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# Calibrating the Costs (and Benefits) of Unification

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## Introduction

This chapter reports simulation results derived from a simple dynamic computable general equilibrium model of North Korea-South Korea economic integration. We focus on the macroeconomic impact of several economic integration scenarios. The scenarios presuppose some kind of political rapprochement between North and South Korea as a prerequisite for a significant deepening of economic integration. One possible avenue would be political unification, but this is by no means necessary and the results reported herein do not presuppose it. In this sense, the shorthand of the chapter's title is misleading: unification would be a sufficient, though not necessary, condition for the simulations that we report.

We believe the quantitative analysis of the costs and benefits of economic integration between North and South Korea that we present is both innovative and informative. But it is probably wise at the outset to note some issues that the chapter does not address. We do not explicitly attempt to estimate the "peace dividend" that presumably would arise from military demobilization, nor the dividends from the elimination of duplicative governmental activities if there were political unification, though implicitly these are captured by the reallocation of labor and

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other factors of production that occur in the context of economic integration as we model it.[1] Similarly, while we present results on possible cross-border labor migration, we do not attempt to analyze negative congestion externalities or other spillover costs associated with significant population movements. Rather, our focus is on the implications of economic integration for the macroeconomic performance of the two economies.

## Single-Country Static Model Results

Noland, Robinson, and Scatasta (NRS, 1997) produced an eight-sector computable general equilibrium (CGE) model of the North Korean economy calibrated for 1990, the most recent year for which reliable data were available. This modeling work focused on three issues: the static income gains due to trade liberalization, the potential for increased total factor productivity (TFP) through technological change, and the prospective "obsolescence shock" to the existing capital stock associated with the economic opening. The principal results obtained through this work are that the North Korean economy is extraordinarily distorted and that under the best-case scenario (complete trade liberalization and capture of the TFP gains) national income would increase on the order of 50 percent, depending on the precise specification of the model. However, these gains could be negated largely if not completely if the North Korean capital stock is subject to an "obsolescence shock" similar in magnitude to that experienced by East Germany—that is, a half to two-thirds reduction in the capital stock's estimated pre-liberalization value. Under liberalization, North Korea experiences enormous shifts in the composition of output. Light manufacturing and mining boom, and the share of international trade in the economy more than quintuples.

This model was then used to estimate the "costs of unification," defined as the capital investment in North Korea needed to raise North Korean per capita income to 60 percent of the South's—a figure conventionally thought to eliminate the incentives for mass migration. According to the NRS model, the cost of unification in 1990 would have been $319 billion. However, with North Korean income falling and South Korean income rising, the capital investment necessary to attain the 60 percent target

1. Bae (1996) among others has attempted to do just this kind of accounting. He concludes that in the mid-1990s, the annual "peace dividend" for the two economies, broadly defined, would have been on the order of $7 billion. However, this estimate (like earlier ones) is based on military budget expenditure rather than on the more appropriate opportunity or shadow cost measure of resources used by the military. Our modeling work implicitly embodies the latter approach in its treatment of the reallocation of resources in the context of economic integration.

increased to $754 billion in 1995, and was projected to rise to $1,721 billion in 2000.

## Two-Country Static Model Results

Noland, Robinson, and Liu (NRL, 1997) extended the NRS model by linking it to a similar CGE for South Korea. Using this two-country model, NRL simulated the effects of the formation of a Korean customs union and a Korean monetary union. In the case of the customs union, the impact on the South Korean economy is slight—relative to South Korea, the North Korean economy is small, and trade with North Korea simply substitutes for trade with other partners. However, for North Korea the effect is dramatic and similar to that obtained in the earlier NRS single-country model. One might think of the formation of the Korean customs union in terms similar to the implementation of the North American Free Trade Agreement—big effects on the small partner, small effects on the big partner.

More substantial effects on the South Korean economy are obtained when the two countries form a monetary union and cross-border factor mobility is permitted. The two-country setup also permitted NRL to examine the issue of technology transfer in a more detailed way than in the NRS single-country work.

In the single-country model, TFP increases as a function of the importation of capital goods from developed countries—imports that embody technological innovation. In this scenario, the economy experiences a sectorally uniform increase in TFP as capital goods from developed countries are imported. However, in the original econometric research done by Coe, Helpman, and Hoffmaister (CHH, 1997), South Korea was not counted as a developed country—so North Korea would not get any "credit" for importing capital goods from South Korea. Although the CHH approach is surely defensible, given the sample period of their data set, it is less appealing in the present context.

