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Keywords

Korean unification, North Korea, dynamic general equilibrium, reform

JEL Classification

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Korean Unification: Economic Adjustments Under German Assumptions[†]

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This paper explores the impact of Korean unification on North and South Korea under the hypothetical scenario that unification takes place along the peaceful but unanticipated path similar to the experience of German reunification. Using a global dynamic intertemporal general equilibrium model, we find that if the unification process is managed peacefully and North Korea adopts comprehensive market-oriented reform and opening, the North Korean economy could capitalize on its growth potentials and experience fast GDP growth. As with the experience of West Germany, unification reduces the growth rate in South Korea for a certain period following the unification shock due to the transfers of resources out of the South into the North and an increase in risk on the Korea peninsula. Given that the relative sizes in population and per capita GDP of the two Koreas are very different from those of East and West Germany, unification can bring about more disruptive effects on North and South Korea, compared to the experience of Germany. The critical factors determining the economic effects of unification are the nature of wage-adjustment, the size of resource transfers from the South to North, and exchange rate policy.

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1. Introduction

Over the past seven decades since Korea was divided into North and South Korea in 1948, the two Koreas have followed very different development paths. While South Korea has experienced astonishing economic growth by adopting market-oriented and outward-looking policies since the 1960s, North Korea remains the most isolated, centrally-planned communist country in the world. Consequently, the socio-economic gap between the two Koreas has widened dramatically. North Korea's per capita income is currently estimated to be USD 1,300, which is less than 5% of South Korea's in 2017. There is also a significant gap in quality of life and social infrastructure between North and South Korea (Table 1). The North Korean economy has been stagnant in the past decades. It grew at an average growth rate of less than 1% over the past decade (Figure 1). While the agriculture and service sectors grew slightly, all other sectors contracted. The North Korean economy is still heavily dependent on the agriculture and mining sectors.

Despite its economic hardship, North Korea has continued its nuclear weapon and long-range missile programs. In 2017 North Korea continued to test nuclear weapons and intercontinental ballistic missile (ICBM) that could hit the US major cities. In response, the U.N. Security Council and the US adopted sanctions on North Korea. Despite harsh sanctions and military threats, however, North Korea continued to pursue a nuclear weapons program. Fears of a military conflict on the Korean peninsula escalated to an unprecedented level.

The situation has dramatically turned around in 2018. The leaders of North and South Korea met three times and made a number of pledges regarding co-operation and peace on the Korean peninsula, including an agreement to convert the Korean Armistice Agreement into a full peace treaty. US President Donald Trump and North Korean leader Kim Jong-un held a historic first summit meeting on June 12, 2018 in Singapore, agreeing to complete denuclearization of the Korean Peninsula, security guarantees for North Korea and new peaceful relations. The possibility of North Korea's denuclearization and economic reform has been rising.

The future of the North Korean economy and Korean unification is highly unpredictable at this moment. The North Korean regime may opt for complete denuclearization and embark on

comprehensive market-oriented reform and opening-up. The successful transformation of North Korea into a market economy could result in peaceful coexistence and a move gradually toward a unification of the two Koreas in the long run. Another possibility could be that in the process of going through the denuclearization and serious domestic economic reform, the North Korean regime falls into chaos or collapse with the unification of Korea taking place abruptly. History tells us that while Vietnam and China were successful examples of shifting to capitalist market systems through gradual and pragmatic reforms, other countries including the Soviet Union, Hungary and the former Yugoslavia suffered from an unstable transition process. It is hard to predict whether, when and how Korean unification will happen. No one expected the fall of the Berlin Wall and German reunification. The moment of Korean unification might come sooner or later, perhaps from the economic and political pressures from the inside rather than the outside.

This study aims at quantitatively assessing the impacts of Korean unification on North and South Korea under the hypothetical scenario that unification takes place along the peaceful but unanticipated path similar to the experience of German reunification. We quantify the consequences of Korean unification on economic activity, trade and capital flows in the two Koreas, using the G-Cubed model of the world economy. G-Cubed is a global dynamic intertemporal general equilibrium model that can analyze more thoroughly the process and impact of Korean unification. The G-Cubed model is built around an inter-industry input-output structure, factor movements and dynamics of consumption and investment (McKibbin and Wilcoxon, 2013). The model incorporates spillovers across industries within economies as well as across the border through trade and financial linkages.

Our earlier study (McKibbin et al, 2018) introduced this new model that incorporates a new macroeconomic and sectoral database for North Korea and explored what would happen if Korean unification occurs, assuming three different scenarios— 1) North Korea's reform and gradual convergence, 2) North Korea's sudden collapse and immediate unification, and 3) chaos and crises in North and South Korea. This current paper builds on this previous work and makes a contribution by assessing the economic impact of unification in Korea, under the hypothetical scenario of German-type unification and adjustments implying that North and South Korea decide to make a unitary state or a federation following an unexpected shock to

North Korea.

We first set up the baseline scenario where North Korea undertakes gradual economic reforms. This is close to the case of gradual reform that we explored in McKibbin et al (2018)— with a key difference being the initial gaps in sectoral productivity which in the current paper are based on recently estimated gaps which are larger than those assumed in the earlier paper. We also assume in this scenario that the central banks and fiscal authorities in North and South Korea remain independent with a floating exchange rate between North and South Korea. We then compare this scenario with a case where reform begins in 2019 but in 2024 there is a crisis in North Korea and an unanticipated unification occurs between North and South Korea. We assume the fiscal authorities continue to remain independent. In contrast, a single central bank administers monetary policy for both North and South Korea. We consider a case where North Korea maintains a fixed exchange rate with South Korea after the North Korean currency is revalued by 100%. This is intended to approximate the policy followed in East Germany. We assume that the labor markets in North Korea are separated from South Korea and the wage setting process is similar in North and South Korea but with different wage levels reflecting the difference between productivity in the two Korea. There is an initial increase in nominal wage in North Korea of 70%. We also assume some migration from North to South Korea scaled to the experience of East and West Germany as discussed below. We focus on assessing the dynamics of adjustment and convergence process of the Korean economy, compared to the experience of Germany, depending on assumption on economic policies adopted by the unified Korea after unification.

The organization of this paper is as follows. Section 2 summarizes the previous studies on Korean unification. In Section 3, we review German unification experience. Section 4 introduces our model, scenario and simulation results. We assess the similarities and differences between Germany and Korea. We conclude in Section 5.

2. Literature on impact of Korean unification

There is an interesting literature on estimating the economic impact of Korean unification. The existing studies adopt various methodologies such as static general equilibrium models, dynamic general equilibrium models, and cross-country comparisons.

