



Assessing the economic performance of North Korea, 1954–1989: Estimates and growth accounting analysis

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This paper adjusts the official data from North and South Korean sources, taking into account hidden inflation to estimate North Korea's GNP growth rates from 1954 to 1989. The factors of economic growth are decomposed subsequently into changes in inputs and factor productivity. Finally, a panel cointegration technique is used to assess the level of productivity in the North Korean economy in comparison with that of the former Soviet Union. We find that the average of annual growth rates of North Korean GNP and GNP per capita from 1954 to 1989 was 4.4 and 1.9%, respectively. The results from decomposition suggest that the prime cause of slow economic growth was extremely low or even negative total factor productivity. According to the panel cointegration estimation, productivity in North Korea was lower than that of the Soviet Union by 33%. *Journal of Comparative Economics* 35 (3) (2007) 564–582. Seoul National University, Seoul, Republic of Korea; Korea Institute for Industrial Economics and Trade, Republic of Korea.

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1. Introduction

North Korea is in the midst of a major economic crisis. News on food shortages and the possibility of mass starvation appears in the media regularly, and its economy is not able to sustain its population without large-scale external aid. The six-party talks involving South and North Korea, United States of America, China, Russia, and Japan have been dealing with an issue on how to address North Korea's nuclear programs. This suggests that North Korea's economic crisis has implications not only for economic and political situations in the region but also for international security.

A number of studies such as Lee and Chun (2001), Lee (1997), Noland (2000, 2004), Noland et al. (2000a, 2000b) and Yoon and Babson (2002) make timely efforts to discuss North Korea's recent economic reforms and their implications. In contrast, there have been few attempts to evaluate the long-term performance of the North Korean economy empirically. One can argue that without knowledge on the past of North Korea's economy, it would be difficult to understand the depth of the problems that North Korea currently faces and to predict the outcome of such reforms.

There are several reasons for the paucity of rigorous quantitative analysis of the North Korean economy. North Korea's official statistics on economic performance including national output have not been regularly released since the 1960s. Researchers attempting to estimate the growth rates of North Korea's output had to rely on some fragmentary statistics appearing in various sources. However, their methodologies are often either non-transparent or based on a series of arbitrary and questionable assumptions. Furthermore, existing studies fail to take into account the fact that official economic statistics in former socialist countries were likely to exaggerate economic performance.¹ As a consequence, their growth estimates are difficult to reconcile with North Korea's recent economic crisis in the 1990s.

This paper has three main purposes. First, it estimates long-term growth rates of North Korea's economy from 1954 to 1989. We use North Korean official statistics on industrial production as well as data on agricultural production compiled by government organisations in South and North Korea. These two entail only a few data which contain time-series information for a relatively long period. We estimate hidden inflation rates using the relations between hidden inflation and the stage of economic development, and use them to correct for biases in industrial production. Second, based on our new estimates of growth rates, we estimate the productivity of inputs and total factor productivity. This analysis is expected to reveal not only the extent of efficiency of North Korea's economy but also its trends. Third, we compare the level of productivity of North Korea's economy with that of the Soviet economy, in order to better our understanding of the relative performance of the North Korean economy. In this analysis, we use a panel cointegration technique that deals with non-stationary data, namely, the Pooled Mean Group Estimator (PMG).

We find that, taking distortions in output and price statistics into account, the average annual growth rate of North Korean GNP and GNP per capita from 1954 to 1989 was 4.4 and 1.9%, respectively. The average annual growth rates of GNP are fairly comparable to those of the Soviet economy from 1928 to 1985 according to Western estimates but the rates per capita are well below those of most socialist economies in the same period (Ofer, 1987). We also find that annual growth rates tended to decline from as early as the 1960s, implying that economic problems in North Korea emerged sooner than suggested by Hwang (1993), Chun and Park (1997), and

¹ For the comparison of estimates of Soviet economic growth between official sources and alternative ones such as the Central Intelligence Agency's or Khanin's, refer to CIA (1990), Khanin (1991) and Harrison (1993, 1998a).

the Korea Institute for National Unification (1993). Our findings indicate that the main cause of slow or negative economic growth was extremely low total factor productivity, and that the productivity of the North Korean economy had been lower than that of the Soviet economy by 33%.

The structure of this paper is as follows. In Section 2, we review existing studies on the estimation of North Korea's economic growth. Following the description of our methodology and datasets, Section 3 evaluates the extent of hidden inflation in the North Korean economy and estimates the growth rates of North Korea's GNP. In Section 4, we apply a growth accounting method to decompose the contribution of capital and labour to growth. Section 5 uses a panel cointegration technique to compare the level of productivity of North Korea's economy with that of the Soviet economy. Section 6 summarises the main findings.

2. Studies on long-term economic growth in North Korea

North Korean official statistics on economic growth follow the convention of socialist economies that estimates Net Material Product (NMP) instead of GNP.² Until 1967, annual figures on real NMP had been available from *Chosun Minjoojoeu Inmin Gonghwakook Inmin Kyungjebaljeon Tonggyejib* (Economic Statistics of Democratic People's Republic of Korea, 1961) and *Chosun Joongang Yeongam* (Yearbook of Democratic People's Republic of Korea: CJY). Annual data for subsequent years, however, are unavailable. From the data published irregularly thereafter, annual average growth rates over several years can be calculated, but such calculation is possible only until 1980.

According to North Korea's official statistics on NMP, the average annual growth rate of NMP was 12.0% from 1953 to 1980. This figure is much higher than the average growth rate of South Korea's GDP in the same period, 6.9%. There appears to be considerable exaggeration in North Korea's figure, as information from various sources indicates that the living standards in the North were substantially lower in 1980 than in the South. Possible causes of such overestimation might include "the Gerschenkron effect", which refers to the impact of the choice of a base year for fixed prices on growth statistics. In particular, as Nove (1977) suggests, the extent of overestimation of growth rates arising from "the Gerschenkron effect" tends to be larger in a socialist economy where markets are not cleared and prices of manufacturing goods are likely to be set relatively higher than those of other goods, compared to a market economy.

