Growth and Total Factor Productivity in the Korean Economy

Byoungki Lee

Korea Economic Research Institute

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Contents

Ⅰ. Introduction

Economists have begun pointing fingers, trying to explain the recent economic meltdown in East Asia. It was not long ago that the East Asian economy recorded "miraculous" economic growth. The growth factors of the East Asian economy are recently under heated debate. Recent debates over whether economic growth depends on technological progress or simply quantitative growth of factors of production have heated up after P. Krugman's article which underpinned the fact that economic growth in East Asian countries has been achieved simply by the quantitative growth of factors of production (Krugman 1994). Present economic crisis is of any significance with its potential implications whether it is caused by certain structural factors. Economic growth and an active government role in the economy tend to be perceived as two opposite sides of a coin. Whether an active government role in economic growth has a positive impact or not should be an important issue for potential countries trying to replicate the East Asian growth model.[1]

The Korean economy has experienced rapid growth, showing high economic growth until recent years. Since the IMF bailout at the end of 1997, however, the causes of the Korean economic crash have been analyzed in many ways. Some economists have been pointing out that the low efficiency of the Korean economy

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[1] Various discussions have evolved over the government intervention after *The East Asian Miracle* (World Bank, 1993). Economist has shown great interests in the discussion broadly classified into Neoclassical, Revisionist and the Market-friendly views. See World Bank (1993) for details.

brought on the crisis. A number of economists have analyzed the sources of economic growth in Korea and other East Asian countries: Kim and Park(1985), Moon, Jo, Whang, and Kim (1991); Pyo and Kwon (1991); Kwon(1994, 1997); Kwack (1997); Lee (1998); Young (1992, 1994, and 1995); Borsworth, Collins, and Chen (1995); Kim and Lau (1994); and Sarel (1997). Most of these analyses dealt with the economic growth in East Asia in terms of the increase of factor accumulation and technological progress.

The purpose of this paper is to analyze the sources of Korean economic growth with the labor input and capital input data adjusted to be consistent with the *National Account.* This paper is structured into five Sections. After the introduction in Section Ⅰ, debates between productivity growth and factor accumulation over the sources of economic growth in East Asia are summarized in Section Ⅱ. Section Ⅲ describes the model and data used in this paper. The estimation uses the Cobb-Douglas model and its major source for estimating total factor productivity is the *National Account*. Labor and capital estimations from the *National Wealth Survey* and the *Input-Output Table* are used to obtain data not available from this source. The results estimated from total factor productivity are discussed in Section Ⅳ. The estimated results are presented by nine sectors and ten manufacturing industries. Section Ⅴ outlines the results and implications of the analysis.

Ⅱ. Economic Growth in East Asian Economy

1. Sources of the Economic Growth

The East Asian economy has experienced rapid growth for the past several decades. Economists, however, have not yet reached an agreement upon the causes of this growth. Analysis of the causes of rapid economic growth in East Asia is a very serious research topic since it would provide other countries trying to imitate the East Asian growth process with numerous implications. Analysis of the economic growth in East Asia is based on the theoretical concept of growth accounting.

Productivity growth can be expressed in growth accounting by a mathematical formula. For instance, if GDP is assumed as a function of capital (K), labor (L) and general efficiency parameter (A), then GDP = A*F(K,L). Therefore, A = GDP/F(K, L). As Radelet, Sachs and Lee (1997) have pointed out, the efficiency parameter (A) is a function of policy (e.g. open trade raises efficiency by increasing the division of labor), economic structure (e.g. geography), and technological level. In short hand, we could write A = A (policy, structure, and technology). Parameter A represents total factor productivity(TFP).

Economic growth relies on the above three factors to some extent. Controversial arguments focus on the contribution of technical change relative to the contribution of production factors. Some believe that the increased use of labor and capital explains out any economic growth, while others argue that economic growth is based on the use of more efficient technology. The controversy on the prerequisites of East Asian economic growth, in other words, is focused on the relative contributions of A, K and L to the overall GDP growth. It is easy to express the increase in output caused by the growth of labor participation, capital and technology in mathematical formula, as done in the above equation.[2]

Application of the equation to a specific economy will help us find the ratio of the increased output, whether it comes from the growth of labor force participation, efficient use of capital, or technological progress.