One major strand of the literature builds static general equilibrium models to simulate unification scenarios. Noland, Robinson and Scatista (1997) construct a computable general equilibrium model of North Korea to simulate various scenarios of reform. They consider three scenarios: trade liberalization, productivity improvement and obsolescence of capital stock. Trade liberalization leads to a huge expansion of international trade with exports concentrated in light manufacturing and mining and imports concentrated in food and capital goods, and raises GDP by more than 30%. The productivity level improves by 18%, leading to a rise in GDP by 40–50%. These combined gains are sufficient to offset a reduction of 50% in capital stock due to obsolescence while maintaining the level of real household consumption. However, even if North Korea were to achieve trade liberalization and productivity improvement, the gap of GDP per capita between North and South Korea remains daunting. The capital transfer required to raise GDP per capita in North Korea to 60% of that in the South rises rapidly as the reform is delayed and their gap in GDP grows. In the same spirit of modeling,

Noland, Robinson and Wang (2000a, 2000b) use a two-country model to analyze economic integration between North and South Korea. They consider two scenarios: product market integration and factor market integration. For North Korea, product market integration generates large welfare gains. Additional gains could be reached through military demobilization. For South Korea, the impact of product market integration is trivial, but the impact of factor market integration is considerable, affecting the output composition, income distribution and growth rate. Given moderately rapid technological convergence, expected levels of cross-border migration and equalization of return rates on capital, GDP per capita in the North remains well below that in the South for an extended period.

Bradford and Phillips (2005) construct a standard dynamic general equilibrium growth model with unskilled and skilled labors distinguished and national defense considered, and use the model to examine the impacts of economic unification of North and South Korea in several scenarios. They consider four phased-in scenarios: 1) economic reform and openness in North Korea; 2) reduction of defense spending by 50% in both North and South Korea; 3) adoption of a free trade area between North and South Korea and of identical conscription and tax policies; 4) full economic integration with free goods trade and factor mobility between North

and South Korea. Their results suggest that the gains for North Korea in all scenarios are dramatic in the short run as well as in the long run. South Korea also gains from openness with North Korea, both in trade of goods and mobility of production factors. The major gain in South Korea comes with full integration due to the migration of labor. Wages of both unskilled and skilled workers in North Korea rise dramatically in every case while wages of skilled workers in South Korea are volatile especially in non-traded sectors.

Funke and Strulik (2005) set up a two-region endogenous growth model in which the productivity is determined by productive public capital and then evaluate the impacts of Korean unification. In the baseline, the relative productivity in North Korea is 10% compared to South Korea, and the government fully compensates lower wages in North Korea through lump-sum transfers and therefore there is no economic incentive for massive migration. The most important finding is that the speed of convergence is very fast, with the relative productivity reaching 50% after 10 years. Initially, over 50% of tax revenues in South Korea have to be transferred to North Korea for complete income compensation. They argue that the cost of unification would be higher with the division continuing as the delay of unification would further widen their income gap.

Bradford, Kim and Phillips (2011) construct a similar dynamic model but focus on internal reform within North Korea. They consider four scenarios of reform: 1) partial market reform in which producers choose capital allocations across sectors with the government fixing the total capital; 2) full market reform in which households choose consumption and savings and firms compete for labor and capital but the public infrastructure investment is kept unchanged; 3) full market reform with public infrastructure investment substantially increased. They find that, in the partial market reform, capital is reallocated dramatically from the government service sector to the manufacturing sector. This reallocation of capital raises the aggregate output in the short run only. The full market reform gives a further boost to output but can generate economic growth in the long run only with an expansion of infrastructure. They conclude that effective reform in North Korea requires not only market mechanisms but also infrastructure growth.

St. Brown, Choi and Kim (2012) build a growth model with productivity catch-up in which the

parameters are estimated from the German unification, and use the model to study the impacts of Korean unification. The baseline scenario of integration assumes that the productivity of North Korea converges gradually to 0.75 of the productivity of South Korea, South Korea suffers from a 15% loss in total factor productivity, the labor migration per year is 0.5% of North Korean population, and capital transfer is 4% of the GDP in South Korea for the first 15 years and 2% for another 14 years. Two optimistic and pessimistic scenarios relative to the baseline are also considered. They find that while North Korea gains due to its productivity catch-up to South Korea, South Korea's GDP per capita suffers from an immediate loss in productivity, which arises from a lack of resources, an increase in uncertainty, a fall of average human capital, and a rise in inefficiencies in South Korea. Choi and St. Brown (2015) adopt the modelling techniques and similar unification scenarios as in St. Brown, Choi and Kim (2012). They also emphasize the possibility of the substantial negative and persistent effect of unification on South Korean economy.

Mun and Yoo (2012) build a standard dynamic general equilibrium model of North Korea and introduce a number of features including a minimum wage system, a wage-productivity gap, an investment transfer, a wage subsidy and an unemployment benefit, and then use the model to analyze the effects of various types of Korean integration on economic performance in North Korea. The parameters of the model are calibrated based on German unification. The study focuses on the role of wage policy because wage policy is one of the major factors of unification costs. They consider three scenarios of integration: 1) a unitary state in which all markets are integrated; 2) a federation in which commodity and capital markets are integrated but labor markets are separated; 3) a special administration region in which all markets are separated. They find that the federation type of integration results in similar unemployment and growth patterns in North Korea to those observed in East Germany after the Germany unification, the unitary state type leads to higher unemployment and lower growth, and the special administration region type has lower unemployment and higher growth.

McKibbin et al. (2018) use a global dynamic intertemporal general equilibrium model and quantitatively assess the impacts of Korean unification on North and South Korea and the rest of the world under three hypothetical scenarios. In the first scenario of reform and gradual convergence in which North Korea gradually implements market-oriented economic reform

and opening and gradual unification between two Koreas occurs. The second scenario assumes that North Korea collapses and there is immediate unification between North and South Korea. The final scenario assumes a chaotic situation in which international investors lose confidence in the capability of the South Korean government to manage the sudden collapse of North Korea and the unification process. The simulation results show that with economic reform enabling fast productivity growth, North Korea can experience a double-digit GDP growth rate, as in the first scenario. If the unification process is gradual along an anticipated path, South Korea can mitigate the adverse effects of unification. On the other hand, costs would increase significantly if the process of unification is not handled well.

Another approach is using historical cross-country data to make projections on the impact of economic integration and unification in the Korean peninsula. Lee (2001) projects the future growth of North Korea conditional on various reform scenarios based on estimated results from a reduced-form model with cross-country data. Lee and Pyun (2018) adopt an empirical approach by relying on historical cross-country data on bilateral trade volume and foreign direct investment (FDI) flows. They estimate the effect of economic integration on trade and FDI flows of North Korean economy and then derive the quantitative estimates on North Korea's potential economic growth rate with increased trade and FDI integration. Jeong (2013) attempts to predict the possible changes of the economic system of North Korea by examining 27 countries that have experienced economic transition since 1990. The study classifies those countries into three transition groups (outstanding, fine, and poor transitions) according to their initial economic conditions and economic performance since their transition into market economy, and concludes that North Korea belongs in the poor transition group.

In a different approach, Auerbach, Chun and Yoo (2005) evaluate the fiscal impacts of Korean unification using generational accounting, considering the inter- and intra-generational redistribution of fiscal burdens among current and future generations of South and North Korea. The fiscal impact of Korean unification is much larger than that of German unification, due to a wider gap in productivity between North and South Korea and a much larger share of North Korea in the total population. The large fiscal burden on South Korea is attributable primarily to the rapid increase in social welfare expenditure for North Korea, rather than to the direct reconstruction cost of the North Korean economy. Early unification would result in a large

increase in the fiscal burden for most current and future generations of South Korea. Economic cooperation between the two Koreas, to help speed the growth of productivity in North Korea, could alleviate the unification burdens.

