a global context. This approach allows us to understand the specific factors associated with economic growth across countries and the key differences between fast and slow growing economies. This exercise provides a basis for understanding the future growth prospects of North Korea and offer insights to the effects of possible policy reforms on its economic growth.

2.1 Cross-Country Analysis of Economic Growth

The basic empirical framework is based on an extended version of the neoclassical growth model, as described by Barro (1991), Barro and Lee (1994), and Barro and Sala-i-Martin

(2004). This model predicts "conditional convergence" of per capita income (or per worker output), implying that a country with a lower initial per capita income relative to its own long-run (or steady-state) potential level of per capita income grows faster than a higher-income country over time. The farther an economy locates from its steady-state level, the greater is the gap of physical and human capital stock and technical efficiency from their long-run potential levels. The gap of existing capital and technology from steady-state levels provides the economy with the chance for rapid catching up, through higher rates of return to investment and the faster diffusion of technology from more technically advanced economies.

The convergence phenomenon is conditional on external environmental and policy variables facing individual economies. Each country is converging to its own steady-state level of per worker output. The long-term, steady-state level depends on policies, institutions, and other country specific circumstances. An economy with more favorable economic policies and structure tends to have a higher steady-state level of per worker output, and, therefore, higher GDP growth at any given initial level of per worker output.

As a reduced-form equation, the model based on the conditional convergence framework can be represented by

$$\Delta \log(y_{i,t}) = \beta_0 + \beta_1 \log(y_{i,t-1}) + \gamma X_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where $\Delta \log(y_{it})$ is country i's per worker GDP growth rate in period t, y_{it-1} is the country's (initial) per worker output in t-1, and X_{it} denotes an array of variables that influence country i's steady-state level of per worker output. GDP data in 2005 PPP-adjusted international dollars are sourced from the PWT 8.0 (Feenstra et al., 2015) and data on population structure by age, from the United Nations (2013), are used to construct per worker real GDP.

A wide variety of external environment and policy variables affect growth rates by influencing the long-run potential level of output. The extended neoclassical growth model emphasizes investment rate, population growth, and human capital as important determinants of the steady-state level of output per worker. Our regression includes investment, fertility, and human capital as fundamental growth factors. Data on the ratio of investment in the GDP (private plus public) are sourced from the PWT 8.0. The stock of human capital is measured by the average years of schooling for population aged 15 years and over (Barro and Lee, 2015).

Previous empirical research also considers institutions and policy factors as important determinants of long-run output per worker. As such, we include three variables to control for

institution and opening policy variables. The first variable is the quality of institutions. Measures of the protection of property and contractual rights and the efficiency of the government's intervention in the market are available from International Country Risk Guide (Political Risk Services, various years). In the regression, an indicator for the overall maintenance of the rule of law in the economy (converted to a 0–1 scale, with 1 representing the highest quality of institutions) is used.

The second variable is international openness. Open economies have greater access to cheap imported intermediate goods, larger markets, and advanced technologies (Lee, 1993; Sachs and Warner, 1995). The openness measure used in this analysis is the log value of trade-to-GDP ratio, sourced from the PWT 8.0. The third variable is a measure of FDI inflows to an economy (Borensztein et al., 1998). The measure is the average ratio of FDI inflows, sourced from the World Development Indicators (World Bank, 2014)

The regression of specification (1) applies to a panel set of cross-country data for 75 countries over eight five-year periods from 1965 to 2005, corresponding to the periods 1965–1970, 1970–1975, 1975–1980, 1980–1985, 1985–1990, 1990–1995, 1995–2000, and 2000–2005. The panel is unbalanced with 529 observations in total. A system of eight equations is estimated by adopting instrumental variable (IV) estimation techniques to control for the endogeneity of explanatory variables. Instruments are mostly lagged values of the explanatory variables. The estimation includes country fixed effects to control for unobservable country-specific effects. Additionally, the regressions include period dummies to control for common shocks to per worker GDP growth in all countries.

2.2 Empirical Results

Table 1 contains empirical results for the cross-country panel regressions. Column (1) of Table 1 includes domestic investment rate and column (2) excludes it. Since their estimation results are similar, we focus on the results of column (1).

[Insert Table 1 about here]

The result shows strong evidence for conditional convergence: the coefficient on the log value of initial per worker GDP is highly significant and negative. Therefore, a poor country with a lower initial income level grows faster, with the variables influencing the steady-state level of income controlled.

The investment rate is positive but statistically insignificant. The log of the total fertility rate is negative and statistically significant at the 10 percent level.[3] The regression result shows a nonlinear relationship between human capital stock and growth, as discussed in Barro and Lee (2015). The coefficients on average years of schooling and its square term are negative and positive, respectively, and statistically significant. The pattern of the coefficients suggest that the growth rate increases with the level of educational attainment only when the society has attained human capital above a certain average threshold of about 7.6 years of schooling.

The regression result provides clear evidence that the institution and policy variables play a significant role in determining economic growth. The quality of institutions has a positive effect on growth, indicating that countries with better protection of property and contractual rights, and more constructive interactions between the government and the market tend to have higher growth rates. The estimated coefficient, 0.0165 (s.e. = 0.0096), implies that each increment of 0.28 in this index on a scale of 1 (around one standard deviation) is associated with an increase in the growth rate of 0.46 percentage points per year.

The openness variable, measured by the log value of the ratio of exports and imports over GDP, appears to be very strongly and positively associated with the growth rate. The estimated coefficient, 0.014 (s.e.= 0.004), indicates that an increase in the trade openness ratio by 10 percentage points in an economy with a sample average of trade openness (= 0.45 for the sample of 75 countries during the entire period from 1965 to 2005) would raise the per worker GDP growth rate by about 0.31 percentage points per year (= 0.014 × 10/0.45). The estimated impact of openness is greater for a more closed economy. For instance, North Korea's total trade to GDP is 0.144 during the sample period up to 2005 (0.19 on average for 1990–2015). Therefore, the growth effect of trade expansion is evaluated at this mean value.

The regression result also confirms the positive relationship between FDI inflows and growth. The estimated coefficient of 0.32 (s.e.= 0.19) implies that an increase of 2 percentage points in the ratio of FDI to GDP (around one standard deviation) leads to an increase in the growth rate of per worker GDP of about 0.64 percentage points per year.

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[3] Note that, consistent with the production function, the dependent variable in the regressions is expressed as the growth in per worker output. Output growth rate is calculated as a sum of per worker output growth rate and the working-age population's growth rate. The estimation shows that a lower fertility rate has a positive effect on per worker output growth, but when it leads to decline in working-age population growth in the long-run, it can have a negative effect on output growth.

2.3. Conditions for North Korea's Catching Up

The empirical exercise on the sources of growth across countries shows that a strong convergence effect from lower per capita income, good human resources environments, and market-based and open economic policies are key factors in sustaining long-run economic growth.