In the NRL model, two additional approaches to modeling technological change are adopted. In the first, the sectoral level of North Korean TFP rises to the level of the South's as a function of capital investment. This means that unlike in the CHH approach, the increase in productivity is not uniform across sectors—in sectors such as agriculture where the North Korean technological disadvantage was relatively slight, there would not be large increases in TFP, whereas in other sectors, such as capital goods, the increase could be enormous.

In the third approach to modeling technological transfer, North Korea is assumed to adopt South Korean technology as a function of capital investment. This means that North Korea not only achieves South Korea's TFP level but adopts its underlying intermediate input use patterns as

well. The main impact of this is to reduce the amount of intermediate inputs to production that North Korea wastes in the production of final goods.

This model can also be used to study the costs of unification. The results can differ from those obtained by NRS because in the two-country setup (a) technological change can be modeled differently and (b) cross-border labor flows can substitute for capital flows in achieving the per capita income target.

In the NRL two-country model, if North Korea successfully adopts South Korean technology and no cross-border labor migration is permitted, the capital investment needed for per capita income to reach 60 percent of that in the South is roughly $240 billion (in 1990). If no investment occurs and the target is reached solely through labor migration, then roughly three-quarters of the North Korean population heads south. NRL also explores intermediate cases in which both capital and labor move, as well as the resulting impact on the distribution of income in South Korea. The effect is to contribute to increased income and wealth inequality.

In the work described thus far, the process of capital transfer amounts literally to taking capital from the South Korean capital stock and moving it north. It would be desirable to model external capital inflows as well. Moreover, the model is a comparative statics model—there is no explicit time dimension. These two issues are related through the fundamental stock-flow ambiguity of comparative statics exercises. In the comparative statics setup, one can model capital inflow as either an exogenous increase in the capital stock (which does not affect the current account balance) or as an exogenous increase in the trade or current account deficit—which does not affect the capital stock. One could think of the latter as representing the moment imported capital goods are purchased, and the former the moment they are installed.

A key issue is how the inflow of foreign capital would affect the real exchange rate. To explore this issue, NRL subjected the monetary union model to a series of trade balance shocks that would leave the measured capital stocks in the two countries unaffected. If the monetary union's trade deficit is increased by the full $319 billion transfer calculated by NRS, the real exchange rate appreciates by 50 percent. Predictably, the level of output in the South Korean traded-goods sectors falls, while the non-traded-goods sectors (construction, public administration, and services) exhibit increases in output.

## Two-Country Dynamic Model Results

While this modeling is informative, its usefulness is inherently limited due to its comparative statics nature. The obvious next step is to introduce

**Table 1 Capital transfer scenarios without labor migration**
(percentages)

**In all cases:**
Labor growth rate: NK: 1.9%; SK: 1.6%
Government experiment growth: 3%
Capital depreciation rate: 5%
TFP growth: 1% SK only
$319 billion capital transfer over 10 years
No labor migration
1990 as the base

| Assumptions: | Implications: |
|---|---|
| **Extreme cases** | |
| EXP1 | |
| External capital inflow only | NK grows 14.5% a year |
| Capital stock growth rate: | SK grows 5.5% a year |
| NK: 16% | 60% income gap not reached (44%) |
| SK: 08% | Trade deficit: 5.6% per year |
| | Exchange rate appreciates 5.2% per year |
| EXP2 | |
| Inter-Korea capital transfer only | NK grows 14.4% a year |
| Capital stock growth rate: | SK grows 2.2% a year |
| NK: 14% | 60% income gap reached |
| SK: 03% | Trade deficit: 0.4% per year |
| | Exchange rate appreciates 1% per year |
| **Intermediate cases** | |
| EXP3 | |
| ½ capital stock from SK and | NK grows 14.4% a year |
| ½ capital from ROW | SK grows 3.4% a year |
| Capital stock growth rate: | 60% income gap not reached (54%) |
| NK: 15% | Trade deficit: 3% per year |
| SK: 5% | Exchange rate appreciates 3% per year |
| EXP4 | |
| ¼ capital stock from SK and | NK grows 14.5% a year |
| ¾ capital from ROW | SK grows 4.5% a year |
| Capital stock growth rate: | 60% income gap not reached (48%) |
| NK: 14% | Trade deficit: 3% per year |
| SK: 7% | Exchange rate appreciates 3.5% per year |
| EXP5 | |
| ¾ capital stock from SK and | NK grows 15% a year |
| ¼ capital from ROW | SK grows 3% a year |
| Capital stock growth rate: | 60% income gap reached |
| NK: 15% | Trade deficit: 1% per year |
| SK: 5% | Exchange rate appreciates 2% per year |

EXP = experiment; NK = North Korea; ROW = rest of world; SK = South Korea; TFP = total factor productivity.