Wolf and Akramov (2005) consider three unification scenarios: (1) unification through system evolution and integration; (2) unification through collapse and absorption; (3) unification through conflict. Corresponding to these scenarios, they estimate the capital costs of doubling North Korea's GDP in four or five years without population movement. The capital costs are defined as the capital build-up costs, combined with institutional reform, minus the savings from downsizing the military.

3. The Experience of German Reunification

This section summarizes the experience of German unification. West Germany (the Federal Republic of Germany) and East Germany (the German Democratic Republic) opened the border between them in November 1989 and experienced a rapid process of political and economic unification.

3.1 Macroeconomic developments

The unification shock had devastating effects on the German economy in the early 1990s but the country has recovered from it over time. Nevertheless, there remained still persistent gaps in per-capita income and labor productivity between east and west regions even 15 or 20 years after the reunification.

Immediately following reunification, the East German economy collapsed. Between 1989 and 1991, East German GDP shrunk over 40% —a larger fall than that which the United States experienced during the Great Depression (Sinn, 2002), and then recovered to the pre-reunification level after 1998 (Figure 2). Employment saw a similarly drastic drop after the reunification, although it failed to see the same return to original levels that GDP experienced (Smolny, 2009). According to Akerlof et al. (1991), the post-reunification depression was largely a result of the decision to increase wages to equal those of the West, which forced Eastern wages above the market-clearing level. As the former state-run firms in the East were

less productive than Western firms, the sudden increase in wages made it extremely difficult for producers to cover their variable costs and produce at market prices. Combined with a decreased demand for East German goods as imported products became more affordable, this caused a significantly adverse shock to the East German economy.

The increased marginal cost of labor which contributed to the region's economic depression also led to a sharp increase in unemployment. At the same time, the government's investment incentives encouraged both new and surviving firms to pursue capital-intensive production rather than labor-intensive production (Sinn, 2002). This led to a lower number of jobs, and so subsequently increased unemployment.

In 1991, East German unemployment rate was already over 10%, and surpassed 15% only a few years later (The Economist, 2015). This phenomenon did not disappear when the East German economy began to recover, and unemployment rate actually continued to rise into the mid-2000s. Although the high unemployment was clearly a serious problem for the German economy, the Euro Area showed similar increases during this period, so it is difficult to say how much of the unemployment increase was a result of the Eastern economic downturn, and how much was a result of general regional trends.

Between 1991 and 1997, the East German economy began to recover — averaging a growth rate of 8-9%, although this growth slowed to 1-2% annually after 1997 (Figure 3). The recovery may be partly attributed to the high levels of investments in the early- and mid-1990s. During this period, investment was focused largely on East Germany where investment was nearly 50% of GDP between 1992 and 1995, while in the West this figure was only around 20%. However, the allocation of investment funds may not have been very efficient in the East. Burda (2008) claims that “distorted investment incentives” led to investment in the East being disproportionately used for the building of residential and business structures, with only about 1/3 going into business fixed equipment. The investment incentives also discouraged firms from hiring more workers, further enforcing the damage done by high wages to employment levels (Sinn, 2002).

Since West Germany needed to funnel a part of its investment funds into East Germany, it had

some negative consequences for the West. While East Germany experienced high rates of real GDP growth following reunification, this did not happen in the West. West Germany's real GDP growth in the early-1990s remained under 2%, and even saw a negative 2% growth rate in 1993 (Figure 3). However, East German investment rates began to drop in the mid-1990s, at which point investment rates in the West began to rise slightly, albeit much less dramatically than the decline in East German investment. As a result, investment rates in the two regions became more comparable (Burda, 2008). Likewise, real GDP growth converged, with West Germany overtaking the East's growth rate in 1997 (Sinn, 2002).

3.2 Convergence in per-capita income and wage

In the first seven years following reunification, East Germany experienced relatively quick convergence with the West. However, over time this convergence has slowed, and many discrepancies remain between the regions.

In 1991, GDP per capita in the East was less than half of that of the West. By 1996, the gap had narrowed significantly, increasing this figure to 67%, but little progress has been made since (Burda, 2008). East German states still rank the lowest in terms of jobs and income, despite the region having the highest education levels in the country (Federal Ministry for Economic Affairs and Energy (BMWi), 2016), showing that serious challenges to the regions.

Nominal wages converged quickly following reunification, owing to government regulations and the decisions of Western labor unions. Immediately following reunification, Eastern wages jumped from 7% of those in the West to 37% because of the decision to implement a 1:1 currency exchange rate between Deutsche Marks and Ostmarks, as well as the outcomes of early labor union negotiations (Sinn, 2002). Eastern nominal wages continued to rise from half of those in the West to three-quarters between 1991 and 1997 (Burda, 2008). Since then, however, Eastern wages have stagnated and workers in the East still make significantly less than Western laborers with similar characteristics (Burda, 2008), although there are some specific situations where this is not true. According to Gernandt and Pfeiffer (2009), wages converged faster for commuters—who received approximately 85% as much as their Western counterparts in similar characteristics and full wage convergence occurred for migrants from

East to West Germany. Although wage convergence may be a sign of progress, the sharp wage increase in the East also led to high unemployment rates in the East that remained about twice as high as in the West over the period 1991–2007 (Burda, 2008).

Despite immediate gains in the years following reunification, Eastern Germany is still experiencing issues of low labor productivity, which has stagnated at around 78% of that in the West (Figure 4). There have been a substantial body of researches that investigated the East's low productivity (Fuchs-Schündeln and Izem, 2012). Snower and Merkl (2006) suggest that it is a result of West German “caring hand” measures that led East German workers falling into “traps” that prevented increases in productivity. The high wages and resulting unemployment made workers unable to receive on-the-job training to increase their productivity— a trap exacerbated by investment incentives which encouraged capital— rather than labor-intensive production. Specific human capital embodied in East German workers depreciated at the time of unification since it did not match the skill requirements typically used in West German labor markets. Likewise, as unemployment encouraged younger workers to migrate, the East was left with older workers with older skills. Thus, human capital endowment of the East German economy further deteriorated because of selective migration, impeding a fast convergence in productivity between East and West Germany (Ragnitz, 2006). Burda and Hunt (2001) find that directly following reunification, East German migrants did not receive much return to their education, but by 1999 they had nearly equal return to education as Western workers. They also found that Eastern workers saw a negative return to experience between 1989 and 1999. These facts suggest that at the time of reunification, Eastern skills and experience may have been significantly worse than those in the West, and thus – if true – the older workers who remained in Eastern Germany had highly outdated skills.

The low labor productivity may also be attributed to job characteristics, rather than worker characteristics. Some studies point out the over-fragmentation of the East German economy. Only a third of Eastern industrial workers are employed in in companies with a workforce over 250, while in the West over half of these workers are, although the number of large companies in Eastern Germany has been rising in recent years. The high level of fragmentation has also led to low levels of private-sector R&D funding in the East which is typically undertaken by larger firms (BMW, 2016). Other possible reasons for the low productivity include managerial

and organizational deficiencies (Yellen, 2001) and agglomeration effects (Uhlig, 2006). In their study of unemployment between 1998 and 2004, Fuchs-Schündeln & Izem (2012) find that unemployment increases the further a county is from the former East-West border. Workers living in East Germany but with the possibility to commute to the West can find jobs there. Therefore, even if differences in skill may account for labor productivity differences immediately following reunification firm differences must account for the remaining productivity gap.