The sample for regressions does not include North Korea because comparable data are unavailable. The available GDP data from the Bank of Korea show that the average GDP growth rate of North Korea was -0.6% over 1990–2014 (Figure 1).[4]

[Insert Figure 1 about here]

Nevertheless, we can conjecture that due to its low per capita income, North Korea exhibits favorable conditions for the future economic catch-up. Conditional convergence implies that the lower per worker output level of North Korea could provide a strong starting point for its convergence effect, if other growth factors influencing the steady-state level of per worker output are improved.

[Insert Table 2 about here]

North Korea also has some natural advantages that can provide a sound basis for export-led growth (Lee, 2001). It is a coastal economy with natural seaports endowed with rich mineral resources (Table 2). The relative abundance of labor implies low initial wages and the ability to compete internationally in labor-intensive manufacturing sectors, such as footwear, apparel, textiles, and electronics.

North Korean data on school enrollment and educational attainment show that it has a substantial educational stock. Eberstadt (1995) reports that North Korea had about 4.3 million pupils aged between 6 and 15 enrolled in primary and secondary schools in 1987. The enrollments implied a gross enrollment ratio of about 96 percent.

Table 2 shows estimates of gross enrollment ratios by education level for North Korea, compared to South Korea, in 2014. They are estimated based on data on the number of school-aged population and school enrollments from the United Nations (2013) and the Statistics Korea (http://kosis.kr/eng/). The gross enrollment ratios for primary and secondary education in North Korea are high, reaching 99 and 96 percent, respectively, similar to the

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[4] Kim et al. (2007) estimate North Korea's long term growth rates and find the main cause of slow or negative economic growth to be extremely low total factor productivity, and that the productivity of the North Korean economy (1954-1989) had been lower than that of the Soviet economy (1945-1980) by 33 percent.

ratios in South Korea. The gross tertiary enrollment ratio of North Korea (33 percent) was much lower than South Korea's (95 percent). There were about 520,000 North Korean students in tertiary schools in 2014, implying 408 students per 10,000 population compared to 573 in South Korea.

In terms of the quantity of human resources and education attainment, North Korea has a significant amount of human capital. However, the quality of its human capital must be low because of inefficiency in the education and training system in terms of curriculum contents and instruction quality. As experienced in the German unification, workers from the command economy had difficulties in adjusting to market incentives and competition in the labor market and showed lower productivity. In the North Korean economy, allocation and utilization of human resources are also inefficient due to the rigid labor markets of the command economy.

Given its relatively good conditions in terms of initial income level, and natural and human resources, North Korea's growth potential can be considered positive. However, whether North Korea can actually achieve high growth potential and catch up with advanced countries, particularly South Korea, depends on the prospects of North Korea's substantial reforms toward market-oriented and open economic policies. Figure 2 shows the institutional quality measures from the Political Risk Services' International Country Risk Guide, for selected years 2000, 2010, and 2014. The measure is the simple average of four individual indicators—government effectiveness (bureaucratic quality), regulatory quality, rule of law, and control of corruption. The institutional quality in North Korea has decreased from 0.43 in 2000 to 0.31 in 2014. North Korea was falling behind South Korea (0.73), China (0.47), and Vietnam (0.55) in 2014.

[Insert Figure 2 about here]

3. Estimation of Trade and FDI Dependence between South and North Korea

In this section, we investigate the trade and FDI dependence of North Korea on South Korea using a sample of 186 individual countries for 1950–2009. Our strategy is to assess the potential bilateral trade volume and FDI flows between the two Koreas by comparing them to historical experiences of other countries, which include not only developed economies but also developing economies, former socialist economies, and those with warfare and ongoing sanctions. We estimate bilateral trade volume and FDI flows between the two Koreas

assuming different scenarios with regard to the degree of North Korea's reform and trade, and FDI integration with South Korea. Subsequently, using current North Korea and South Korea data available, we project North Korea's trade expansion with respect to the aforementioned scenarios.

Figures 3 and 4 show the current status of North Korea's trade and FDI flows. In Figure 3, the main trading partners of North Korea are South Korea and other adjacent countries, such as China and Japan. North Korea's trade with South Korea and China had increased until 2007. However, after North Korea launched the first nuclear test in October 2006, its trade with China has continued increasing, while that with South Korea has stagnated. Particularly, North Korea has no official trade with Japan since 2006.

[Insert Figure 3 about here]

Figure 4 depicts FDI flows to North Korea during 2004–2015. Again, major investor countries to North Korea are South Korea and China. While South Korea's direct investment in North Korea was executed only through the KIC under government supervision, Chinese investors invested in North Korea independently. Due to the KIC, North Korea's FDI dependence on South Korea had deepened. South Korea's FDI flow to North Korea through KIC increased up to USD 1.2 billion in 2015. However, this economic relation was vulnerable to political shocks between the two countries: North Korea's two nuclear tests in 2009 and 2013 halted the operation of the KIC temporarily. Finally, South Korea shut down the KIC in 2016, owing to North Korea's incessant nuclear tests and missile launches.

Chinese foreign investment flows to North Korea were first reported as USD 1.1 million in 2003 and increased subsequently. In particular, the flow increased since 2010. Cumulative FDI inflows from China to North Korea were around USD 280 million during 2003–2012. However, the magnitude of Chinese FDI inflows to North Korea is smaller than South Korean FDIs to North Korea. Note that net FDI flow from South Korea to North Korea is the difference between gross flows shown in Figure 4.

[Insert Figure 4 about here]

3.1. Estimation of Bilateral Trade

We first estimate the determinants of trade and their marginal effects on trade using an empirical gravity model for trade between two countries. For bilateral trade flows, we introduce modified gravity equation as follows:

$$\ln\left(\frac{Trade_{ijt}}{GDP_{it} \times GDP_{jt}}\right) = \beta_0 + \beta_1 \ln(GDPPC_{it}) + \beta_2 \ln(GDPPC_{jt}) + \beta_3 war_{ijt} + \beta_4 alliance_{ijt}$$

$$+ \beta_5 sanction_{ijt} + \beta_6 GATT/WTO_{ijt} + \beta_7 RTA/FTA_{ijt} + \beta_8 CU_{ijt} + \phi_{ij} + \varepsilon_{ijt}, \quad (2)$$

where $Trade_{ijt}$ is bilateral trade between countries i and j in year t. GDP_{it} and GDP_{jt} are the GDPs of countries i and j, respectively. Although the theoretical model of gravity equation calls for trade flows as a dependent variable, we modify our dependent variable as a share of trade to product of the GDPs of two countries, because our prediction comprises not only the future values of trade between the two Koreas, but also those of their GDPs.[5] $\ln(GDPPC_{it})$ and $\ln(GDPPC_{jt})$ are logs of GDPs per capita of countries i and j, respectively. The empirical trade model often includes GDP per capita as a proxy for a country's development and quality of institutions (e.g., Rose, 2004). Trade data are collected from Direction of Trade at IMF and the Correlates of War (COW) project webpage. GDP data are from the World Development Indicators and Gleditsch's GDP dataset (Gleditsch, 2002). We also collected North and South Korea's bilateral trade data from the databases of the Statistics Korea, and the Bank of Korea's Economic Statistics System (ECOS).