There are few studies that provide alternative estimates of North Korea's GNP or its growth rates. The main reason for this is the mere lack of data. North Korea has not released much of the data that are essential for the estimation of GNP. Detailed data on industrial and agricultural production gradually became inaccessible after the early 1960s. Currently the data on the growth rate of total industrial output, which had been published until the end of the 1980s, stand as the only annual official data available for an extended period. Some fragmentary data on output were released occasionally from the mid-1960s to 1990. However, the release of such fragmentary data came almost to a complete halt in 1990 and no data were provided afterwards.

South Korean government institutions, such as the Ministry of Unification and the Bank of Korea, have been estimating the growth rates of North Korea's GDP from 1980 onwards. According to the Ministry of Unification's estimates, the North Korean economy grew annually by

² NMP is close to the Western concept of net national product less the value added of most services. For details on NMP, refer to Becker (1972).

3.6% during the 1980–1985 period and 1.4% during the 1985–1990 period.³ Although the Institute of North Korea Studies, a private research institute in Seoul, provides estimates of annual GNP growth rates from 1960 to 1980, its estimation method is far from being clear; without further explanations, it reveals only that the estimates are based mainly on growth rates of industrial production (Institute of North Korea Studies, 1983). Hwang (1993) estimates North Korea's GNP from 1955 to 1989 using several North Korean and CIA sources but fails to use a consistent estimation method. For example, his estimates use both nominal and real figures without distinction, which is not valid unless there was no inflation in North Korea during the period studied. Cho (1993) attempts to estimate North Korea's GNP by using nominal GNP series available from the Ministry of Unification of the South Korean government. In order to convert nominal GNP to real figures, he applies the average annual inflation rate in former socialist countries appearing in official sources. However, this method is likely to result in overestimation of the growth rates, because it is widely found that official inflation rates were highly underestimated in these countries. Yoon (1986) uses both the official exchange rate of North Korean currency against US dollars and the US wholesale price index to estimate North Korea's GNP deflator. In doing so, this method is based on a questionable assumption that North Korea's official exchange rate has a meaningful relationship with US inflation.

In Table 1, we summarise various estimates of North Korean GNP growth rates together with those of South Korea. Table 1 shows that, with the exception of Yoon's (1986) estimates, North Korea's growth rates until 1985 were favourable. In fact, North Korea's official figures and Cho's (1993) estimates suggest that the average growth rate of North Korea's economy from 1953

Table 1
Various estimates of North Korea's annual growth rates compared with those of South Korea

	Estimates of North Korea's growth rates						Estimates of South Korean growth rates (GDP)
	North Korean official estimates (NMP)	South Korean official estimates (GNP)	Institute of North Korea studies	Hwang (GNP)	Cho (GNP)	Yoon (GNP)	
1953–1956	30.1						2.9
1956–1960	21.0			32.3			4.5
1960–1965	9.9		9.4	11.4			6.5
1965–1970	5.4		7.4	12.8	10.2		10.4
1970–1975	14.2 ^a		6.1	25.0	10.1	8.5	7.9
1975–1980	4.0 ^b		5.3	9.2	10.2	–2.0	6.9
1980–1985		3.6		7.2	8.5	–1.5	7.8
1985–1990		1.4		2.4	5.1		9.5

Sources: Central Statistical Office of DPRK (1961); Lee (1972, 2000); Ministry of Unification (various years, 1996); Institute of North Korea Studies (1983); Cho (1993); Yoon (1986); Korea National Statistical Office (2000).

^a The estimate for 1971–1974.

^b The estimate for 1974–1980.

³ The Ministry of Unification, however, has not disclosed its estimation method and the detailed data relating to such estimation. The method employed by the Bank of Korea (various years) for estimation of growth rates since 1990 is based on statistics on output of some goods in quantity multiplied by South Korean prices of the corresponding goods. Although this can be viewed as a practical compromise given the lack of necessary price statistics, it is difficult to justify the assumption that changes in the prices of the corresponding goods in North Korea are the same as those in South Korea. Moreover, the sources of the data on the quantity of some products are not provided.

to 1985 was higher than that of South Korea in the same period. If this was true, then North Korean GNP per capita should be higher than that of South Korea. This is implausible given North Korea's past and current economic conditions. For example, using physical indicators, [Chun \(1992\)](#) and [Chung \(1993\)](#) estimated that the income per capita of North Korea in 1989 or 1990 was about a quarter of that of South Korea.⁴ Another feature of North Korea's economic performance, as all the estimates in [Table 1](#) show, is that growth rates tended to decline over time.

In sum, the major weakness of the existing studies is their uncritical use of North Korea's official statistics on output and prices, despite strong evidence suggesting the unreliability of statistics sources in socialist countries such as the Soviet Union. For example, the Soviet central statistical office (TsSU) estimated that annual growth rates of Soviet NMP or GNP was 8.8% from 1928 to 1985, while the United States Central Intelligence Agency (CIA) and [Khanin](#) suggested that they would be 4.3 and 3.3%, respectively ([TsSU, various years](#); [CIA, 1990](#); [Khanin, 1991](#); [Harrison, 1993, 1998a](#)). A number of studies find evidence of the underestimation of prices ([CIA, 1990](#); [Schroeder, 1972](#); [Harrison, 1998b, 2000](#); [Harrison and Kim, 2006](#); [Kim, 2002a](#)) and overestimation of output in physical quantity ([Khanin, 1991](#); [Harrison, 1993](#)). The extent of distortion in statistics, as the above studies find, is often substantial. For example, [Kim \(2002a\)](#) argues that actual retail market prices from 1970 to 1989 increased by 42% as opposed to 14% suggested by official statistics. [Khanin \(1991\)](#) claims that output statistics were inflated and the extent of such an overestimation reaches to about 38% on average from 1928 to 1985. Moreover, substantial hidden inflation, as documented in [Harrison \(2000\)](#) and [Harrison and Kim \(2006\)](#), further weakens the reliability of the official statistics on prices.