The flow of capital into Eastern Germany at the expense of the Western investment also led to deep structural changes between the two regions. The capital inflow caused Eastern capital-labor ratios to increase drastically, and even overtake Western ones in certain areas – including the overall production sector. As a result, since reunification, much of the industrial production previously located in the West has shifted to the Eastern states. While Eastern Germany's share in manufacturing increased, Western Germany has seen many secondary sector jobs taken over by tertiary sector jobs, leading the two regions to become structurally dissimilar. Although it is true that West Germany was already seeing this trend prior to reunification, the rise of manufacturing in the East increased its speed significantly in the early-1990s (Burda, 2008).

3.3 Labor migration

There were significant migration flows to the West, amounting to 2% of East German population during 1989 and 1990 (Figure 5). Since 2000, annual net outmigration has averaged roughly 64,000 or 0.4% of the Eastern population and was especially concentrated among the youth (Uhlig 2008). Better job opportunities and higher wages in West Germany attracted East Germans, even though migrants may lose some of their specific human capital when they work in West Germany. East German total population and working-age population shrank gradually, compared to the West's.

As discussed earlier, the extreme hike in wages was one of the main reasons that eventually led to a crippling of the Eastern economy. While West German labor unions claimed to support a rise in Eastern wages out of “solidarity and equality with Easterners”, their true reasoning was to prevent mass migration to the West. The mass migration would have threatened the job

security of West German laborers, as well as decreased wages – both clearly unfavorable for Western workers. The government’s decision to implement West German unemployment benefits to Eastern workers may have helped to reduce the pressure on outmigration. Upon reunification, East Germany received the same generous unemployment support. On the other hand, this placed upward pressure on wages, which remained even once the East gained power to choose their own wage regulations and continued to affect the Eastern economy to this day.

In 1991, Akerlof et al. predicted that “The real cause of most migration from East to West will be lack of Eastern jobs, not wage differential”. Their fear of mass migration was not misplaced; in the first 15 years following reunification, nearly 10% of the East’s population moved to the West in search of better opportunities. Of these migrants, the largest group those aged between 30 and 49 years old. This was especially true for the period leading up to 1993 when – as Akerlof had predicted – many families left Eastern Germany for the West after losing their jobs. Young adults (aged 18-29) have also had a high tendency to migrate since reunification, particularly during the late-1990s when Germany was hit by economic crisis (Uhlig, 2008; Glorius, 2010).

Because of migration, East Germany also suffered from “brain drain”. Statistics show that of the migrants who left East Germany between 1999 and 2003, 32% held a university entrance certificate, despite only 18% of East Germans at the time having this qualification (Glorius, 2010). This shows that – along with losing potential workers – East Germany was also losing significant human capital. While many of those who left did so seeking employment, a large portion also went West for their tertiary education. The data also show that highly-qualified occupations (such as engineers and technicians) were overrepresented in the population of migrants from the East.

3.4 Fiscal and monetary policy

Following reunification, the West German government had to decide how best to integrate the East which Hunt (2006) described as “a region with decrepit infrastructure, outdated technology and no capitalist experience”. Part of the critical decision was how much money to transfer to the East, and how this money should be apportioned between consumption and

investment, as well as capital and labor. Because of their decisions, West Germany had transferred 940 billion Euros to the East between 1991 and 2003, and East Germany had a fiscal budget per resident about 15% higher than that in the West (Uhlig, 2008). These transfers amounted to 4-5% of the West's GDP and initially constituted over 50% of Eastern GDP, although after the East began to recover this fell to 33% (Hunt, 2006).

About a half of West German transfers went into social assistance – such as unemployment and retirement benefits – and, as a result, these transfers paid for 25% of private consumption in the East (Snower and Merkl, 2006). Another 12% of the transfers was allocated to subsidies for building infrastructure (Sinn, 2002). Although the “solidarity tax” introduced following reunification succeeded in raising 90 billion Euros between 1991 and 2000, most West German transfers to the East were paid for by increasing the national debt (Uhlig, 2008). However, despite financing these transfers through debt, German central government debt did not rise too high, fluctuating around 40% by 2008, lower than the figure of the overall European Union (World Bank, 2016). Likewise, East Germany had a large current account deficit – of which 2/3 was financed by the West German transfers – but the country as a whole had maintained a balanced current account.

Despite Germany as a whole still performing well economically, many argue that the generous transfers from the West have in fact crippled the Eastern economy and prevented continuing convergence. Sinn (2002) argues that a market solution would have been more effective at promoting convergence between the regions as “commodity trade, capital movements, and the migration of people” would have led to equalization of factor prices over time. Instead, the German government's attempt to artificially create this equilibrium has been described by Sinn (2002) as “a serious and expensive mistake”.

Following reunification, the West German government decided to pursue monetary union by unifying the East and West German currencies with a one-time upward revaluation of the Eastern Ostmarks ('Mark') – mainly for political reasons rather than economic ones (Hunt, 2006). The one-to-one exchange rate was applied to flow variables such as prices and wages, while another conversion rate of two Mark to one western DM was applied for stock variables

such as savings and debts.¹ The overvalued exchange rate is seen by some as a significant factor in East Germany's economic downturn. The sharp appreciation decreased costs of imported inputs by over 75%, encouraging Eastern industries to favor the use of imports rather than domestically produced materials (Akerlof et al. 1991). Likewise, real prices of imported consumer goods declined, leading to lowered demand for East German goods. The exchange rate appreciation also had an unfavorable impact on East German exports which had already been hit heavily by the collapse of the Soviet Union and the Council for Mutual Economic Assistance (COMECON) trade bloc. It also led to a rise of the non-tradeable sector in the region (Snower and Merkl, 2006). This included a rise in the construction sector in Eastern Germany, and the significant boom-bust cycle in this industry has had long term consequences for the region.

However, some argue that the choice of a one-to-one exchange rate was not a significant factor in Germany's reunification experience. This is because a change in the nominal exchange rate does not necessitate a further change in the real exchange rate (Hunt, 2006). This view supports the idea that other factors – such as the decision to artificially raise wages – were of greater consequence than exchange rate policy.

4. Simulation of the Consequences of Unification

We adopt the G-cubed model of McKibbin et al. (2018) to analyze the economic effects of the German-type unification on Korean economy. The G-Cubed model, which is an intertemporal general equilibrium model of the world economy, considers an inter-industry input-output structure, factor movements and dynamics of consumption and investment and incorporates spillovers across industries within economies as well as across the border through trade and financial linkages. The main features of the North Korean economy and G-Cubed model are

¹ In early 1990, East Germany publicly revealed the "shadow exchange rates" which were used internally to convert deutsche mark, dollars and ruble into mark. The conversion rates in 1989 were 1 deutsche mark = 4.4 Mark; 1 U.S. dollar = 8.14 Mark; and 1 transfer ruble = 4.67 Mark (see Akerlof et al., 1991).

outlined in McKibbin et al. (2018).²

In order to explore the unifications scenarios, we need to have a baseline scenario with which to compare. In McKibbin et al. (2018) we assumed North Korea remained a closed and isolated economy in the baseline scenario. In the current paper we assume that in 2019 North Korea begins to open the economy and follow a path of economic reform, much like the scenario in the previous paper of “gradual convergence and reform”. The two key differences to the earlier paper is that we use the productivity differentials of the six North Korean Sectors from the equivalent South Korean Sectors.³ These gaps are much larger than those assumed in the earlier paper. In order to approximate the growth rate of productivity in “gradual convergence and reform” scenario the earlier paper we also assume slower catchup to the frontier sectors. Specifically, we assume that each North Korean sector closes the gap to the frontier US sector by the (arbitrary) time path of the catchup rate by 0.02% until 2024 when the catchup rate remains at 0.1% per year forever. This can be considered gradual reform. The South Korea catchup rate remains at 2% per year to the United States over the entire period.