The measure of military conflict, war_{ijt}, is a binary time-varying variable representing whether two states are engaged in military conflict, of which the level of hostility is greater than 2 in year t. It is constructed from the database of the COW project. This data set codes for all military interstate disputes (MID) with a level of hostility ranging from 1 to 5 (1 = no militarized action, 2 = threat to use force, 3 = display of force, 4 = use of force, 5 = war). The MID dataset (version 3.02) is transformed to dyadic events with corrections made by Maoz (2005). Martin et al. (2008) and Lee and Pyun (2016) show that bilateral and multilateral trade affect interstate conflict significantly and vice versa. $Sanction_{ijt}$ is a binary variable coded as 1 if source country i imposes economic sanction on country j. The data are collected from Threat and Imposition of Sanctions (TIES) data.[6] For the measure for inter-state

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[5] The theoretical derivation for the gravity model is based on the equilibrium condition of monopolistic competition model of trade. $m_{ij} = \frac{y_i y_j}{y_{world}}\left(\frac{t_{ij}}{P_i P_j}\right)^{1-\sigma}$ from Anderson and van Wincoop (2003). However, our dependent variable is constructed by dividing both sides by the product of GDPs for countries i and j, $\frac{m_{ij}}{y_i y_j} = \frac{1}{y_{world}}\left(\frac{t_{ij}}{P_i P_j}\right)^{1-\sigma}$.

[6] http://www.unc.edu/~bapat/TIES.htm

economic cooperation, we introduce a General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO) membership dummy and trade agreements, such as a free-trade area/regional trade agreement (FTA/RTA) dummy. FTA/RTA is time-varying binary variable taken from de Sousa (2012). Lastly, we include a currency union dummy. We also control for geographical proximity and political, historical, and cultural factors. However, variables such as bilateral distance, contiguity (border), common language, historical colonial relationship—common colonizer, past colony, one country in history—and the product of land size for countries are soaked up by country-pair fixed effects.

Table 3 shows the results for the regression of bilateral trade share. Column (1) of Table 3 shows the baseline results of the gravity equation of trade, including possible attributes that influence trade. Column (2) includes country-pair fixed effects, which incorporate the multilateral resistance term (time-invariant) that represents multilateral trade costs (Anderson and van Wincoop, 2003). Although the fixed effects result does not exhibit the estimates on time-invariant controls such as distance, border and common language, this method avoids omitted variable bias caused by the multilateral resistance term and provides consistent estimates on time-varying variables, such as war and sanction. In column (3), we also introduce the Poisson pseudo-maximum likelihood (PPML) estimator with country-pair fixed effects to address the problem of zero trade (Silva and Tenreyro, 2006). In this specification, we use bilateral trade volume as a dependent variable, and include GDPs of countries i and j on the right-hand side.

The estimated results on political factors, such as war, alliance, and sanctions, are consistent across columns. RTA and GATT/WTO membership show significant and positive effects on trade. War and sanction have significantly negative effects on bilateral trade and alliance has a positive effect, although the magnitudes of the estimates vary across specifications. Note that our projection is, however, not very sensitive to a choice of specification.

[Insert Table 3 about here]

3.2. Estimation of Bilateral FDI

We introduce a bilateral FDI share equation. Unlike the gravity model of trade, there is no firm theoretical background for the determinants of country level bilateral FDI. Bénassy-Quéré et al. (2007), following a gravity model of trade, set up a version of the gravity model

in FDI. We slightly modify their bilateral FDI equation with a special focus on a host-country FDI model. Bilateral FDI data are collected from the OECD FDI statistics[7] that report OECD countries' FDI flows or position to other world countries for 1982–2009. We obtain the data of direct investment to North Korea from the Statistics Korea (2016). Given that many developed countries are sources of foreign investment, we mainly consider FDI flows from developed countries to the world countries in the regression.

$$\frac{FDI_{ijt}}{GDP_{jt}} = \beta_0 + \beta_1 \ln(GDPPC_{it}) + \beta_2 \ln(GDPPC_{jt}) + \beta_3 war_{ijt} + \beta_4 sanction_{ijt} + \beta_5 alliance_{ijt}$$

$$+ \beta_6 \frac{Export_{ijt}}{GDP_{jt}} + \beta_7 RTA/FTA_{ijt} + \beta_8 \text{Investment\_Risk}_{jt} + \beta_9 CU_{ijt} + \kappa_{ij} + e_{ijt}, \qquad (3)$$

where FDI_{ijt} is the outward FDI flow from country i to country j in year t. We use a share of FDI inflows to host country j's GDP as dependent variable. $\ln(GDPPC_{it})$ and $\ln(GDPPC_{jt})$ are GDPs per capita of countries i and j, which is a proxy for a country's development, respectively. War_{ijt} is a binary time-varying variable of whether two states are engaged in military conflict of hostility level above 2 in year t. Li and Vashchilko (2010) find that interstate military conflict indeed lowers country level FDI. $Sanction_{ijt}$ is a binary variable coded as 1 if a source country i imposes economic sanction on country j. For the measure for economic cooperation, we introduce a GATT/WTO membership dummy and economic agreement, such as a FTA/RTA dummy. A currency union dummy is also included. Since export is often considered as a firm's internationalization strategy, which is either substitute or complement to FDI, export to host country's GDP is included as a control variable. To receive foreign investment, the host country needs to guarantee safe institutional environment for investors by reducing risk involved with investment. Therefore, we include the investment risk (expropriation risk) index, which is collected from the Political Risk Services' International Country Risk Guide. We rescale this variable from 0 (lowest risk) to 12 (highest risk). We also control for country-pair fixed effects to address country-pair time-invariant heterogeneity, such as bilateral distance, contiguity (border), common language, historical colonial relationship, common colonizer, past colony, current colony, one country in history, and the product of land size for countries.

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[7] https://stats.oecd.org/

Table 4 shows the result for bilateral FDI flows. We report pooled ordinary least squares (OLS) estimates from column (1) and add the results with country- and country-pair fixed effects in columns (2) and (3), respectively. Overall, the estimated results are consistent across columns. The estimated coefficients on war and sanction are negative, but only those on war relations are statistically significant over all columns. RTA/FTA and currency unions have positive effects on FDI. Exports as a share of GDP also has a positive effect on FDI, which supports a complementary relationship between export and FDI.