**Table 2 Capital transfer scenarios with labor migration** (percentages)

| **In all cases:** | |
|---|---|
| Labor growth rate: NK: 1.9%; SK: 1.6% | |
| Government experiment growth: 3% | |
| Capital depreciation rate: 5% | |
| TFP growth: 1% SK only | |
| Labor migration is allowed | |
| **Assumptions:** | **Implications:** |
| EXP6 | |
| ½ capital stock from SK and ½ capital stock transfer from the ROW | NK grows 13.7% a year<br>SK grows 3.7% a year |
| 15% NK labor force migrated | 60% income gap reached |
| Capital stock growth rate:<br>NK: 15%<br>SK: 5% | 3.16 million people migrated from NK to SK<br>Trade deficit: 3% per year<br>Exchange rate appreciates 3% per year |

EXP = experiment; NK = North Korea; ROW = rest of world; SK = South Korea; TFP = total factor productivity.

some explicit dynamics. To this end, the NRL model has been respecified as a dynamic model.[2] As a first cut, very simple dynamics were imposed: in essence, the comparative statics exercise was turned into a 10-year process. This allows us to begin investigating the capacity of the monetary union to absorb and finance varying levels of foreign capital inflows.

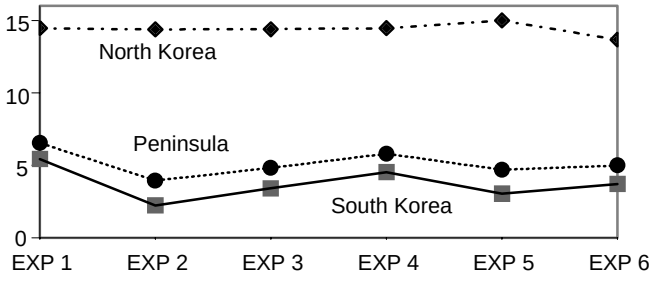
Following the previous work, we first examine the extreme cases—all of the capital transfer comes from abroad, and all of the capital transfer comes from South Korea—and then look at the intermediate cases in which both South Korea and the rest of the world (ROW) contribute to the capital inflow to North Korea (table 1). We then take an intermediate case and permit some cross-border labor migration as well (table 2).

As shown in table 1, and depicted graphically in figure 1, as South Korea bears a greater share of the financing burden, its own rates of capital accumulation and economic growth fall. North Korea actually achieves the 60 percent income target in the two scenarios where South Korea bears the greatest burden. Total peninsular growth is maximized in the scenarios where the external capital inflow is the greatest, however.

Moreover, as shown in table 1 and figure 2, these capital inflows appear financible. When the capital inflow is financed entirely by the ROW, the joint current account deficit never exceeds 8 percent of GDP, and it averages 6 percent for the decade. *A critical caveat is that the model is calibrated to begin in 1990*—the necessary capital inflow has been growing faster than the peninsula's income since 1990, and *if the model were*

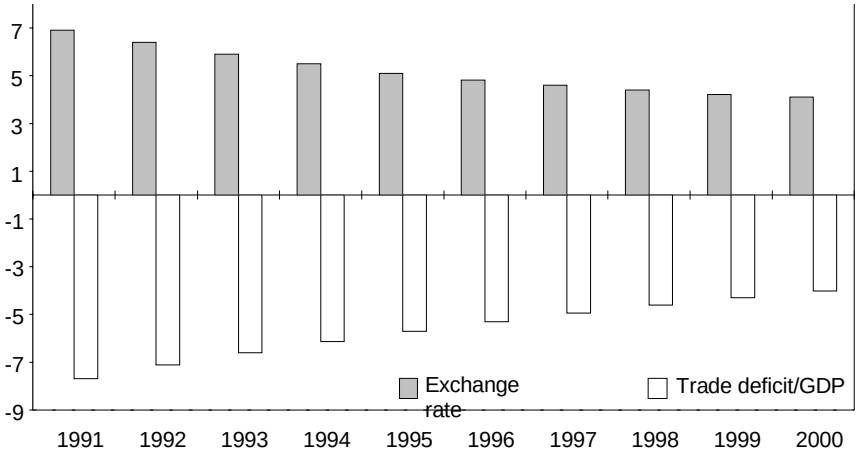
2. A complete explanation of the underlying dynamics will have to await a subsequent write-up. Similarly, we are in the process of endogenizing the underlying dynamic processes.