We also assume that South Korea transfers 0.5% of South Korean GDP per year to North Korea through direct payments. These transfers are allocated half to government spending in North Korea and half to consumers through direct transfer payments. In North Korea, the total payments are 23% of North Korean GDP which gives a large boost to households and to government spending in North Korea.

Figures 6 and 7 show the time paths of major macroeconomic variables of North Korea in this baseline scenario of gradual reform. By 2023, North Korean GNP is 80% higher than 2019 although GDP is only 12% higher than baseline. In this reform scenario, economic growth in North Korea rises to 5% by 2023 through increased investment, higher consumption and higher government spending that supported a productivity increase. By 2023 the North Korean real

² A number of studies have used the G-Cubed model or its earlier version to assess a range of issues related to German unification (McKibbin 1990; Gagnon et al. 1996).

³ McKibbin et al. (2018) presents the estimates of sectoral labor productivity of North Korea in 2008, but does not consider the initial productivity differentials across sectors in the simulations.

exchange rate has appreciated by 80% relative to 2019 and real interest rates are 400 basis points higher by 2023 compared to 2019.

4.1 The unification scenario

In this scenario we assume that North Korea will implement market-oriented economic reform while gradually opening to the world economy beginning from 2019 (exactly as above). Thus, both scenarios are the same until 2024.

We assume that in 2024 there is the completely unanticipated collapse of North Korea and unification between North and South takes place abruptly.⁴ A chaotic situation is assumed to occur for a year and then an orderly process of comprehensive reform in North Korea and sectoral productivity convergence between North and South takes place (this also leads to income convergence). This unification process has many similar characteristics to those of German reunification as described in Section 2. But, the details need to be modified due to the specifics on the North Korean situation, and some of them (such as defense spending cut after unification and North Korea's trade and direct investment integration with global markets) cannot be considered in these simulations. There are many new assumptions that are needed to make the scenario more plausible. The major assumptions in our unification scenario are as follows:

- i) One-third of physical capital stock in all North Korea sectors becomes obsolete immediately in 2024. Labor productivity also falls by 30% over the first two years. Although arbitrary in size this generates approximately the collapse in the value of capital and rise in unemployment in East Germany once the communist planning economy had collapsed.
- ii) Comprehensive economic reforms begin to be implemented in North Korea from 2025 and the convergence process accelerates at a faster pace than in the previous

⁴ Technically this is a challenge to implement in a model like the G-Cubed model, because some agents have rational expectations. We use a technique of rolling simulation where we run the model from 2018 until 2100 assuming the information set in 2018. We then roll the model forward. We then shock the model in 2024 with the new information of a collapse in North Korea. The dynamics inherited by 2024 are from the gradual reform scenario but the forward looking variable in 2024 jump to the new path.

reform period. We assume that the catchup rate rises by 0.2% per year, starting from 2025 until it reaches 2% per year.

- iii) There are larger fiscal transfers from South Korea to North Korea compared to the previous reform period without unification. These amount to an addition 46% of North Korea's initial GDP (1.0% of South Korea's initial GDP) – of which 50% are assumed to be used for direct transfers to households, and the other 50% is used to investment subsidy and to build public infrastructure. Note that the total transfers in 2024 are 1.5% of South Korea GDP. The fiscal transfers are financed by an increased budget deficit in South Korea.
- iv) Labor productivity in South Korea drops by 1% per year consecutively for three years after the unification. Considered what happened to West Germany, the unification shock can lead to decline in average human capital and economic efficiency and institutional quality. In addition, due to the uncertainty in the North and South Korea's ability to handle unification, there is a sharp jump in the country risk premium of South Korea of 500 basis points (5 percentage points) in 2024 and then gradually falls back to baseline by 0.5% per year until back at baseline by 2034.
- v) There are migrants moving from North to South Korea every year equal to 2% of the North Korean population or 1% of South Korea's population over the first two years and afterward 0.4% over 15 years. This is scaled to the East German case.
- vi) Capital controls are removed in North Korea although higher risk slows the movement of capital into North Korea for a decade.
- vii) We assume the North Korean exchange rate is fixed to the South Korea Won at a rate 100% higher than before the collapse.

4.2. Simulation Results

The results for the gradual reform scenario and the unification scenario in North Korea are shown in Figures 6 and 7 for North Korea and Figure 8 for South Korea. The first panel in Figure 6 and 8 show the rate of economic growth for each economy from 2023. The remainder of these figure show major variables expressed as an index relative to 2023 for the gradual reform versus the unification scenario under a fixed exchange rate. It should be noted that in McKibbin et al. (2018) we modeled a floating exchange rate regime during unification with an independent North Korean monetary authority.

The gradual reform in the baseline is the dotted line. As expected it shows a gradual rise in real GDP, consumption and investment over time in North Korea. By 2023 the North Korea real exchange rate has appreciated by 30% relative to 2018 (not shown).

In the unification scenario, there is a sharp decline in real GDP with the collapse in the capital stock and fall in labor productivity. There is a deep recession in North Korea in 2024 with the real GDP growth rate falling from 5% to negative 16%. The top right panel of Figure 6 shows the level of real GDP and it is clear that the level of real GDP does not recover to the pre unification level until 2028 but it is below what it would have been without the collapse as shown by comparing the gradual reform scenario with the pre unification scenario.

Investment initially falls sharply under unification with the index by 2025 at -0.2 which is 20% less investment than in 2023. Consumption however rises largely due to the fiscal transfers from South Korea which can be seen in the change the real GNP which comprises real GDP plus net income transfers from South Korea. It is clear that without the fiscal transfers going to households and the government in North Korea, the impact of consumption would be dramatically negative.

The estimated effects of the unification shock on the North Korean economy depend critically on the assumptions imposed in the scenario, particularly on the nature of wage-adjustment, exchange rate policy and fiscal transfers from South Korea. For example, if North Korea adopted floating exchange rate, the magnitude of recession in North Korea in 2024 can be mitigated significantly.

It is clear that after the initial collapse in North Korea, the responses of variables are similar to that experienced in Germany. Economic growth recovers in North Korea but the level of real GDP and incomes take a long period to rise. Eventually investment rises due to higher productivity resulting from the faster pace of economic reform after 2025 and real wages also rise reflecting initially a sharp rise in the nominal wage and then reflecting the higher marginal product of labor in North Korea over time.