[Insert Table 4 about here]

3.3. Projections for Trade and FDI between South and North Korea

Using the results with country-pair fixed effects in Tables 4 and 5, we estimate North Korea's trade and FDI with South Korea, depending on three different scenarios on North Korea's reform and integration: (i) North Korea does not abandon nuclear weapons and suffers from sanctions; (ii) the two Koreas have peaceful relationships without any conflicts and build up a normal trade relation, which assumes that gradual reform for opening is preceded by no political and military conflicts between them and the lift of sanctions on North Korea; and (iii) North Korea pursues further economic cooperation, such as joining RTAs/FTAs and the WTO.

Table 5 reports the results on the estimates of trade and FDI between the two Koreas. In the second column, we show average bilateral trade between North and South Korea and South Korea's FDI to North Korea during 2011–2015. Owing to North Korea's lagged development and its isolated economic policy, trade and FDI volume is not large.[8] North Korea's trade dependence on South Korea is 8.8 percent of North Korea's GDP for 2011–2015 and the FDI inflow (through the KIC) is 4.1 percent of North Korea's GDP. In our first scenario, we assume that North Korea continues its hardline stance on nuclear weapons and South Korea imposes harsh sanctions on North Korea. Our projection shows that North Korea's trade volume and the FDI inflows from South Korea decline to 0.01 and 0 percent of North Korea's GDP, respectively. Note that if we consider the sanctions imposed by an international community, in particular China, North Korea's total trade and inward FDI will decrease further.

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[8] However, North Korea's trade and FDI dependence on South Korea is relatively greater than on other countries with which North Korea has economic relationships.

Our finding is consistent with previous studies, such as Evenett (2002) and Hufbauer et al. (2009), which show that sanctions reduce bilateral trade significantly. Evenett (2002) estimates the impact of eight industrialized countries' sanctions against the South African Apartheid regime on bilateral trade between these countries and South Africa, and shows that the US sanction had the strongest influence on South African exports. Hufbauer et al. (2009) find that the imposition of economic sanctions significantly reduces the volume of bilateral trade between the imposing and the target state. In Figure 5, we also provide two selective examples to understand the effect of sanction. Figure 5 depicts changes in US bilateral trade with the targeted countries, such as Iran and Haiti, where the US imposed sanctions. During the sanction periods, both exports and imports between countries declined significantly.

[Insert Figure 5 about here]

Subsequently, we introduce scenarios that assume a brighter future for North Korea. First, North Korea's moderate reform scenario assumes that political tension will disappear between the two Koreas, which indicates that they abolish any type of military dispute and lift economic sanctions against each other (and select political alliance). Furthermore, from this scenario of reform and economic cooperation, we assume the two Koreas recover potential for normal trade that other country pairs similar to the two Koreas (in terms of geographical, historical, cultural characteristics) have enjoyed. Technically, we measure this unobserved potential for normal trade between the two Koreas as the average of the estimates of country pair fixed effects derived from the country pairs that are contiguous, use the same language, and have similar colonial experience.

Lastly, an extensive reform scenario includes active economic cooperation between the two Koreas—they sign a free trade agreement and North Korea joins the WTO. According to these two scenarios, we forecast trade and FDI expansion between two Koreas for 2016–2020. Bilateral trade will increase to 24.9 percent and 35.5 percent of North Korea's GDP in each moderate reform and extensive reform scenarios, respectively. FDI inflow is estimated to increase to 5.4 percent and 5.9 percent of North Korea's GDP, respectively.

[Insert Table 5 about here]

4. Growth Prospects for North Korea

This section estimates the GDP growth rates of the North Korean economy, based on the different scenarios for economic reform and trade and FDI integration with South Korea.

Table 6 summarizes North Korea's growth effect from institutional reform, and trade and FDI expansion from the opening policy. In a baseline *status quo* scenario, in which the North Korean government makes minimum institutional and policy changes only as a means to survive, North Korea will grow at 1 percent per year according to an estimate by Kang et al. (2014). Their estimate is close to North Korea's average GDP growth rate during 2011–2015.

[Insert Table 6 about here]

We begin by analyzing the growth effect if North Korea continues its hardline stance on nuclear weapons. For no reform and a hard sanction scenario, in which North Korea continues developing nuclear weapons and South Korea imposes an embargo against it (i.e., KIC closure and additional sanctions), North Korea would face dismal consequences on not only trade and FDI, but also growth rate.

Owing to economic sanctions against North Korean trade, bilateral trade as a share of North Korea's GDP is expected to decrease by 8.77 percentage points from the actual bilateral trade share for 2011–2015. The growth effect driven by this trade decrease is estimated to be -0.85 percent per year (= -8.77 × 0.014/0.144).[9] Moreover, as North Korea's current nuclear standoff and the KIC closure halt FDIs from South Korea, FDI inflow (as a share of GDP) would decrease by 4.06 percentage points from the average FDI share during 2011–2015. The growth effect from this FDI decrease is estimated to be -1.3 percent per year. Therefore, the estimated total growth effect in this scenario is a reduction of 2.15 percentage points from the baseline growth rate of 1 percent per year, that is, North Korea is expected to grow at -1.15 percent per year. Again, this growth estimate is conservative in that we only consider sanctions on bilateral trade between South Korea and North Korea. If the international community, including China, imposes harsh sanctions, North Korea will face even lower economic growth.

However, North Korea's nuclear renunciation and its market reform and opening would promote a different growth outcome. We assume two different reform scenarios—moderate and extensive reforms—in terms of institutions and integration policy variables. First, the moderate reform scenario assumes that North Korea would improve institutional quality from 0.31 to 0.5, similar to the values of China and Vietnam. The extensive reform scenario assumes North Korea adopts improvement in institutional quality up to 0.73, similar to that of

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[9] Neuenkirch and Neumeier (2015) show empirically that UN and US sanctions have adverse effect on target country's economic growth over the period 1976-2012. They also find that UN sanctions have greater negative effect than US sanctions.

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South Korea in 2014. The conjecture shows that North Korea's grow rate will increase by 0.35 percent points per year in the moderate scenario and by 0.73 percentage points in the extensive reform scenario. For both reform scenarios, we also assume that normal trade relations without political tensions between the two Koreas are restored. Accordingly, bilateral trade as a share of North Korea's GDP is expected to increase by 16.08 percentage points compared to the average bilateral trade share for 2011–2015.[10] The growth effect driven by this trade expansion is estimated to amount to 1.56 percent per year (= 16.08 × 0.014/0.144). This trade gain comes mainly from preventing military disputes and lifting economic sanctions. This can be a conservative estimate because we do not take further GDP expansion or GDP per capita from trade expansion into account. If we include the effect of subsequent increases in GDP or GDP per capita on trade, bilateral trade between the two Koreas is expected to increase further.