**Figure 1 Growth rates, North and South Korea** (percentage)




EXP = experiment.

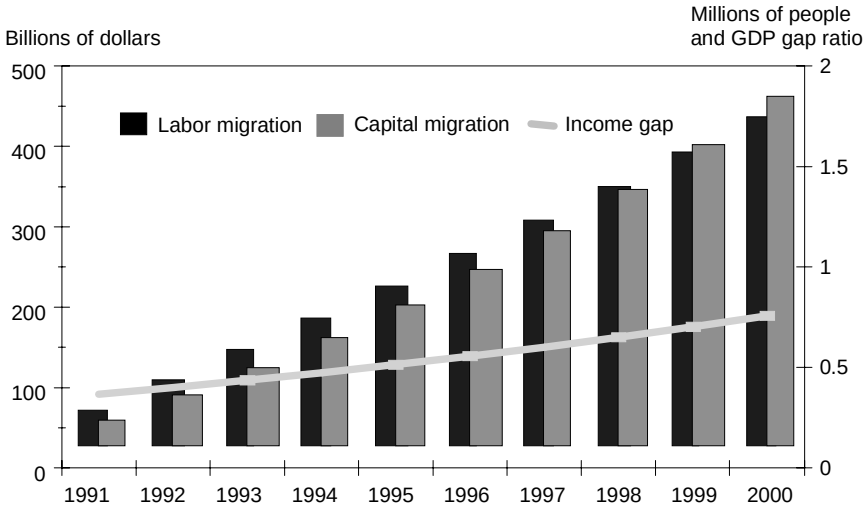
**Figure 2 Exchange rate appreciation and trade deficit: $319 billion external capital transfer** (percentage)




*recalibrated so that the process began in a later year, the financing burden relative to GDP would be higher.* Some crude calculations reported in Noland (1996) suggest that it could be implausibly high.

The intermediate scenario in which both cross-border capital and labor migration are permitted is summarized in table 2 and figure 3. The 60 percent income target is achieved in 2000, at the end of the decade-long adjustment period, when roughly 1.6 million workers migrate from North to South and North Korea experiences something over $400 billion in capital inflows, half coming from South Korea and half coming from the ROW. *Again, it should be emphasized that if the model were recalibrated so that the adjustment process began after 1990, the amounts of capital and labor migration required would be greater.*

**Figure 3 Labor, capital migration, and income gap**




Finally it should be reiterated that we have arbitrarily imposed the basic scenario—that is, linear adjustment over a decade. When the dynamics of the model are fully endogenized, the model may behave far differently. In particular, the cross-border flows of labor and capital may be far more abrupt than depicted in this work, leading to more precipitous shifts in trade balances and the real exchange rate, which would thus be more similar to those obtained in the comparative statics framework.

## Conclusion

Recent CGE models calibrated for 1990 indicate that the costs of unification, defined as the capital investment needed to raise North Korean per capita income to 60 percent of that of South Korea, are on the order of $200 to $400 billion, assuming that capital transfer and not cross-border labor migration is the principal mechanism through which incomes are made to converge. The main factors that contribute to this range of estimates are the extent to which North Korea experiences an "obsolescence shock" reduction in the imputed value of its capital stock, the extent to which North Korea can adopt South Korean (or other modern) technology, the amount of cross-border labor migration, and the rapidity of these changes. The worse the obsolescence shock, the higher the capital transfer necessary to hit the income target; the greater the productivity gain, the larger the cross-border migration; and the faster these occur, the smaller the sum required.

It should be emphasized that the models are calibrated for 1990, and on current trends the costs appear to double roughly every five years. By 1995 the costs could be on the order of $400 to $800 billion and, extrapolating to 2000, increase to $800 to $1,600 billion—all under the assumption that capital and not labor flows are the primary channel through which income convergence is achieved.

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