The results for South Korea are shown in Figure 8. Again, the dotted line is the scenario of gradual economic reform in North Korea. The dark line is the results for the unification scenario. As with the experience of West Germany, unification reduces the growth rate in South Korea. This partly reflects the transfers of resources out of the South Korean economy into North Korea. It also reflects an increase in risk on the Korea peninsula (captured by rise in the country risk premium) which causes investment to drop. The GDP growth rate falls to 2% which is not a recession in South Korea because underlying GDP growth was 4.5%. Over time the growth rate in South Korea rises above the growth rate that would be expected from the baseline scenario of gradual reform in north Korea. South Korea's potential growth rate is gradually declining over time due the catchup of productivity as South Korea approaches the technological frontier and due to demographic factors.

The results show that under the hypothetical unification scenario, South Korea can overcome the adverse effects of unification in a short period and sustain its growth along the long-term steady-state path. These results are critically dependent on the assumptions on the fiscal transfers and migration. Given that the relative sizes in population and per capita GDP of the two Koreas are very different from those of East and West Germany, unification could bring about much larger migration and much larger fiscal transfers than assumed here, causing more disruptive effects on South Korean economy.

5. Concluding Remarks

This paper analyzes the economic impact of Korean unification on North and South Korea. Using a global dynamic intertemporal general equilibrium model, the paper explores the hypothetical scenario that German-type unification occurs in the Korean Peninsula. The simulation results show that while the unification can bring about disruptive effects on both North and South Korea, North Korea could experience its strong growth potential and South Korea could also handle the unification process and manage sustained growth.

The critical assumption of the simulations is that the unification process is managed peacefully, and North Korea adopts comprehensive market-oriented reform and opening after the unification. However, the process of Korean unification must be highly uncertain. It could

involve a disastrous military conflict on the Korean peninsula and instability in Northeast Asia. The reform even after the unification could be too slow and limited for North Korea to seize its growth potentials.

There are many more scenarios that the framework developed in this paper can be used to explore. One of the important issues that could be explored further is the assumptions of labor market adjustment. We have assumed similar (although separate) wage setting processes in North and South Korea. We could explore a single Korean labor market or subsidies for employment of workers from the North. There are also a number of different assumptions about the monetary regimes in a unified Korea. Would the monetary system be like the Euro model with a single central bank setting interest rates to balance output gaps and inflation relative to targets on average across the monetary union? We could also explore the fiscal implications of unification under different assumptions how unification is financed. In this paper we assume that South Korea borrows the funds through running a fiscal deficit which implies a model-determined mix of foreign and domestic borrowing. An alternative assumption could be a unification tax as well as further other fiscal measures. These assumption and further test of the sensitivity of results to model assumptions will be the focus of future papers.

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Table 1. Comparison of South and North Korean Economies, in 2017 or the latest year

	(unit)	North (A)	South (B)	A/B*100 (%)
Gross National Income	(KRW, billions)	36,631	1,730,461	2.1
Per Capita GNI	(KRW, thousands)	1,464	33,636	4.4
Population	(thousands)	24,897	51,246	49
Population aged 15-64	(%)	69.9	72.6	96
Total Fertility Rate	(births per woman)	1.9	1.2	158
Life Expectancy at Birth	(year)	70.8	81.3	87
Total Trade	(USD billion)	5.5	1,052.2	0.5
Exports		1.8	574	0.6
Imports		3.8	478	0.8
Power Generation	(billion KWh)	2.4	540	4.4
Crude Oil Imports	(thousand barrel)	3,885	1,078,119	0.4
Grain Production	(thousand M/T)	3,859	3,972	97
Rice Production	(thousand M/T)	2,192	3,972	55
Coal production	(thousand M/T)	1,726	31,060	1800
Iron Ore production	(thousand M/T)	5,249	445	1180
Length of Railways	(km)	5,226	3,918	133
Length of Roads	(km)	26,176	108,780	24

Source: The Statistics Korea

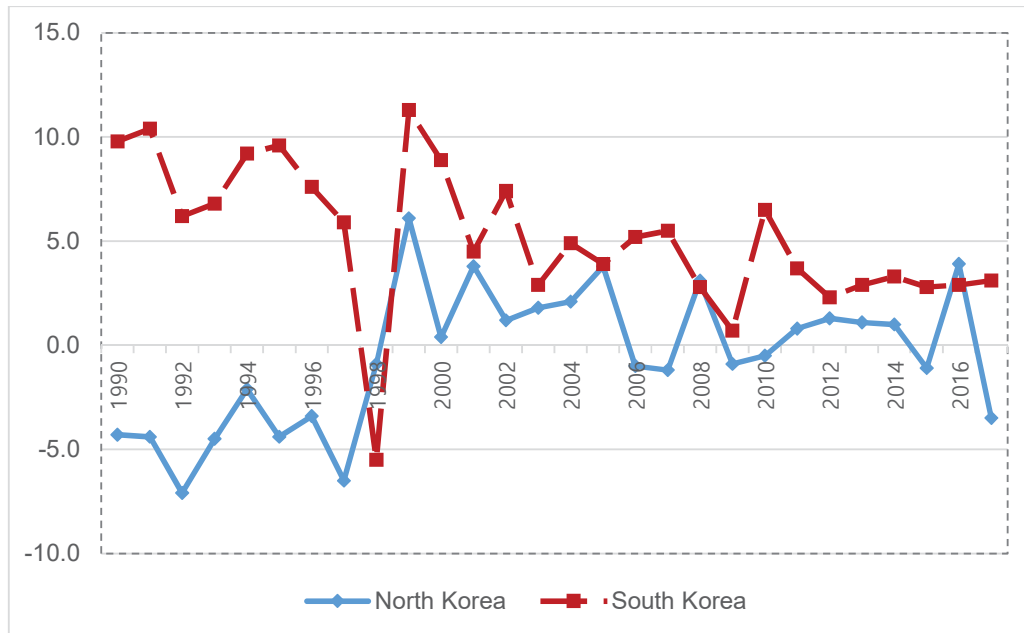
Table 2 Economies and regions in the G-Cubed model

United States	North Korea (PRK)
Japan	China
Australia	India
Europe	Eastern Europe the former Soviet Union
Republic of Korea (KOR)	Oil Exporting Developing Countries
Rest of OECD	Rest of the World