In the moderate reform and normal trade scenario, North Korea's FDI inflow (as a share of GDP) is estimated to increase by 1.29 percentage points from the average FDI share during 2011–2015. The estimated growth effect from this FDI increase is 0.29 percent per year. Therefore, additional growth in the moderate reform scenario is 2.2 percent per year. Note that North Korea's growth potential becomes greater when we consider additional increases in total trade and FDI with other countries.

Consider the extensive reform scenario with further economic cooperation between the two Koreas through an FTA and North Korea joining the WTO. The extra increase in trade due to the FTA and WTO entry is estimated at 10.63 percentage points. Hence, bilateral trade, as a share of GDP, is expected to increase by 26.71 percentage points from the real bilateral trade share for 2011–2015. The growth effect driven by this trade increase is estimated at 2.6 percent per year (= 26.71 × 0.014/0.144). Moreover, further economic cooperation in the extensive reform scenario is expected to increase FDI additionally. The estimated extra increase in FDI from the extensive reform scenario is 0.53 percentage points and, thus, total FDI increases by 1.82 percentage points. The estimated growth effect of FDI due to further economic cooperation is 0.42 percent per year. Combined with extensive market-oriented reform and economic cooperation, the North Korean economy is forecasted to grow at 4.75 percent per year over the next decade.

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[10] Sohn and Yoon (2001), using a gravity model of trade, show that with the normalization of trade relations and the elimination of trade barriers, bilateral trade between South and North Korea could expand to as much as five times the current level.

5. Concluding Remarks

Owing to its relatively lower income level and relatively good natural and human resources, North Korea has substantial potential for catching up with South Korea and other East Asian countries through institutional reforms and economic opening. However, its current centrally-planned and closed system does not allow it a high potential growth path.

We have analyzed the effects of hypothetical policy reforms and opening that North Korea could adopt to stimulate the economy. If it embarks on market-oriented reforms and opens its economy, its trade and FDI integration with South Korea would increase significantly, contributing to higher growth. Our projections show that, with substantial reforms of institutions and economic policies, North Korea's trade with South Korea would increase significantly to 35.5 percent of North Korea's GDP and its FDI inflows from South Korea will also increase to 5.9 percent of its GDP. Trade and FDI integration with South Korea is expected to increase the annual average GDP growth rate significantly by as much as 3 percentage points. Combined with an additional growth effect from the extensive institutional reform, the North Korean economy is forecasted to grow, on average, at 4.7 percent per year for the next decades. Achieving a high growth rate can cause North Korea to display dynamism, as South Korea and other East Asian countries previously did.

Presently, it is difficult to predict when and to what extent the North Korean regime will embark on fundamental reforms towards a market-oriented and open economy. The projections provided in this paper are, therefore, hypothetical and illustrate the potential of the North Korean economy, which it can secure depending on the extent of market reforms and opening policies. Conversely, for the time being, tough economic sanctions imposed on North Korea are expected to significantly decrease its trade and direct investment flows, significantly reducing economic growth.

The long-term peace and prosperity of the Korean peninsula must be in the best interest of the surrounding countries and the international community. Either the sudden collapse of North Korea or a military conflict on the peninsula will cast a serious threat to regional security and peace. In order for North Korea to survive the current economic predicament and evolve, it should abandon nuclear weapon and missile programs and embark on far-reaching reforms towards market economy and an open trade regime.

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Table 1. Determinants of Real per Worker GDP Growth

Dependent variable	Five year average growth of real GDP per worker	
	(1)	(2)
log(lagged per worker GDP)	-0.0538***	-0.0536***
	(0.00543)	(0.00541)
log(fertility rate)	-0.0148*	-0.0161*
	(0.00899)	(0.00891)
Investment ratio	0.0169	
	(0.0259)	
Quality of institutions	0.0165*	0.0172*
	(0.00958)	(0.00956)
log(trade openness ratio)	0.0144***	0.0146***
	(0.00422)	(0.00425)
FDI/GDP	0.318*	0.319*
	(0.190)	(0.190)
Total schooling years	-0.00918**	-0.00895**
	(0.00362)	(0.00359)
Total schooling years squared	0.00060***	0.00058***
	(0.00022)	(0.00022)
Number of countries	75	75
Observations	529	529

Notes: The panel specification uses pooled data for eight five-year periods from 1965–2005 (1965-1970, 1970–1975, …, and 2000–2005) for 75 economies. The estimation adopts instrumental variables panel estimation with fixed effects. Data for lagged per worker GDP is for the initial year of each of the five-year periods (1965, 1970, …, and 2000). Other regressors are averages over periods. Lagged values used as instruments. Period dummies are included. Standard errors are in parentheses. Asterisks denote the following significance levels: * $p < .1$, ** $p < .05$, and *** $p < .01$.

Table 2. Comparison of South and North Korean Economies, in 2014 or the latest year

	(unit)	North (A)	South (B)	A/B*100 (%)
Gross National Income	(KRW, billions)	34,236	1,496,593	2.3
Per Capita GNI	(KRW, thousands)	1,390	29,680	4.7
Population	(thousands)	24,662	50,424	48.9
Population aged 15-64	(%)	69.2	73.0	94.8
Total Fertility Rate	(births per woman)	2.0	1.3	153.8
Life Expectancy at Birth	(year)	69.8	81.4	85.7
Total Trade	(USD billion)	7.6	1,098.2	0.7
Exports		3.2	573	0.6
Imports		4.4	526	0.8
Gross Enrollment Ratio	(%)			
Primary		99	99	100.0
Secondary		96	98	98.0
Tertiary		33	95	34.7
Number of Tertiary Students	(per 10,000)	408	573	71.2
Power Generation	(billion KWh)	21.6	350.5	6.2
Crude Oil Imports	(thousand barrel)	3,885	927,524	0.4
Grain Production	(thousand tons)	4,802	4,828	99.5
Rice Production	(thousand tons)	2156	4,241	50.8
Iron Ore	(thousand tons)	5,471	693	789.5
Length of Railways	(km)	5,302	3,590	147.7
Length of Roads	(km)	26,164	105,673	24.8

Source: The Statistics Korea
Note: Enrollment ratios and number of tertiary students are authors' construction, based on raw data from the United Nations (2013) and the Statistics Korea.