3. Estimation of the growth rates

3.1. Methodology

Using a simplified version of [Maddison's \(1998\)](#) approach, we estimate North Korea's annual growth rates as follows:

$$\frac{Y_{t+1} - Y_t}{Y_t} = \frac{A_t}{Y_t} \cdot \frac{(A_{t+1} - A_t)}{A_t} + \frac{I_t}{Y_t} \cdot \frac{(I_{t+1} - I_t)}{I_t} + \frac{S_t}{Y_t} \cdot \frac{(S_{t+1} - S_t)}{S_t}$$

where subscript t refers to year, Y is real GNP, and A , I and S are real GNP produced in the agricultural sector, in the industrial sector and in the service sector, respectively. Note that industries are broadly classified in North Korea's official statistics so that they include manufacturing, mining, forests, fishery, and energy industries. That is, the above equation suggests that an annual growth rate of an economy is the average of the growth rate in each sector of the economy weighted by the share of GNP in each sector as a proportion of total GNP.⁵

We use the following sources to estimate the annual growth rates of agricultural and industrial production. First, we use North Korean official data on annual growth rates of industrial production from 1954 to 1989.⁶ Second, as for agricultural production, we rely on North Korea's

⁴ [Lee \(1990a, 1990b\)](#) provides some anecdotal evidence that North Korea was still a low-income country in the 1980s.

⁵ [Maddison \(1998\)](#) estimates Chinese annual growth rates using value added in six sectors in the economy. According to him, Chinese growth rates in the periods 1952–1978 and 1978–1995 were 4.4 and 7.5%, respectively, while official estimates suggest 6.1 and 9.9% in the respective periods.

⁶ North Korean official data on annual growth rate of industrial production were compiled from various sources by the Ministry of Unification of South Korea. See [Ministry of Unification \(1996\)](#) for the details of the data sources.

official data from 1954 to 1960, and South Korean government's official data provided by either the Ministry of Unification or the Ministry of Agriculture and Forest for the years 1961 and onwards.⁷ As we noted before, the main reason for using these data is that they entail one of only a few time-series data that can be used for the estimation of growth rates for a long period. As for the growth rates in the service sector, we assume that they are equal to the average growth rate of agricultural and industrial production weighted by its share as a proportion of total GNP. That is, we assume the growth rates of the sum of agricultural and industrial production, which is roughly equivalent to those of NMP, are equal to those of service sector and consequently to those of GNP.⁸

We also check the reliability of these data against qualitative information from independent sources. For example, a decline in the annual growth rate of agricultural production from 8% in the 1956–1960 period to 2% in the 1960–1965 period, as shown by South Korea's official estimates of agricultural production, is consistent with Kim Il-Sung's remark in 1965 that agricultural production had been stagnant for several years (Kim Il-Sung, 1982, vol. 20, p. 9). A surge in investment in the early 1970s driven by borrowing from the West was reflected in a higher growth rate of industrial output in the early 1970s compared to the period before; the official growth rate of industrial output had increased from 11.1% in 1966–1970 to 18.6% in 1970–1975. However, such a positive trend in the growth rate of industrial production came to a sudden halt in the latter half of the 1970s. This corresponds to a well-known foreign debt crisis faced by the North Korean economy in that period.⁹

An index number problem suggests that estimates of growth rates may differ according to the choice of a base year. In more detail, weights that are applied to industry as opposed to agriculture and service tend to be smaller when a base year is set to the end year of the period. Since industry is likely to grow faster and relative prices of industrial products tend to fall, this will lead to a lower growth rate compared with the case in which an early year of the period is used as a base year.¹⁰ For example, Bergson (1961) estimates that the annual Soviet economic growth rate from

⁷ North Korean official data on agricultural output were compiled by Ministry of Unification (1996). South Korean estimates were reported in Korea National Statistical Office (1998). The ministry in Seoul operates farms near the North Korean border and uses information from these farms in order to estimate the harvest in North Korea. South Korean estimates are similar to those of USDA that are based on infrared satellite photography. This can be viewed as evidence of increased confidence of the estimates we use for 1961–1989. However, both of these series differ significantly from the official North Korean statistics and the FAO estimates that are highly correlated each other. Haggard and Noland (2007) suggest that South Korean/USDA estimates are likely to be more accurate in tracking actual changes in grain output.

⁸ According to Marer et al. (1992), there are no significant differences in the growth rates of NMP and GNP in former planned economies. We checked the extent of a possible bias caused by this assumption using data from countries such as China and the Soviet Union. In general, differences in average growth rates were found to be negligible, but variances of growth rates became somewhat larger when we substituted the growth rates of service production with the average growth rates of agricultural and industrial production.

⁹ One may argue that growth rates of industry or agricultural production, which are not based on value-added produced but on gross production in each sector, can differ from the growth rates of GNP produced in industry or agriculture. Although we acknowledge such a possibility, an examination of the relationship between value added and gross production in China in the pre-reform period suggests that these two statistics display a very close similarity; the annual growth rate of value added and that of total production in industry was 11.5 and 11.4% from 1952 to 1978, respectively, and those in agriculture was 2.2 and 2.4%, respectively, for the same period (Maddison, 1998).