Table 3 Sectors of Production in Each Economy

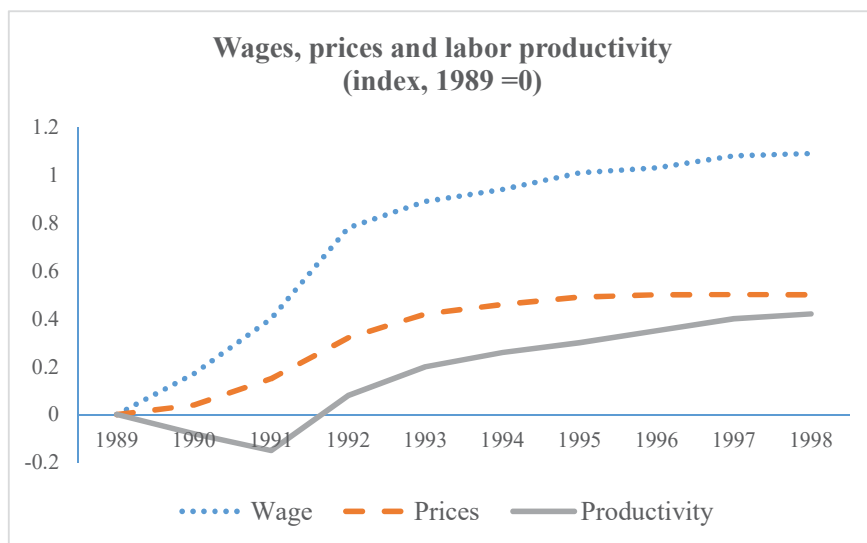
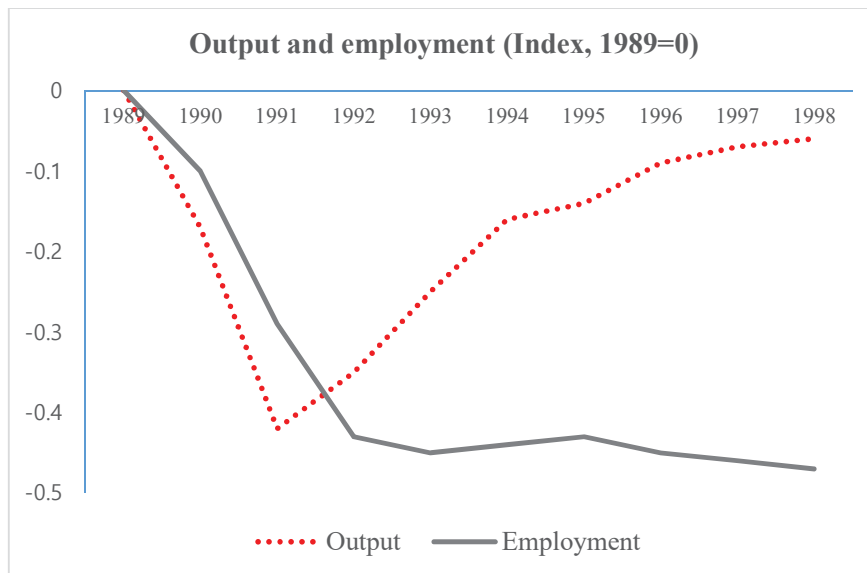
Energy	Durable manufacturing
Mining	Non-durable manufacturing
Agriculture	Services

Figure 1. Growth Rates of Real GDP, South and North Korea (%)



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

Figure 2. Macroeconomic Developments of East Germany after Reunification



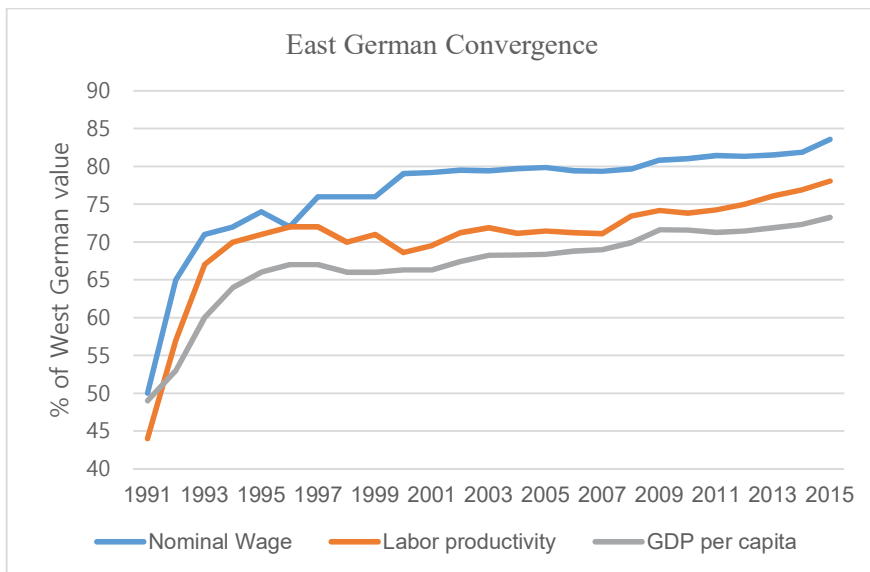
Source: Smolny (2009)

Figure 3. GDP Growth Rates in East and West Germany after Reunification



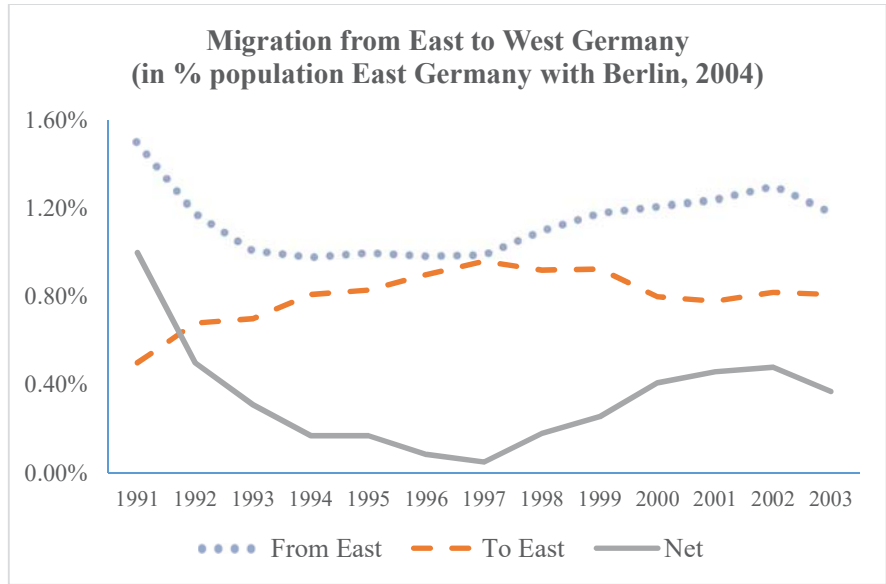
Source: Volkswirtschaftliche Gesamtrechnungen der Länder (2017). Bruttoinlandsprodukt, Bruttowertschöpfung in den Ländern der Bundesrepublik Deutschland 1991 bis 2016, Reihe 1. (https://www.destatis.de/DE/Publikationen/Thematisch/VolkswirtschaftlicheGesamtrechnungen/VGRderLaender/VGR_LaenderergebnisseBand1.htm)

Figure 4. Convergence of East Germany



Source: Data for 1991 – 1999 come from Burda (2008) and data from 2000 – 2015 are from Volkswirtschaftliche Gesamtrechnungen. der Länder (2017)

Figure 5. Pattern of Migration after German Reunification



Source: Uhlig (2008)

Figure 6: North Korean Baseline of Gradual Reform versus Collapse and Unification

