A PRACTICAL APPROACH TO THE ESTIMATION OF NORTH KOREA'S GNP

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In spite of the problems caused by the difference in economic systems and the data unavailability, North Korea's(NK's hereafter) GNP has been estimated by many in response to urgent needs. Traditionally, estimation of NK's GNP has been made through an expenditure approach, a distribution approach or a real indicator approach. The first two approaches are, however, subject to the data problems, while the third one is believed to lack in theoretical basis. For this reason, the SNA estimation method, which is employed by the Bank of Korea(hereafter, BOK) has drawn great attention, since it can avoid the usual difficulties involved in the estimation of NK's GNP.

The new approach is often criticized for its fictional nature of the estimates. However, its practical usefulness is believed to overcome such criticism. This paper is to prove the practical usefulness and theoretical soundness of the SNA approach by employing a simple macroeconomic model, which is a short-cut estimation model. The estimation model is to demonstrate the level of statistical fit and forecasting accuracy. (JEL C51, E17, P27)

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1. INTRODUCTION

Several studies were made to estimate North Korea's GNP. The estimation was, however, secretly conducted by those who got either permission or requests from the South Korean government[1]. Furthermore, the estimation results were kept secret unless allowed. The main and only interest in the estimation project was simply to compare the two Koreas' economic power from the cold-war perspectives, and thus the estimation results received little respect.

Now the difference in GNP between South and North Korea (SK and NK, hereafter) is so obviously significant that the comparison of GNP loses its meaning. What we are interested in now is to throughly analyze and to evaluate NK's economy, and by so doing, to provide the basis for pursuing effective economic co-operation.

Putting aside the political aspect, we still have to face some methodological difficulties in estimation, which stem from the data nonavailability and socialist economic system. For example, NK has measured the level of economic activities on the basis of a material product system (MPS, hereafter). So, some modification is necessary to get the capitalistic GNP.

In spite of such difficulties, traditionally NK's GNP has been estimated by emphasizing the expenditure aspect or the distribution aspect, but of course, with some computational modification to make the GNP estimate comparable to that of SK. On the other hand, other approaches have been made by utilizing the real sector indicators, which are expected to be highly correlated with the GNP. It is obvious, however, that these approaches are lacking in theoretical basis.

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[1] Of course, this argument may not be applicable to those studies made by foreign nationals or institutions

Realizing such problems, the Bank of Korea (BOK, hereafter) has adopted a totally new approach to the estimation of NK's GNP. Since 1992, the BOK has estimated NK's GNP based on South Korea's economic system and its structural characteristics. This approach is obviously disregarding NK's economic system and its structural characteristics. It has however a strong advantage in that it can avoid the problems of meaningless prices and foreign exchange rates of NK, and in that it can depict NK's economy from the market economy perspectives, which will be our prime interest in the case of unification.

Firstly, this paper intends to review traditional estimation techniques, and then to pursue a new and practically meaningful estimation approach as a substitute for the old ones. The practicality of the new approach will be evaluated from the statistical fit aspect in due course.

II. SOURCES OF DIFFICULTY IN ESTIMATION

The major difficulty of estimating NK's GNP stems from the fact that we have to measure a capitalistic concept of GNP for the level of production of the socialistically operating economic system. NK is known as a traditional socialist country, in which all the means of production are state-owned and the economy is operated through centralized economic planning. So, the concept of production, distribution, price and foreign exchange rate in NK is not directly comparable to that in SK. Four major sources of difficulty in estimating NK's GNP are as follows.

First, in capitalist countries, GNP is calculated based on the SNA(System of National Accounts), while in the socialist countries GSP(Gross Social Product) is calculated based on the MPS(Material Product System). GSP concept is based on Marx's labor theory of value, and thus counts only the so-called productive activities of labor, which of course exclude the so-called unproductive activities such as government services, education, health care, housing and transportation, etc.

TABLE 1

Productive vs. Unproductive Sectors in NK

Productive Sectors	Unproductive Sectors
. manufacture . agriculture . construction . freight transportation . productive postal & telegraph services . productive business . other productive activities	. government administration and management . education, science, performing arts, health and sanitation . passenger transportation . unproductive postal & telegraph services . unproductive business . other unproductive activities

GSP is the total sum of values of products, and thus includes not only value-added but also the values of intermediate inputs. So, in order to get the NI(national income) equivalent measure, we have to calculate NMP(Net Material Product) by deducting depreciation costs and intermediate input costs from the GSP. And in order to get the GNP equivalent, we have to further consider turnover tax(a sort of indirect tax) and government subsidies. Of course, the so-called non-productive economic activities should be counted in, too.