¹⁰ The weights applied to Eq. (1) are actually a variable. After setting the base year, the respective shares of the three individual sectors can be calculated using the data on the share of each sector in the base year and each sector's annual growth rate. For example, value-added in industry in 1988 can be obtained from dividing value-added in 1989 by $(1 + \text{growth rates of industry in 1989})$. After applying the same approach to the sectors of agriculture and service, one can calculate the share of industry in total GNP in 1988 by dividing value-added in industry in 1988 by the sum of value-

1928 to 1937 reached to 11.9% when the base year was set to 1928, while that in the same period was only 5.5% when the year 1937 was used as a base year. In this paper, we follow Bergson (1989), Harrison (1993), and Maddison (1998) in that we use the end year of the period we study, 1989, as our base year.¹¹ We assume that the shares of agriculture, industry and services for 1992 in total GNP are the same as those for 1989, because the official data on the share of each sector in total GNP exist only for 1992–1996. According to some North Korean official data provided to the UNDP (1998), the share of agriculture, industry and services in 1992, as a percentage of total GNP, was 22, 38, and 40%, respectively.¹²

In estimating North Korea's growth rates, we take into account the possible overestimation arising from hidden inflation. A number of studies suggest that the North Korean economy shared similarities with the Soviet-type economy until the period of economic crisis in the 1990s (Chung, 1974; Hwang, 1993; Chun and Park, 1997; Lee, 1997). The existing studies on the Soviet economy suggest that such an overestimation was the result of systematic problems inherent in the economy rather than errors made accidentally (Harrison, 1998a, 2000).¹³ This view is reinforced by several independent estimates that such an overestimation is not confined to one country but is common to virtually all socialist economies (Kornai, 1992). In fact, one detailed study using data from a North Korean source shows that hidden inflation and overreporting of output were real problems faced by the economy (Goto, 1981).

Our estimation method differs from those used in existing studies in the following ways. First, unlike Cho (1993) and Yoon (1986), we first use the officially released data on the growth rates of industrial and agricultural production. We label the unadjusted growth estimates using such original data as Estimates I, which can be viewed as the upper bound of growth rates given the strong possibility of overestimation in industrial output. Second, we correct Estimates I for overestimation arising from hidden inflation, which is typical for any Soviet-type economies. In other words, we apply the extent of hidden inflation in the Soviet economy to North Korea. We obtain the extent of Soviet hidden inflation by subtracting the CIA estimates of growth rates of Soviet GNP from the official estimates of growth estimates of Net Material Product. Also it appears that hidden inflation as conventionally measured has been higher in earlier stages of economic development, given that most swift structural change took place in earlier stages of economic development for which the proportional change in assortment was most rapid and most open to manipulation. Hence, using the Soviet data we estimate the following equation and apply the coefficients obtained from this estimation to North Korean data:

$$H_t = \alpha_0 + \alpha_1 y_t + \alpha_2 y_t^2 + u_t$$

added in the three sectors in the same year. The share of the industrial sector in the early period will be lower if the base year is set to a later period, because the growth rate of the industrial sector is by far higher than that of the agricultural sector.

¹¹ An advantage in using the end year of a period as a base year is that the extent of distortion in relative prices in a socialist economy is likely to become smaller over time. In addition, setting the end period as the base year is preferred in most countries to the method with the initial year as the base (Landefeld and Parker, 1997).

¹² The original source of these figures is data submitted by the North Korean authorities to an IMF mission team in 1997. The original figures are also reported in Tables 1–3 of the Noland et al. (2000b).

¹³ For example, Harrison (1998b) suggests that hidden inflation was the inevitable outcome of asymmetric information between planners and producers who had strong incentives to charge higher prices on their goods. In general, producers used product innovation, which was often not real but simulated, to create the opportunity for them to exert upward pressure on the average level of plan prices, first by inflating the nominal costs at which new and upgraded products were priced, and second by skewing the assortment towards newer products.

where H_t is the share of hidden inflation defined as the gap between the annual growth rates of Soviet official estimates of industrial output and those of CIA estimates of industrial output, of total inflation, which is the sum of officially reported inflation and hidden inflation, y_t , as a proxy for the stage of economic development, is log of GNP per capita based on the official estimates expressed in dollars,¹⁴ y_t^2 is y_t squared which is intended to capture a non-linear effect of y_t on hidden inflation, and u_t is white noise.

Using the Soviet data from 1928 to 1989 except the Second World War years of 1939 to 1945, we obtain the following estimation results (absolute t -values are in brackets)¹⁵:

$$H_t = 9.292 - 1.952y_t + 0.105y_t^2. \quad (1)$$

(2.76) (2.70) (2.72) $R^2 = 0.24$

The results show that hidden inflation decreases as the economy grows but at a decreasing rate. The average annual hidden inflation rate in the Soviet Union from 1928 to 1989 is 3.67%, which is 47.8% of the average of Soviet official annual growth rate during that period. In particular, hidden inflation during the Stalinist era, namely from 1928 to 1953, is 6.75% while that from 1954 to 1989 is 1.56%. These represent 69.1 and 30.8% of the average growth rate in each period, respectively. Applying the above coefficients to the North Korean GNP per capita (Estimates I divided by the number of population),¹⁶ we adjust the growth rates of industrial production.¹⁷ We label these estimates as Estimates II, which are our preferred estimates.

3.2. Estimates of GNP growth rates

The first column of Table 2 shows one of our estimates of annual GNP growth rates from 1954 to 1989. According to these estimates, namely, Estimate I, the average annual growth rate from 1954 to 1989 was 5.2%. In comparison with other estimates, as shown in Table 1, these estimates are lower in most of the periods we study. For example, Estimate I suggests that the growth rate from 1954 to 1980 is less than half of North Korea's official estimates suggesting that its economy had grown by 12.0% per annum in the same period.¹⁸ The series are considerably lower than the estimates of other studies, in spite of the fact that North Korea's official data on

¹⁴ GDP per capita in US dollars from 1928 to 1989 were obtained by assuming that GDP per capita in 1928 is 955 US dollars (in terms of purchasing power parity) according to CIA estimates and applying official growth rates of GDP per capita to the initial GDP per capita.