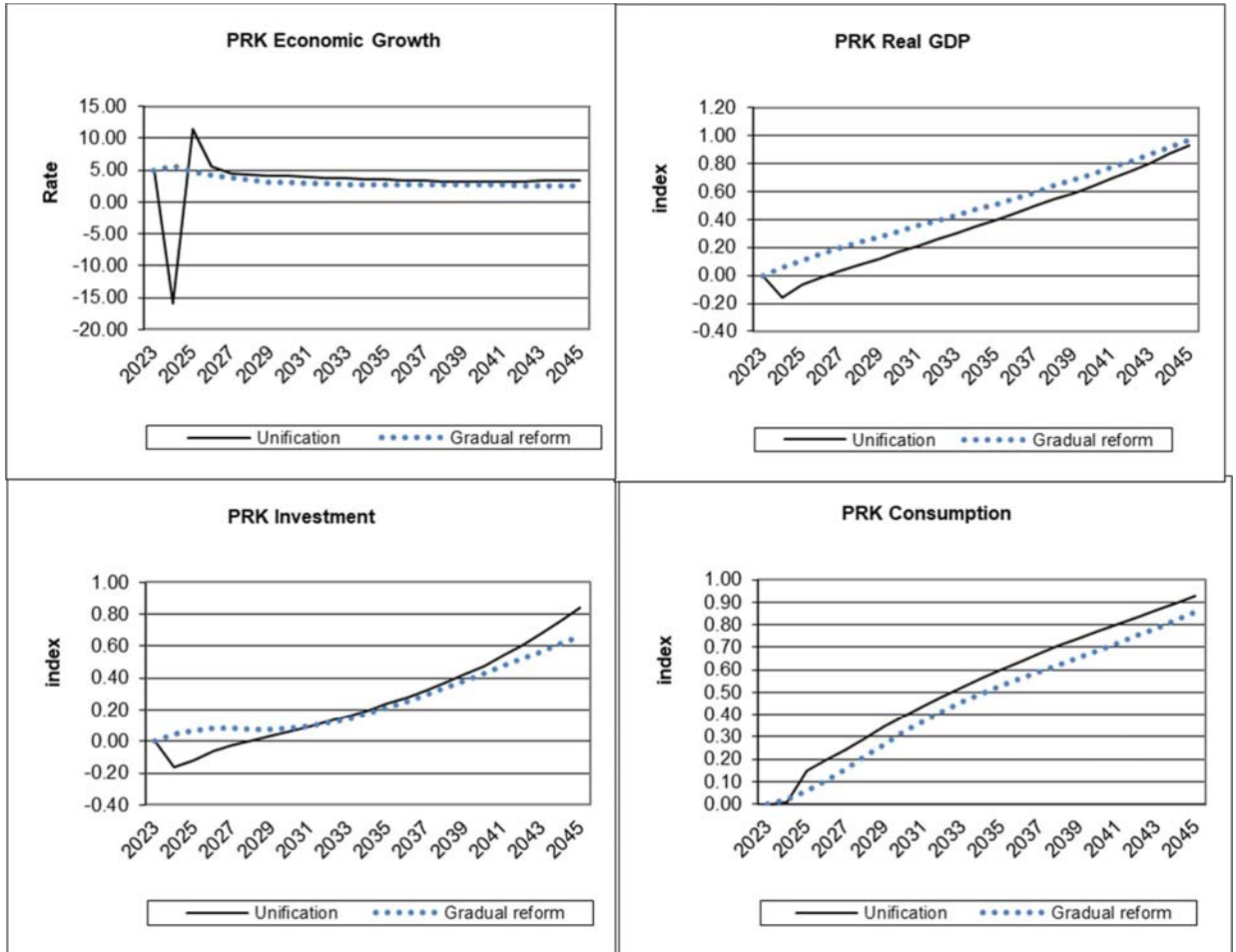


Figure 7: North Korean Baseline of Gradual Reform versus Collapse and Unification

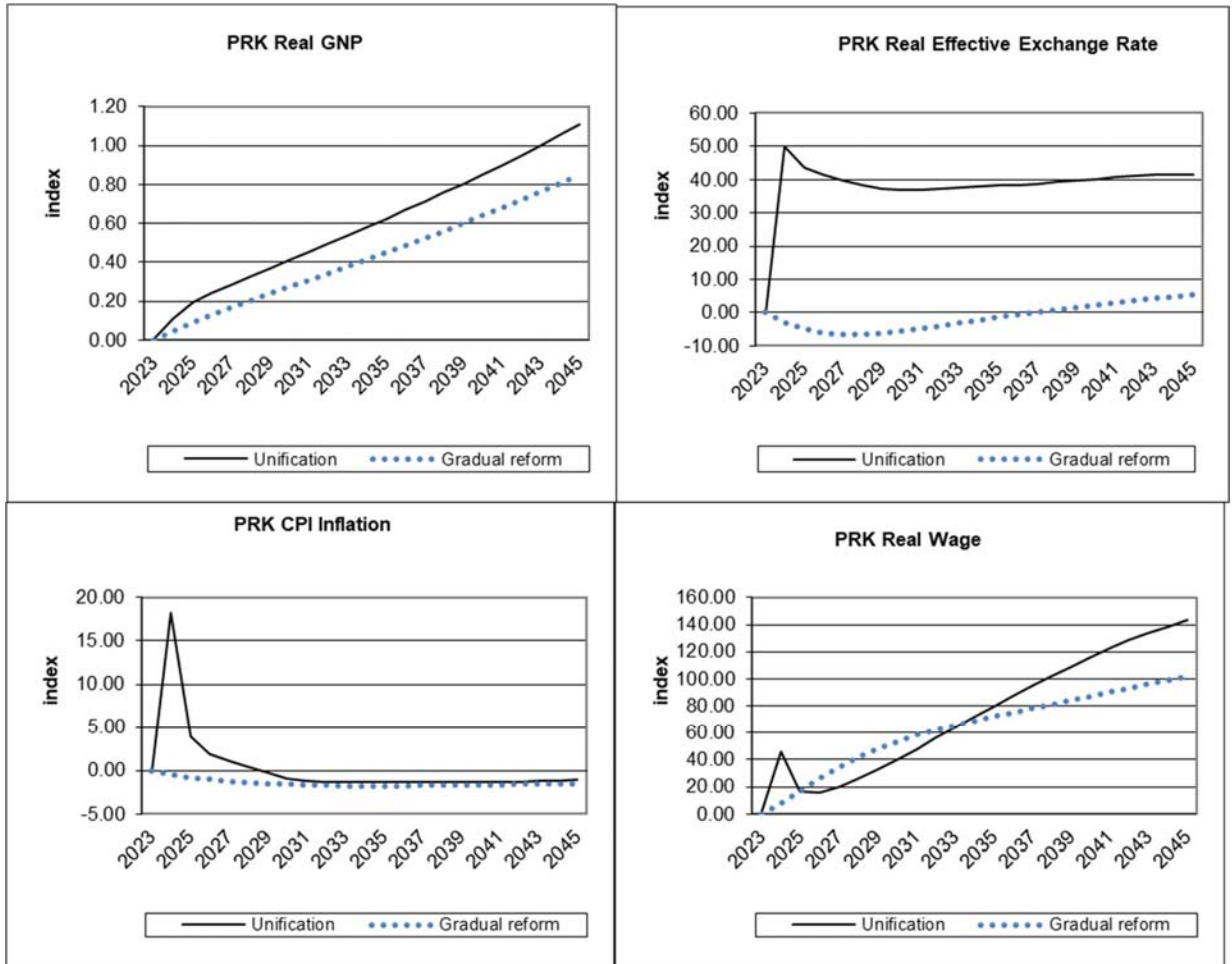


Figure 8: South Korean Baseline of Gradual Reform versus Collapse and Unification