Table 3. Regression for Bilateral Trade Share

Dependent variable	log(Bilateral Trade/GDP$_{it}$*GDP$_{jt}$)		Bilateral trade
			PPML
	(1)	(2)	(3)
log(GDPPC$_{it}$)	0.3416***	-0.5111***	-0.0997***
	(0.0128)	(0.0278)	(0.0011)
log(GDPPC$_{jt}$)	0.2218***	-0.1583***	0.3663***
	(0.0127)	(0.0255)	(0.0009)
war$_{ijt}$	-1.4087***	-0.8023***	-0.1846***
	(0.3259)	(0.1981)	(0.0010)
alliance$_{ijt}$	0.3751***	0.0374	0.2425***
	(0.0629)	(0.0770)	(0.0007)
sanction$_{ijt}$	-0.4943***	-0.7258***	-0.0522***
	(0.1877)	(0.1352)	(0.0007)
RTA/FTA$_{ijt}$	0.3859***	0.0824*	0.2246***
	(0.0642)	(0.0434)	(0.0004)
One GATT/WTO	0.6999***	0.2995***	0.5494***
	(0.0614)	(0.0498)	(0.0012)
Both GATT/WTO	1.1673***	0.5732***	0.9657***
	(0.0652)	(0.0555)	(0.0013)
Currency Union$_{ijt}$	0.1777	0.3188***	0.0695***
	(0.1438)	(0.0995)	(0.0005)
log(Distance)	-1.3413***		
	(0.0274)		
Border	0.6448***		
	(0.1358)		
Common language	0.6166***		
	(0.0565)		
Colonial relationship ever	0.9400***		
	(0.1900)		
Common colonizer (post 1945)	0.5469***		
	(0.0778)		
Colony (post 1945)	1.4382***		
	(0.2299)		
Same country historically	0.9254***		
	(0.2213)		
Product of Land size	-0.0302***		
	(0.0059)		
Country-pair fixed effects	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	425,509	445,129	437,865
R-squared	0.276	0.633	--

Notes: PPML is Poisson pseudo maximum likelihood. Robust standard errors are in parentheses. Asterisks denote the following significance levels: * p < .1, ** p < .05, and *** p < .01.

Table 4. Regressions for FDI Shares

Dependent variable	Outward FDI flow from i to j/GDP$_{jt}$		
	(1)	(2)	(3)
log(GDPPC$_{it}$)	0.0460**	0.1499	0.2919*
	(0.0198)	(0.1122)	(0.1545)
log(GDPPC$_{jt}$)	0.0158	0.3473**	0.2098*
	(0.0122)	(0.1415)	(0.1135)
war$_{ijt}$	-0.1046**	-0.2369***	-0.1021*
	(0.0515)	(0.0753)	(0.0582)
alliance$_{ijt}$	0.0126	0.0469	-0.0371
	(0.0347)	(0.0360)	(0.0554)
sanction$_{ijt}$	-0.0233	-0.092	-0.0984
	(0.0782)	(0.1247)	(0.2236)
RTA/FTA$_{ijt}$	0.0358	0.1242**	0.1642***
	(0.0331)	(0.0532)	(0.0408)
Currency Union	0.1954**	0.2100*	0.1434*
	(0.0918)	(0.1096)	(0.0765)
Export$_{ijt}$/GDP$_{jt}$	0.0775**	0.0764**	0.0607*
	(0.0356)	(0.0368)	(0.0339)
Risk to Investment$_{jt}$	-0.0308*	-0.0441	-0.0441
	(0.0162)	(0.0275)	(0.0281)
log(Distance)	0.0381	0.0631	
	(0.0289)	(0.0608)	
Border	0.0111	0.0346	
	(0.0412)	(0.0381)	
Common language	0.0944	0.0899	
	(0.0660)	(0.0592)	
Colonial relationship ever	0.0882	0.0754	
	(0.1137)	(0.1229)	
Common colonizer (post 1945)	0.1464**	0.1545**	
	(0.0681)	(0.0733)	
Colony (post 1945)	-0.1333	-0.2011	
	(0.1345)	(0.1378)	
Same country historically	0.4038***	0.4221***	
	(0.1136)	(0.1331)	
Product of Land size	-0.0078**	0.1102	
	(0.0036)	(0.2424)	
	OLS	Country FEs	Country-pair FEs
Year fixed effects	Yes	Yes	Yes
Observations	31,954	31,954	32,313
R-squared	0.092	0.099	0.276

Notes: Robust standard errors are in parentheses. Asterisks denote the following significance levels: * $p < .1$, ** $p < .05$, and *** $p < .01$

Table 5. Forecast on Trade and FDI between the Two Koreas

	Real data (avg. 2011–2015)	Sanction/KIC closure	No political tension	Economic cooperation
NK-SK trade/NK GDP (%)	8.78	0.01	24.86	35.49
SK FDI to NK/NK GDP (%)	4.06	0	5.35	5.88

Notes: No political tension indicates that the two Koreas abolish any type of military disputes and lift economic sanctions against each other (and select political alliance). Economic cooperation means that the two Koreas sign a free trade agreement and North Korea joins the WTO.

Table 6. North Korea's Growth Prospects under Alternative Scenarios

	Scenarios		
	No reform and sanctions[b]	Moderate reform and trade and FDI integration w/o political tension and economic sanctions[c]	Extensive reform and trade and FDI integration and economic cooperation[d]
Growth from			
Reform of institutions	0%	0.35%	0.73%
Trade	–0.85%	1.56%	2.6%
FDI	–1.3%	0.29%	0.42%
Growth from status quo scenario[a]	1.0%	1.0%	1.0%
Total GDP growth	–1.15%	3.20%	4.75%

Notes: (a) The *status quo* scenario assumes that North Korea implements muddling-through policies without serious policy changes and opening. The long-term GDP growth rates with *status quo* are assumed to be 1 percent per year, which was North Korea's average GDP growth rate during 2011–2015.

(b) The no reform and sanctions scenario assumes that North Korea continues its hardline stance on nuclear weapons and tough economic sanctions, including the KIC closure, are imposed.

(c) The moderate reform and integration scenario assumes that North Korea would improve institutional quality from 0.31 to 0.5, similar to China and Viet Nam, and that the two Koreas abolish any type of military dispute and lift economic sanctions against each other (and select political alliance).

(d) The extensive reform and integration scenario assumes that North Korea adopts improvement of institutional quality to 0.73, similar to South Korea and that the two Koreas sign a free trade agreement and North Korea joins the WTO.