¹⁵ Taking the possibility of the first-order serial correlation, we applied Hildereth–Lu (1960) search procedure and re-estimated this equation. However, we found that the coefficients were not significantly different from those reported in the text. We also performed the Breusch (1978)–Godfrey (1978) test for higher-order serial correlation and found no evidence of such correlation.

¹⁶ According to Maddison (1995), South Korea's GDP per capita (in terms of purchasing power parity, 1990 prices) in 1954 was 1,153 US dollars. We assume North Korea's GDP per capita in 1954 was the same as that of South Korea. Official estimates of GDP per capita in subsequent years were obtained by applying our Estimates I of growth rates of GDP per capita to the initial GDP per capita.

¹⁷ The CIA methodology for the estimation of Soviet GDP is based on the assumption that Soviet official price statistics were not reliable because of their failure to reflect high prices often charged on new products and the overstatement of quality improvements. See CIA (1990) for its methodology. Khanin (1991) was suspicious of both price and output statistics, and developed his own methodology of estimation on the basis of physical and indirect measures of output. However, his data of physical output failed to be confirmed by independent assessment.

¹⁸ A sudden increase in the growth rate from 1981 to 1985 may be due to the effect of a high growth rate in 1981 that was caused mainly by very low agricultural production in the preceding year.

Table 2

Estimates of North Korea's growth rates (per annum, %)

	Estimate I	Estimate II
1954–1960	9.0	9.3
1960–1965	3.2	3.3
1965–1970	3.7	3.3
1970–1975	5.9	4.6
1975–1980	3.5	2.2
1980–1985	6.5	4.0
1985–1989	4.0	2.7
1954–1989	5.2	4.4

Notes. Estimate I is derived from North Korean official data on industrial production for 1955–1989, and North Korean official data on agricultural production for 1955–1960 and South Korean estimates of agricultural production for 1961–1989.

Estimate II is obtained by multiplying the coefficients derived from estimating hidden inflation to growth rates of industrial production.

the growth rate of industrial production were used. Given that Estimate I is the upper bounds of the growth rates, these estimation results are indicative of the possible degree of overestimation in other studies.

Estimates II, as shown in the second column of Table 2, are obtained by using the predicted value of hidden inflation estimated based on (1). In the early years from 1954 to 1965, these methods result in faster growth than that suggested by Estimates I. This is because a downward adjustment of the growth rates of industrial production is reflected with a larger share of industrial sector in the early years. According to these estimates, North Korea's national income is found to have grown by 4.4% from 1954 to 1989.

One striking finding is that a slowdown in North Korea's economy had started as early as the early 1960s.¹⁹ Although differing from the traditional view of high economic growth until the mid-1970s (Ministry of Unification, 1990; Hwang, 1993; Cumings, 1997; Hart-Landsberg, 1998), this finding is consistent with some available evidence. For example, Kim Il-Sung himself mentioned in 1965 that production per capita had not increased for some years (Kim Il-Sung, 1982, vol. 19, p. 155). Also a gradual withdrawal of official statistics from the public domain from 1961 indicates that economic situations had worsened from the early 1960s. More direct evidence of a much lower growth rate in the 1960s relative to the previous period is suggested in official statistics on freight transport: North Korea's official statistics show that annual growth rates in freight transport decreased sharply from 22% in 1956–1960 to 5% in 1960–1964 (CJY, various years).

The comparison of growth rates between the two Koreas shows that only in the 1950s, North Korea's growth rate was higher than that in South Korea. Based on an assumption that GNP per capita in South Korea was equal to that in North Korea in 1954, namely one year after the Korean war ended, it is found that South Korea's GNP per capita began to surpass that of North Korea from the mid-1960s. This is in contrast with the view held by the CIA and South Korea's Ministry of Unification, which suggests that North Korea's GNP per capita had been higher than South Korea's until the mid-1970s (Ministry of Unification, 1990; Hwang, 1993; Cumings,

¹⁹ A slowdown of growth rates following a high growth after a war has been observed in most economies experiencing a war. This indicates that one should be careful in interpreting the slowdown in North Korea's growth rates as evidence of a failing system per se.

1997). According to Maddison (1995), GDP per head in terms of purchasing power parity in South Korea was \$1153 in 1954 and \$8294 in 1989, both at 1990 prices. If GDP per head was the same in North and South Korea in 1954, our estimates based on Estimates II suggest that North Korean GDP per capita in 1989 in terms of purchasing power parity was \$2258.²⁰

4. Growth accounting

4.1. Data on labour force and capital stock

It is necessary to estimate the size of the labour force and capital stock for an exercise of growth accounting. For population and labour force, we use data compiled by several different institutions, such as South Korea's National Statistical Office, South Korea's Ministry of Unification and the United Nations Population Division. In particular, we use the recently released data from the 1993 official population census of North Korea.²¹ For capital stock, we use North Korean official data on fixed capital investment from 1954 to 1976, available from documents published by the Supreme Congress of North Korea (Ministry of Unification, 1988). However, no data have been released on investment since 1977. Hence, based on the data from 1954 to 1976, an assumption is made that the share of capital investment is 50% of the sum of government expenditure on the national economy and that on defence released in the state budget of the North Korean government.²² In addition, we assume that capital coefficient defined as the share of net capital stock in GNP is 0.6 at the end of 1954, and the depreciation rate is 5%.²³

4.2. Inputs and input productivity

Based on the estimates of annual growth rates from the preceding section and those of employment and capital stock, we decompose the factors of North Korea's economic growth. Tables 3 and 4, which are based on Estimates I and II, respectively, show trends in GNP growth, input and productivity.