FIGURE 1

Nation Income Concepts

Socialistic Concept of National Income (NI)

Narrow Concept of Capitalistic NI	Net Indirect Tax (= turn over tax - subsidies)	Factor Income of Nonproductive Sectors

Capitalistic Concept of Net Domestic Product(NDP)

Considering the facts shown above, we can calculate NK's GNP by the following procedure.

NDP = Socialistic NI + Factor Incomes of Nonproductive Sectors

NNP = NDP + Net Factor Income from Abroad

GNP = NNP + Depreciation Costs

Of course no data is available either for factor incomes of nonproductive sectors or for depreciation costs for NK. So, some kind of inference should be made on the basis of proxy data observed in other or previous socialist countries.

Secondly, even if the above stated problems are solved, we still have a serious problem of calculating NK's GNP, because there are no market price concepts in NK. Only the so-called accounting price exists in NK, which is used simply for the convenience of accounting. [2] It does not reflect the purchasing power of the currency at all and is of no use from a practical point

[2] The accounting price concept has been, however, partially modified since July 1, 2002.

of view.

Thirdly, international trades are basically barter trades and thus official rates of foreign exchange are far from the real values of foreign currencies.[3] It is natural that the pursuit of self-contained closed economy cannot generate economically meaningful foreign exchange rates.

Fourthly, if we adopt either an expenditure or distribution approach to get GNP, we have to face other problems such as the evaluation of ration, education, housing, health care, etc.

Ⅲ. TRADITIONAL ESTIMATION TECHNIQUES

Choi(1978) was the first researcher in Korea to employ the expenditure approach to estimate NK's GNP. He calculated the GNP by adding up personal income expenditures, domestic investments and balance of payments. Choi's work got some criticism for the following facts. He assumed that all the means of production in NK are nationalized, and thus only the government investments exist. But even in NK, most farmers have small pieces of land for private use, and many small scale family-operating manufactures exist across the country. Besides, co-operative firms can make investments by using their own retained profit earnings. Futhermore, Lee(1981) pointed out that Choi neglected the inventory investments. Nevertheless, what we can conclude from these criticismsis that Choi's estimate must have been downwardly biased. However, the problem is that there exists no data in practice to eliminate such drawbacks,

Due to the problems associated with the expenditure approach, Kim(1980) and Lee(1981) adopted the distribution approach. By so doing, they were able to avoid some of the above-stated problems, but still had to suffer from the problems of unrealistic prices and foreign exchange rates.

[3] The North Korean currency was devaluated from 2.2 to 150 against 1 USD on July 1, 2002.

On the other hand, Yeon(1984) estimated NK's GNP by using the fact that government budget and GNP have a stable correlation. Also, Chun(1991) utilized some other real variables which he believed had a high correlation with GNP. Obviously, such analyses, which we may call real sector indicator approach, can avoid data unavailability. But they can be only a convenient short-cut method at best, since it can hardly get sound theoretical backup.

There are some other estimates on NK's GNP that deserve mention. Most of those were made by foreign nationals or foreign institutions such as U.S. CIA, SIPRI of Sweden, IISS of U.K., etc. The first one belongs to an expenditure approach. It utilized the NMP (net material product) concept. The last two are a sort of real indicator approach. They utilized the military expenses/GNP ratio. These estimation studies, however, are not superior to those made in SK, either in the precision aspect, or on the theoretical basis.

Ⅳ. A NEW APPROACH : SNA APPROACH

The common characteristics of the above approaches is that they are based on the recognition of the socialist economic system. The BOK, however, adopted a totally new estimation methodology, the SNA approach. The BOK began to estimate NK‘s GNP on the basis of structural characteristics of SK's economy since 1992. In other words, it utilized the SNA(System of National Accounts) approach for the estimation of NK's GNP. The estimation procedure can be summarized as follows.

i) Estimate the product level of individual commodity group.
ii) Multiply that by the market price of SK.
iii) Apply SK's value-added ratio to get the value-added of the individual commodity group.
iv) Then calculate their weighted average for each industry.

v) Finally calculate the estimate according to the SNA system.

The first advantage of this approach we can think of is to avoid the problem of using NK's unrealistic prices. It has a disadvantage at the same time; it will produce fictional estimates. The most useful and practical aspect of this approach is, however, that the SNA estimate of NK's GNP can be inferred or forecasted by utilizing a simple macro econometric model, which will be introduced in the following section. Furthermore, the BOK has been and will be providing estimates every year. Neither personal nor private estimation works are supposed to surpass the BOK's work in these respects. We have to wait for the final judgement on this approach, however, until proper assessments are made in the following section.