Figure 1. Growth Rates of Real GDP, South and North Korea (%)
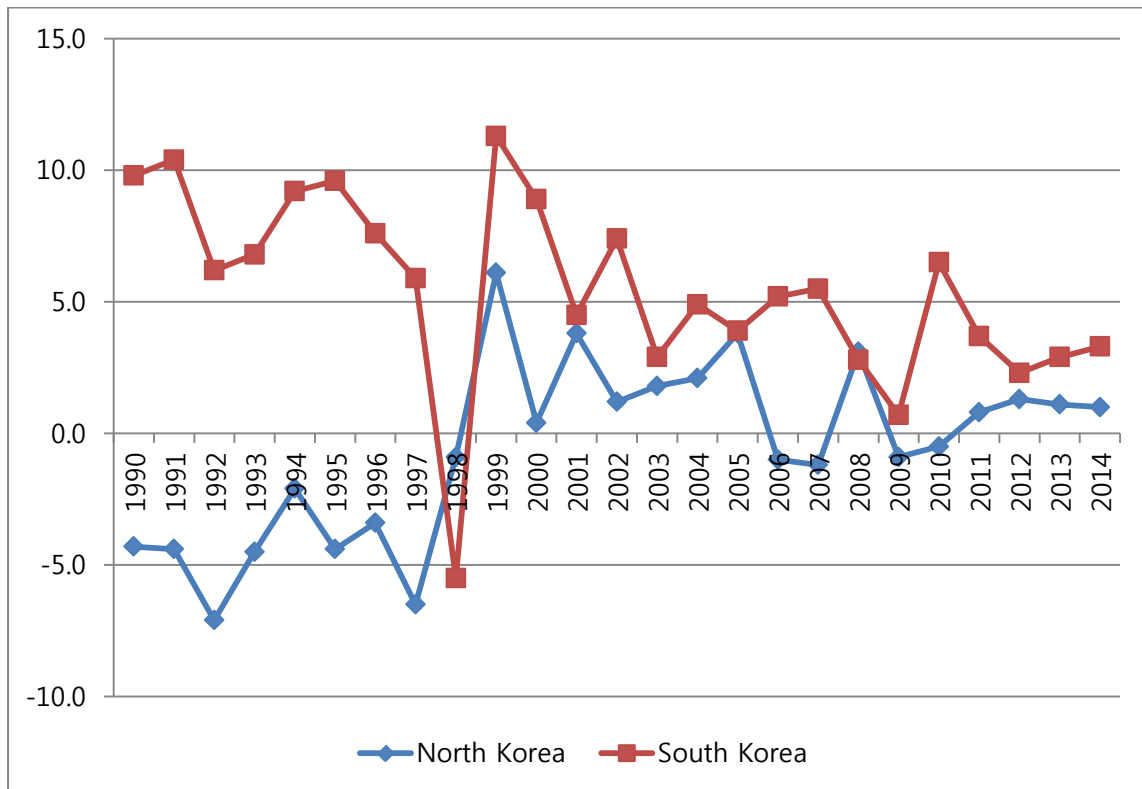
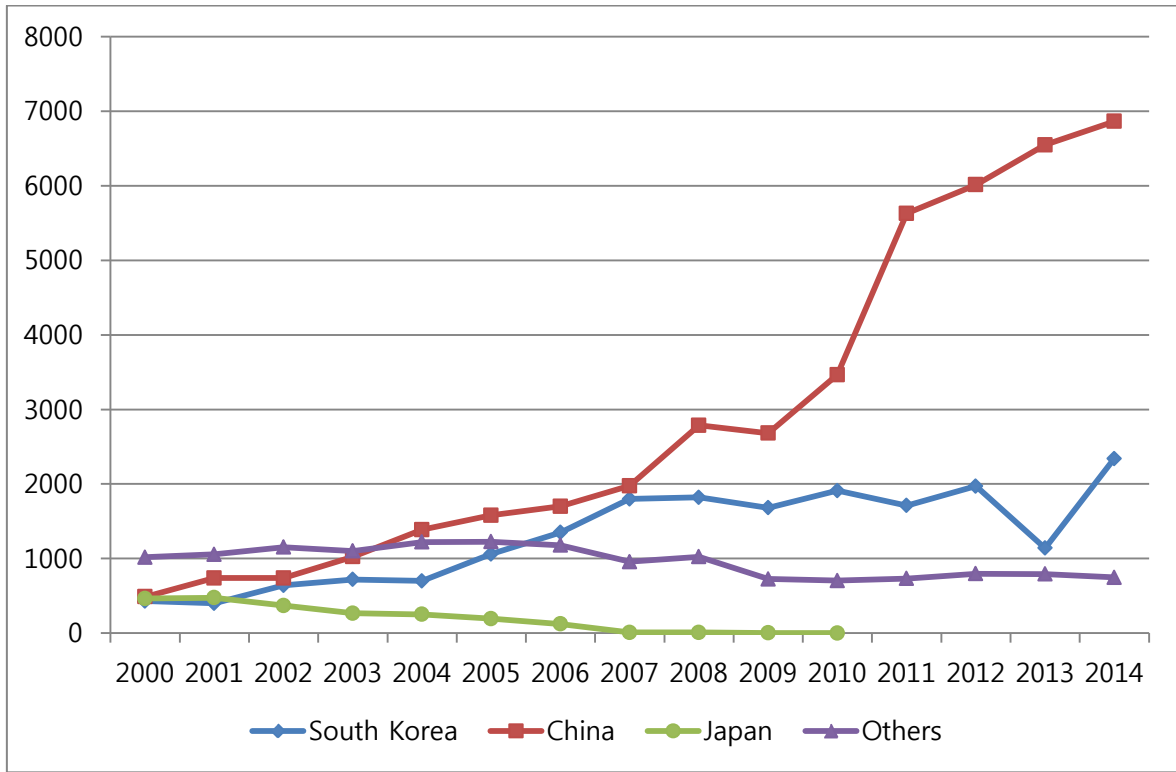Source: Economic Statistics System (ECOS), Bank of Korea.