As the tables show, the average annual growth rate of GNP per capita from 1954 to 1989 was between 2.8 and 1.9%, which varies according to the estimates we use. This appears at best modest, even in comparison with other socialist economies in a similar period. For example, the average annual growth rate of the Soviet GDP per capita from 1950 to 1985 was estimated to be 3.2% (Ofer, 1987).²⁴ The main reason for the slow growth appears to be negative growth rates of capital productivity compounded by low labour productivity. According to Tables 3 and 4, the average growth rate of capital productivity in North Korea was -3.2% from 1954 to 1989, while

²⁰ This estimate is remarkably similar to Noland's (2000) estimate of \$2284 in 1990, which was obtained using an approach independent of ours. This may be viewed as additional credence to our estimates.

²¹ As regards estimates of labour force and population, refer to Kim (2002b).

²² Such a share is estimated not to exceed 41% in the early 1970s, 53% in 1974, and 65% in 1976. However, the high share in 1976 was affected by substantial borrowing from abroad, which disappeared subsequently. Our assumption of 50% is not very different from the average of the three figures. For details on the estimation of capital investment, refer to Kim (2002b).

²³ Huang and Duncan (1997) assumed that the capital coefficient in China was 0.6 in 1952. We applied the same coefficient to North Korean capital stock in 1954. We experimented different coefficients, namely 0.7 and 1, but the extent of inefficiency obtained from panel cointegration was fairly similar to the result using 0.6 as the capital coefficient.

²⁴ Since Soviet growth rates appearing in Ofer (1987) are based mainly on CIA statistics, Estimates II of North Korea's growth rates are closest to such figures for the Soviet Union in terms of concept.

Table 3

Trends in GNP per capita and factor productivities in North Korea based on Estimates I (growth rates per annum, %)

	GNP	GNP per capita	Labour force	Capital stock	Labour productivity	Capital productivity
1954–1960	9.0	5.3	5.7	12.6	3.1	–3.2
1960–1965	3.2	0.6	5.2	6.8	–1.9	–3.4
1965–1970	3.7	1.0	3.8	4.5	–0.1	–0.8
1970–1975	5.9	2.9	4.0	8.6	1.8	–2.5
1975–1980	3.5	1.8	4.5	8.1	0.1	–4.2
1980–1985	6.5	4.8	3.0	11.2	3.3	–4.2
1985–1989	4.0	2.8	2.6	8.9	1.4	–4.5
1954–1989	5.2	2.8	4.1	8.7	1.1	–3.2
1960–1989	4.5	2.3	3.7	8.0	0.7	–3.2

Table 4

Trends in GNP per capita and factor productivities in North Korea based on Estimates II (growth rates per annum, %)

	GNP	GNP per capita	Labour force	Capital stock	Labour productivity	Capital productivity
1954–1960	9.3	5.7	5.7	13.0	3.5	–3.2
1960–1965	3.3	0.7	5.2	6.9	–1.8	–3.4
1965–1970	3.3	0.6	3.8	4.1	–0.5	–0.8
1970–1975	4.6	1.6	4.0	7.3	0.5	–2.5
1975–1980	2.2	0.4	4.5	6.6	–1.3	–4.2
1980–1985	4.0	2.3	3.0	8.6	0.9	–4.2
1985–1989	2.7	1.5	2.6	7.5	0.1	–4.5
1954–1989	4.4	1.9	4.1	7.8	0.3	–3.2
1960–1989	3.4	1.2	3.7	6.8	–0.4	–3.2

that of labour productivity ranged between 0.3 and 1.1% in the same period. It is noteworthy that growth rates of capital productivity have been negative since the 1950s. This implies that although it had grown relatively fast in the 1950s, the economy from its earliest stages of growth faced a problem common to other socialist economies, which was low efficiency.

4.3. Estimates of total factor productivity

In order to understand the extent of the economy's inefficiency, we estimate total factor productivity. Following Bergson (1989), we apply both the Cobb–Douglas (CD) and constant elasticity of substitution (CES) production functions to derive total factor productivity. In more detail,

$$\text{CD production function: } Y = AK^\delta L^{1-\delta} \quad (2)$$

$$\text{CES production function: } Y = A[\delta K^{-\rho} + (1 - \delta)L^{-\rho}]^{-1/\rho} \quad (3)$$

Collins and Bosworth (1996) suggest that the elasticity of production to capital, δ , normally ranges between 0.3 and 0.4, and Bergson (1989) applies $\delta = 0.325$ to Soviet data in order to estimate Soviet total factor productivity. We also set δ to be 0.325 for the North Korean economy. As to the CES function, we assume that the elasticity of substitution between capital and labour

(σ) is 0.35, suggesting that ρ is 1.857.²⁵ The elasticity of substitution tends to be low in socialist economies, and it is likely to be the case in North Korea as well (Kontorovich, 1988; Kim, 2002b).

Tables 5 and 6 show the results of an analysis of factors contributing to growth of labour productivity. In more detail, growth of labour productivity was decomposed into two sources: the increase in capital intensity and growth of total factor productivity. The difference between Table 5 and Table 6 is whether we use Estimates I or II, as shown in Tables 3 and 4, respectively. Yet, both tables suggest that total factor productivity in North Korea tends to have declined over time. Of course, given lower growth rates, Table 6 displays a sharper deterioration in total factor productivity.