V. USEFULNESS OF THE NEW ESTIMATION APPROACH

The above review can lead us to expect that the BOK's estimation approach is more practical and useful than the traditional one. In the rest of the paper, we will either evaluate or demonstrate the dependability and meaningfulness of the newly-employed estimation technique employed by the BOK. For this purpose, a practical model of forecasting NK's GNP will be employed, which is derived based on a simple macro econometric framework. And then the stability and accuracy of the model will be tested through simulation processes. In the last section, the forecasting ability will be examined.

1. A SIMPLE MACRO ECONONETRIC MODEL IN REDUCED FORM

A basic framework of macro econometric model consists of aggregate supply (AS, hereafter) and aggregate demand (AD, hereafter). And general equilibrium is reached where AS curve and AD curve intersect.

As well known, the AS curve is derived by considering the labor market and production function, while the AD curve is derived by considering the commodity market, money market and foreign market and thereby considering IS, LM and BOP curves.

FIGURE 2

A Basic Framework of Macro Econometrics Model

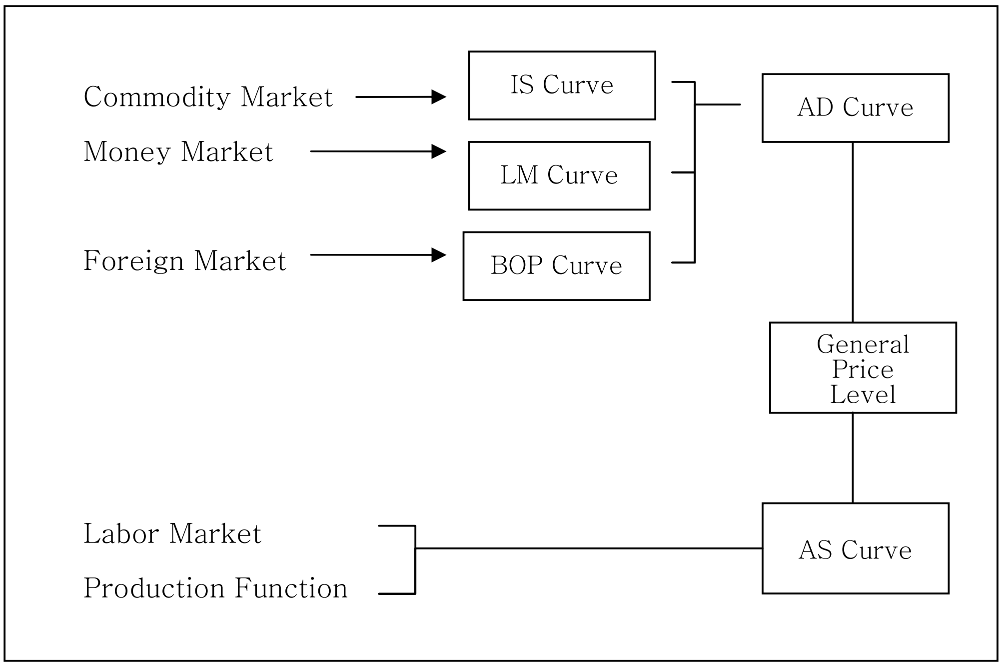
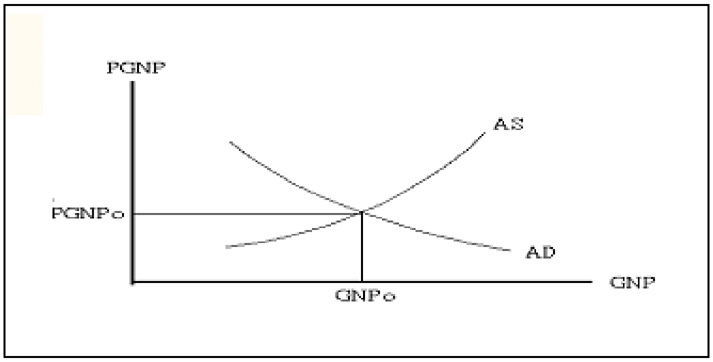


Figure 3 is a Marshallian cross, which depicts an equilibrium between a downward sloping AD curve and an upward sloping AS curve. Equilibrium levels of national income(GNP) and general price, i.e., GNP and PGNP correspond to the intersection point between the two curves.

FIGURE 3

Equilibrium of a National Economy



Based on the basic framework described above, we can build diverse estimation models considering the data availability. This approach, a short-cut method for the BOK's SNA estimation procedure, is obviously superior either to the expenditure approach or to the distribution approach, in the sense that it considers not only the demand side but also the supply side.