Figure 2. North Korea's Quality of Institutions in Comparison with South Korea, China, and Viet Nam, for 2000, 2010, and 2014
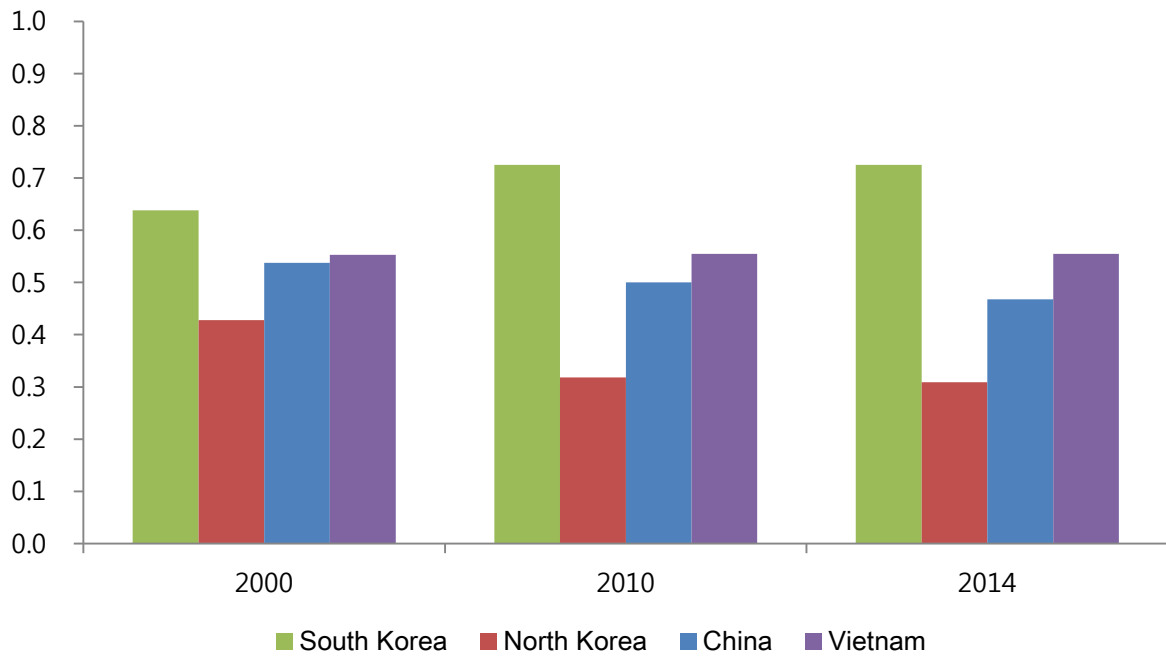
Notes: Quality of institutions is an aggregate measure of four indicators—government effectiveness, regulatory quality, rule of law, and control of corruption—on a 0–1 scale, with 1 representing the highest quality.
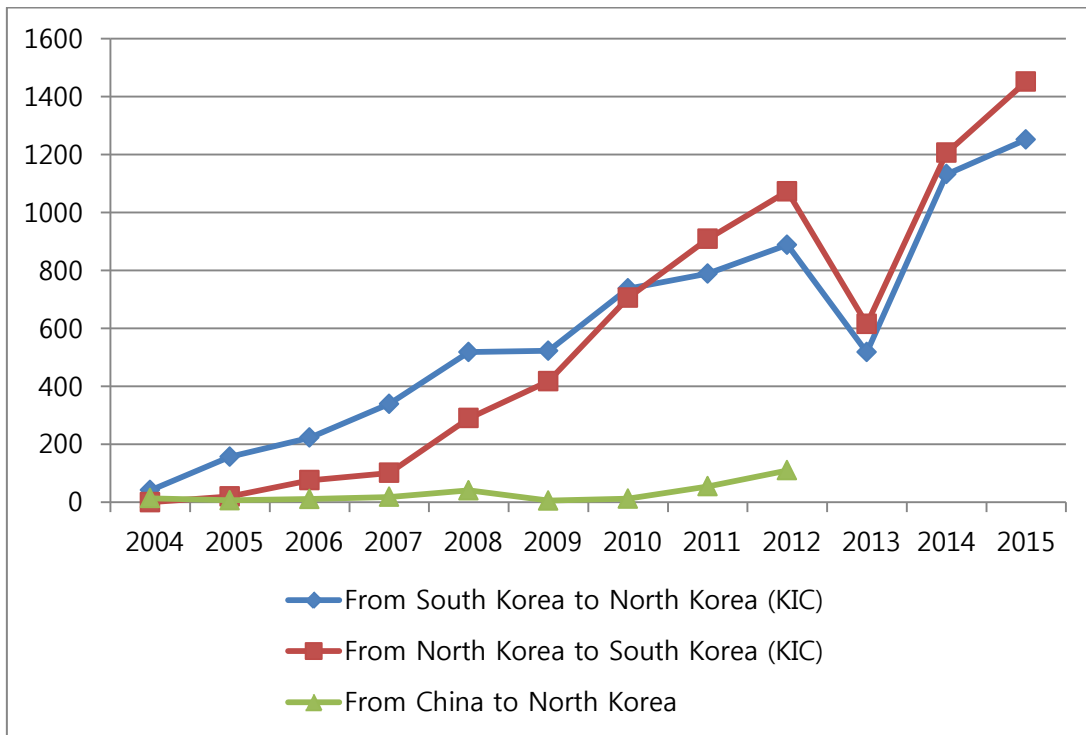Source: Political Risk Services' International Country Risk Guide.
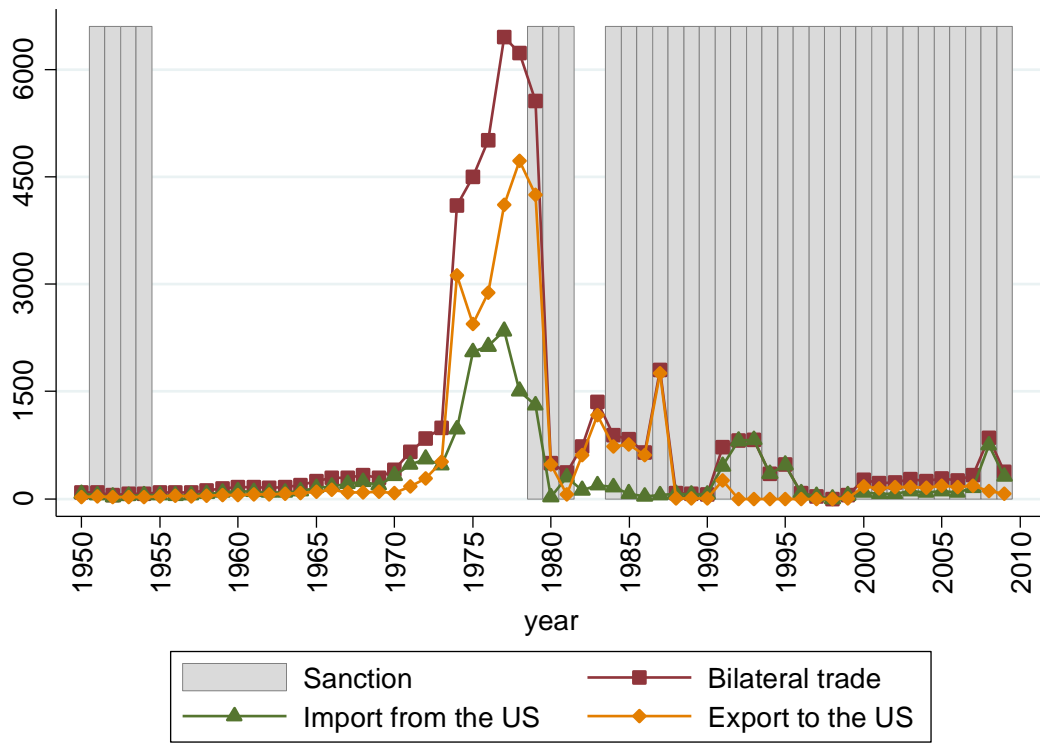
Figure 3. North Korea's trade (USD mil.)

Source: Economic Statistics System (ECOS), Bank of Korea.

Figure 4. FDI flow to North Korea (USD mil.)

Source: North Korea Statistics, Statistics Korea and Statistics Bulletin of China's Outward Foreign Direct Investment, MOFCOM database
(http://english.mofcom.gov.cn/article/statistic/foreigninvestment/)

Figure 5. Sanction and Trade
   Panel A. Iran–US trade

Panel B. Haiti-US trade