According to Ofer (1987), the average total factor productivity in the Soviet Union from 1928 to 1985 was estimated to be 1.1%, suggesting that average annual total factor productivity growth in North Korea, which ranged between 0.1 and -0.9% according to Tables 5 and 6, is lower than that in the Soviet Union. In addition, compared with the Soviet case in which total factor productivity became negative only from the late 1970s, our estimates indicate that North Korea

Table 5
Decomposition of labour productivity growth based on Estimates I (growth rates per annum, %)

	Labour productivity	Cobb–Douglas ($\delta = 0.325$)		CES ($\sigma = 0.35$)	
		Capital intensity	Total factor productivity	Capital intensity	Total factor productivity
1954–1960	3.1	2.1	1.0	3.0	0.3
1960–1965	–1.9	0.5	–2.4	0.5	–2.4
1965–1970	–0.1	0.2	–0.3	0.2	–0.3
1970–1975	1.8	1.4	0.4	1.2	0.6
1975–1980	0.1	1.4	–1.3	0.9	–0.8
1980–1985	3.3	2.6	0.8	1.0	2.4
1985–1989	1.4	2.0	–0.6	0.5	1.0
1954–1989	1.1	1.5	–0.3	1.1	0.1
1960–1989	0.7	1.3	–0.6	0.7	0.0

Table 6
Decomposition of labour productivity growth based on Estimates II (growth rates per annum, %)

	Labour productivity	Cobb–Douglas ($\delta = 0.325$)		CES ($\sigma = 0.35$)	
		Capital intensity	Total factor productivity	Capital intensity	Total factor productivity
1954–1960	3.5	2.3	1.2	3.5	0.0
1960–1965	–1.8	0.5	–2.3	0.7	–2.4
1965–1970	–0.5	0.1	–0.6	0.1	–0.6
1970–1975	0.5	1.0	–0.5	1.0	–0.5
1975–1980	–1.3	1.0	–2.2	0.9	–2.1
1980–1985	0.9	1.7	–0.8	1.1	–0.2
1985–1989	0.1	1.6	–1.4	0.7	–0.6
1954–1989	0.3	1.2	–0.9	1.2	–0.9
1960–1989	–0.4	1.0	–1.3	0.8	–1.1

²⁵ This is derived from the following relation: $\sigma = 1/(1 + \rho)$.

experienced negative factor productivity earlier, that is, even in the 1960s. This is striking if one considers that North Korea adopted a socialist economy only during the latter half of the 1940s. Furthermore, the performance of factor productivity in North Korea shows that, unlike some former socialist economies, the economy failed to experience significantly positive factor productivity at an early stage of economic growth. The slow growth of labour inputs as well as negative total factor productivity growth contributed to the reduction of GNP growth rates. Deteriorating growth of both labour input and total factor productivity over time, as our tables show, suggests that the economy was doomed to decline, heading toward a crisis.

5. Comparison of growth performance between North Korea and the Soviet Union: panel cointegration approach

In this section, the level of productivity in the North Korean economy is compared with that in the Soviet Union. We use the following equation to estimate a difference in productivity between the two economies:

$$\log y_{it} = C_i + \alpha \log k_{it} + \beta \log l_{it} \quad (4)$$

where y denotes real GNP, k and l are capital stock in real terms and employment, and subscripts i and t denote country (1 = Soviet Union; 2 = North Korea) and year, respectively.²⁶ Because of the lack of Soviet GNP series for the whole period we study, we use NMP as a proxy of Soviet GNP.²⁷

We compare the performance of the Soviet economy from 1928 to 1971 except 1940–1948, which is the period affected by the Second World War, with that of the North Korean economy from 1954 to 1989. The reason for using different periods for the two countries is to account for the stage of economic development in the two countries. One can argue that GNP per capita in South Korea in 1954, which is \$1153 in 1990 US dollars according to Maddison (1995), is similar to that in North Korea in the same year, that is, one year after the Korean War ended. Also Maddison (1995) estimates that GNP per capita of the Soviet Union in 1928 is 1370\$ in 1990 US dollars.

Figures 1 and 2 show trends in logs of national output, capital stock and employment of North Korea from 1954 to 1989 and those of the Soviet Union from 1945 to 1980. In order to facilitate a comparison, real national output, real capital stock and employment in both countries are normalised to 100 in the beginning of the period and subsequently transformed into log values. As shown in the graphs, North Korea displays higher growth in terms of inputs, namely labour and capital, during the period of study, compared with the Soviet Union. However, economic growth in North Korea during the above period was slower than that in the Soviet Union, suggesting that North Korea's economy was less efficient than the Soviet economy.

In order to determine the appropriate estimator to employ in estimating the above equation, we test whether the variables are non-stationary. It is well known that non-stationarity of the data will lead to spurious regressions if a simple fixed effect model or a pooled Ordinary Least

²⁶ As regards Soviet GNP per capita, we use estimates provided by Maddison (1995). As for data on capital stock and employment, we use those available in Easterly and Fischer (1994). For North Korean data, Estimates II of North Korean growth rates and data on capital stock and employment derived in the previous sections are used.

²⁷ Cohn (1972) argues that the difference in the method of national income accounting between NMP and GNP has little impact on discrepancies in growth statistics between the two. Furthermore, Ofer (1987) reports that growth rates of NMP do not differ substantially from those of GNP.



Notes. Figures are normalised in a way that real output, real capital stock and employment of both countries were set to 100 in 1954. The above graphs are based on log transformation of normalised real output, real capital stock and employment.

Fig. 1. Trends in output, capital stock and employment in North Korea from 1954 to 1989.



Fig. 2. Trends in output, capital stock and employment in the Soviet Union from 1945 to 1980.

Squares is applied (Pesaran et al., 1996, 1999).²⁸ In fact, panel unit root tests by Hadri (2000) suggest that all of our variables are non-stationary.²⁹

We use a dynamic heterogeneous non-stationary model, namely PMG estimator developed by Pesaran et al. (1996, 1999). This estimator can provide consistent estimates with non-stationary data. In addition, it can take into account the heterogeneity across countries, dynamics, and differentiation between long-run and short-run properties.³⁰ In PMG estimations, cross-sectional heterogeneity is permitted in short-run responses and intercepts, while long-run relationships are common across the panel.

Differences in intercepts in long-run relationships between the two countries reflect a productivity gap that is not explained by the contributions of the inputs. In other words,

$$gap = C_1 - C_2 \quad (5)$$

where *gap* is difference in productivity, expressed in a percentage, between North Korea and the Soviet Union, C_1 is the constant estimated from Eq. (4) by the PMG for the Soviet Union, and C_2 is constant similarly estimated for North Korea.