A simple AS and AD curve can be defined as a function of major macro economic variables.

(1) AS = f (PGNP, labor employed, capital stock, ...)

(2) AD = f (PGNP, wage level, government expenditure or budget,

Money supply, foreign exchange rate, foreign reserves, etc. ...)

(3) AD = AS

The above equations are a simultaneous equation system which represents an equilibrium of a national economy. If the data for these variables is available, a theoretically sound and desirable GNP estimate can be inferred. As pointed out before, there exists no realistic general price level data for NK. We can hardly get data for wages and capital stock, etc., either. Moreover, we have to solve the so-called identification and bias problem of the simultaneous equation system. To avoid all these problems, we can derive a reduced form equation system which may well be described as the following.

(4) GNP = f (labor employed, capital stock, wage level, government

expenditure or budget, money supply, foreign exchange rate, foreign reserves, etc., ...)

(5) PGNP = f (labor employed, capital stock, wage level, government expenditure or budget, money supply, foreign exchange rate, foreign reserves, etc., ...)

Equation (4) is the one we can utilize for the estimation of national income. By considering the data problem, equation (4) is finalized as the following.

(6) GNP = f (LF, ENERGY (or ELEC, or OIL, or COAL), GE (or GERGNP or ARMY), ROE, FR (or DEBT RATIO), BOT, ...)

ABBREVIATIONS

LF : labor force (in 1,000 persons)

Energy : total supply of energy (in 1,000 toes)

ELEC : electric power produced (in 1,000 toes)

OIL : imports of crude oil (in 1,000 barrels)

COAL : production of coal (in 1,000 toes)

GE : government expenditure (in 1.0 bill₩)

ARMY : military expenditure (in 1.0 bill₩)

GERGNP : GE/GNP

ROE : rate of exchange (₩/＄)

FR : foreign reserves (in 1.0 bill₩)

DEBT RATIO : $\frac{DEBT}{GNP} \times 100$ (%)

BOT : balance of trade (in 0.1 bill＄)

Actually, LF implies labor force. But, it can serve as a proxy for the labor-employed variable, since unemployment is not allowed in NK. We can utilize either ENERGY or ELEC, etc., as a proxy for the capital stock variable, whose data is unobtainable. On the other hand, we can try GERGNP for GE or Government Budget. The Korea won is used for the unit of measurement, since the GNP is to be estimated in wons. The ARMY variable can also be used as a proxy for GE. For the foreign sector consideration, ROE is the most appropriate variable. But, FR, DEBT RATIO, or BOT variable is considered as an alternative.

2. ESTIMATION

Using the series data generated by the BOK's SNA approach, we estimated the model by using a diverse combination of the explanatory variables, and the following is the final selections based on the goodness of fit and statistical significance.

TABLE 2

Estimation Results for the NK's GNP Series

Estimation Period	Explanatory Variables						R^2 / $\bar{R}^2$	d.w.	Estimation Method
	constant	LF	ELEC	ROE	GERGNP	Dummy (oil-ahock)			
1965-2003	-12617.284 (-7.328)	2.5963 (22.714)	20.137 (3.518)	14.375 (2.301)	-36.699 (-1.658)	-2473.546 (-4.002)	0.979 /0.976	1.031	OLS

* : data in parenthesis represents the t ratio

The best estimation results are obtained when four explanatory variables (LF, ELEC, ROE, GERGNP) are introduced. values are greater than 0.9, and most of the t values are big enough to prove statistical significance as shown in table 2. Although d.w. value is somewhat low, Corcrane-Orcutt estimation method was not introduced since it seems to me that the low d.w. value was caused not by the positive autocorrelation but either by the structural change or by the specification error.

In order to evaluate the estimation results in some different ways, we calculated the elasticities for respective explanatory variables. The elasticity represents the degree of impact of the unit change in individual explanatory variables on the dependent variable.

TABLE 3

Elasticities of Explanatory Variables

Explanatory Variables			
LF	ELEC	ROE	GERGNP
2.03240	0.37293	0.01707	-0.24905

Table 3 shows that LF variable has the highest elasticity. This means that the labor is the most influential input for GNP, and that the GNP in NK depends more on the quantity of inputs than on the quality of inputs. This result is quite natural, considering the fact that there have been little incentives for productivity improvement in NK especially due to forced labor.

Ⅵ. EVALUATION

Now the problem is how well the above model can trace the data series generated by the BOK through the SNA estimation process. By demonstrating the high level of statiscal fit and forecasting accuracy of the model, we can safely argue that the SNA approach is practically useful and theoretically sound as well, since the above simple maroeconomic model is designed to serve as a short-cut estimation method for the SNA-estimation approach.

1. GOODNESS OF FIT TEST

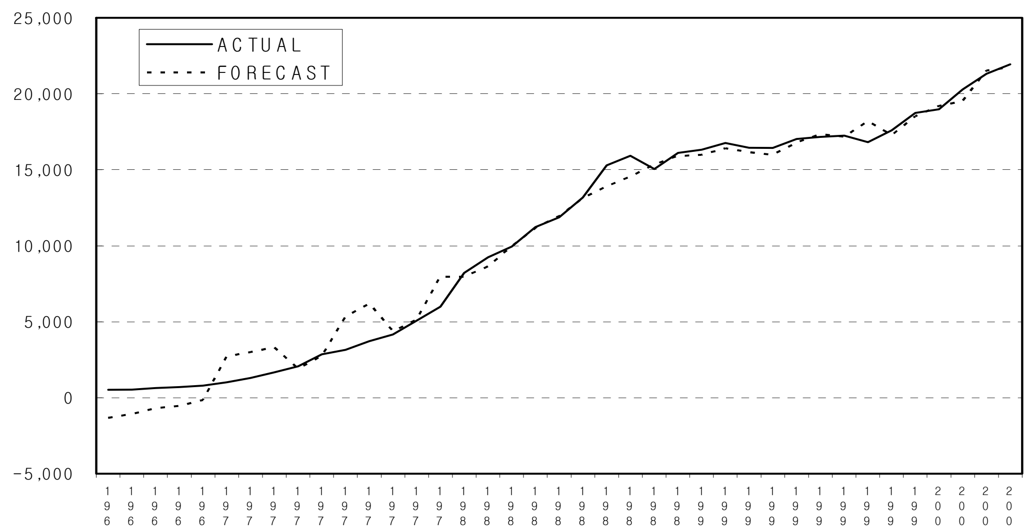
First of all, historical simulation is employed in order to examine goodness of fit of the model.

The most commonly used technique for the goodness-of-fit test i.e., the historical simulation is executed, and the goodness-of-fit is evaluated in terms of the standard test statistic, RMSPE (= $100\sqrt{\frac{1}{n}\sum_{t=1}^{n}(\frac{GNP_{SIM}-GNP_A}{GNP_A})^2}$; GNP_{SIM} is the simulated value of the GNP ; GNP_A is the actual value of the GNP). For the period between 2001 and 2003, calculated value of RMSPE is 2.07%. It is near 2%, which proves high goodness of fit of the model.

On the other hand, Figure 4 shows that the simulated values trace the actual values quite satisfactorily. All of the above facts found in simulation results are excellent proof that the SNA approach is theoretically and practically meaningful.

FIGURE 4

Turning Point Tests



2. FORECASTING ACCURACY

The most commonly used evaluation technique to check the forecasting ability of estimation models is to find out the accuracy of ex-post forecasts.

Table 4 shows the NK's actual and forecasted GNP values for the year 2003, which is reestimated for the period 1965-2002

TABLE 4

Goodness of Fit Test for the Ex-post Forecasts

Actually Observed Values of Explanatory Variables in 2003				NK's GNP		RMSPE
LF	ELEC	ROE	GERGNP	Actual Value	Forecasted Value	
11,919	196	145	71.2	21,946.6	21,569.1	1.72

Calculated value of RMSPE is listed on the right-hand-side of the table. It turned out to be under 2%, which proves the model's high accuracy of forecasting.

Ⅶ. SUMMARY AND CONCLUSION

In spite of the problems caused by the difference in economic systems and the data unavailability, NK's GNP has been estimated by many in response to urgent needs. Traditionally, estimation of NK's GNP has been made through an expenditure approach, a distribution approach or a real indicator approach. The first two approachs are, however, subject to the data problems, while the third one is believed to lack in theoretical basis. For this reason, the SNA estimation method, which is employed by the BOK has drawn great attention, since it can avoid the usual difficulties involved in the estimation of NK's GNP.

The new approach is often criticized for its fictional nature of the estimates. However, its practical usefulness is believed to overcome such criticism. This paper is to prove the practical usefulness and theoretical soundness of the SNA approach by employing a simple macroeconomic model, which is a short-cut estimation model. The estimation model demonstrated a high level of statistical fit and forecasting accuracy. Moreover, the model successfully traced NK's GNP series that was generated by the BOK.

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