The estimation results are as follows (*t*-value are in parentheses)³¹:

$$\log y_{it} = C_i + 0.27 \log k_{it} + 0.60 \log l_{it} \quad (2.17) \quad (2.77)$$

$$C_i = \begin{bmatrix} 0.97 \\ 0.64 \end{bmatrix}, \quad i = 1, 2.$$

The suggested coefficients imply that our Cobb–Douglas function is not far away from linear homogeneity as assumed in Eq. (2). The coefficient on capital stock, 0.27, is higher than the magnitude we assumed in the previous section, 0.35, but the two are not significantly different.³²

A main finding is that the productivity of North Korea's economy is lower by 33% compared with the Soviet economy. This difference appears considerable. To put this gap into a broader context, we rely on Bergson's findings on the comparative productivity between Western market economies and former Soviet type economies. Bergson (1987) applies a cross-country analysis to estimate a productivity difference in 1975 between four former socialist economies including the Soviet Union and seven developed market economies such as the United States, the United Kingdom and France. He argues that productivity in former socialist economies was lower by about 30% than that in market economies. In his later article, taking possible overestimation of

²⁸ Pesaran et al. (1999) suggest that in the presence of dynamics and slope heterogeneity, the use of standard panel techniques, such as the fixed-effects estimator or the Anderson–Hsio estimator, leads to inconsistent estimates and potentially misleading inferences even for large N (the number of countries) and T (the number of time periods) panels. Pesaran et al. (1996) also show that in the case where T is small under certain assumptions, the cross-section regression based on time-averages of the variables will provide consistent estimates of the long-run coefficients. However, the required assumptions are quite strong. Only for the special case in which the regressors are strictly exogenous and the dynamics are homogeneous across members of the panel can valid inferences be made from the standardised distribution of a coefficient or its associated *t*-statistic.

²⁹ All test statistics are significantly different from zero and thus the null of stationarity is strongly rejected. Results are available upon request.

³⁰ This estimator has been recently applied in various empirical studies (Haque et al., 2000; Fedderke, 2004).

³¹ The choice of lag was based on the Akaike Information Criterion with a maximum lag length 2.

³² To test the robustness of our results, we used the same period for both North Korea and the Soviet Union, namely, from 1954 to 1989. The result suggests that North Korea's productivity is lower by 38% compared to that of the Soviet Union.

outputs and capital into account, Bergson (1992) revises his estimates and suggests that the shortfall of productivity of former socialist economies relative to market economies would reach to about 40%. Although it does not take into account the stages of economic development, technological level, and economic growth strategy, all of which were likely to be different from those of the Soviet Union, our estimate of the shortfall of productivity implies that North Korea's economy has been extremely inefficient even in comparison with a socialist economy at a similar stage of development.³³

6. Conclusions

In spite of extensive debates on the economic performance of North Korea, conclusive findings have not yet been presented for three major reasons. First, there are severe deficiencies in the data on North Korea's economy, which hinders the estimation of its growth rates for a long period. Second, existing work tends to suffer from methodological problems such as a non-transparent estimation method, and arbitrary and often questionable assumptions. Third, established findings from other Soviet-type economies were not reflected in studies on North Korea's growth rates.

This paper can be considered as the first attempt to take the above issues into account. We have used the available official data from both North and South Korean sources, applied a transparent and widely accepted method to estimate North Korea's GNP growth rates, and adjusted the initial estimates by utilising the findings from other socialist economies. In addition, the factors of economic growth have been decomposed into changes in inputs and factor productivity. Lastly, we have assessed the level of productivity in the North Korean economy using a panel cointegration technique, the PMG estimator.

Based on Maddison's (1998) methodology, we have found that annual growth rates of North Korea from 1954 to 1989 was about 4.4% according to our Estimates II. Our estimate is well below half of North Korea's official estimates and is lower than all other existing estimates for the period. Our finding that the average annual growth rate of GNP per capita from 1954 to 1989 was 1.9% also suggests that its economic performance is far from impressive. Furthermore, annual growth rates tended to decrease as early as from the 1960s, implying that economic problems in North Korea emerged sooner than is suggested by other studies.

We also note that although North Korea is known to have adopted a resource mobilisation strategy for growth, its economy was subject to slowing down of the growth rates of labour input from the early 1980s, which was an additional cause for the stagnation. In a market economy such as South Korea, slowing down of labour growth was offset by the increase of labour productivity or technological progress. Yet, in the case of North Korea, slower labour growth was accompanied by slower or negative growth in labour productivity. These are found to be major causes of the economic stagnation. By decomposing the contributing factors of economic growth, we have found that the primary cause of slow economic growth was extremely low or even negative total factor productivity, which was lower than that in the Soviet economy. Our evaluation is that productivity differences between North Korea and the Soviet Union were as large as 33%.

These findings suggest that North Korea's poor economic performance was deeply rooted in the system. North Korea relied heavily on the mobilisation of inputs for economic growth but failed to procure an opportunity for a "take-off" based on technological advancement. Over time, the inefficiency of the system became too large, often sufficient enough to reduce growth

³³ Bergson (1987) suggests that productivities in Poland, Hungary and former Yugoslavia were fairly similar to that in the Soviet Union.

rates to quite a modest level, in spite of a substantial increase in inputs. Although the system had been stable until 1989, namely by the time of the collapse of other socialist economies in Eastern Europe and former Soviet Union, our findings imply that given the extreme inefficiency in North Korea's economy, such a negative shock easily destabilised the economic system. Low and declining economic growth compounded by the negative shock appears to account for the current economic crisis to a large extent. Hence, any changes in the economy or politics are not likely to revive the economy unless they are far-reaching enough to transform the economic system fully toward a market economy.

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