2. Factor Accumulation vs. Productivity Growth

A. Factor Accumulation

Krugman warned that the East Asian economy would come to the point of marginal growth, pointing out that the source of Asian growth is the increase in inputs of production (Krugman, 1994). He argued, “the newly industrializing countries of Asia, like the Soviet Union of the 1950s, have achieved rapid growth in large part through an astonishing mobilization of resources. Once one accounts for the role of rapidly growing inputs in these countries’ growth, one finds little left to explain. Asian growth, like that of the Soviet Union in its high-growth era, seems to be driven by extraordinary growth in inputs like labor and capital rather than by gains in efficiency.” Krugman argued that the East Asian

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[2] See 1 in Section Ⅲ for a more detailed mathematical expression

economy would run into diminishing returns like the Russian economy did, arguing that the growth of the East Asian economy is due not to technological advancements but to the increase of factor accumulation

Krugman also stressed that the government development strategy highlighted by revisionists implies little since the growth of Asian newly industrializing countries (NICs) can be explained by quantitative growth of capital and labor. He strongly criticized the revisionist view on the ground that if the growth in Asia reflects the benefits of strategic trade or industrial policies, those benefits should be represented in the form of rapid improvement of economic efficiency and that there is no sign of exceptional improvement of efficiency in reality.

The studies by Young (1992, 1995) and by Kim and Lau (1994), are in line with Krugman's position. Young (1992) estimates total factor productivity in Hong Kong and Singapore economies with the use of growth accounting. According to his findings, growth of total factor productivity of Singapore is lower than that of Hong Kong. The reason of lower total factor productivity in Singapore lies in the stronger industrial policies adopted by the Singaporean government. While Singapore pursued an active intervention policy including comprehensive governmental intervention in economic activities, Hong Kong maintained a passive intervention policy.[3] Young (1995) estimates and compares total factor productivities in Hong Kong, Singapore, Korea, and Taiwan using

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[3] The Singaporean government uses intervention policies in every aspect of the economy in the efforts of supporting the benefits of foreign capital through preferential loans, lower costs for

growth accounting. Table 1 shows that the estimated growth of total factor productivity in these four countries is relatively low.

Table 1 Average Total Factor Productivity Growth

(Percent per annum)

	Hong Kong (1966-1991)		Singapore (1966-1990)		South Korea (1966-1990)		Taiwan (1966-1990)	
	Output	TFP	Output	TFP	Output	TFP	Output	TFP
Economy1)	7.3	2.3	8.7	-0.2	10.4	1.7	9.4	2.1
Manufacturing2)	Na	Na	8.5	-1.0	14.1	3.0	10.8	1.7
Other Industry	Na	Na	Na	Na	11.5	1.9	8.8	1.4
Serves	Na	Na	Na	Na	8.8	1.7	9.1	2.6
Private Sector	Na	Na	Na	Na	Na	Na	7.7	2.3

Notes : NA : Not Applicable

1) In the case of Korea and Taiwan, Agriculture is excluded.

2) In the case of Singapore, the years are 1970-1990.

Source : Young(1995)

Kim and Lau (1994) also point out that technology is a very significant factor in the developed countries, while capital takes the leading role in East Asian countries. They insist that the major source for the economic development in East Asian countries so far has been capital accumulation which accounts for 48~72% of economic growth in the region. It is contrasted with a set of five developed countries (France, West Germany, Japan, Britain and U.S.) where technological progress plays the most important role, accounting for 46~71% of

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building or land leases, and the responsibility of labor training costs. See Young(1992).

their economic growth.

These findings show a pessimistic view on the prospect of economic growth in East Asia.[4] First, it means that economic growth in East Asia has not been miraculous. Economic growth in East Asia is simply an outcome of massive labor force participation and capital accumulation. Second, economic growth in East Asian countries following this growth pattern for the past thirty years cannot be continued. The third point is that the societies in those countries had to sacrifice possible consumption and leisure to achieve the high growth rate.

B. Productivity Growth

Though Bosworth, Collins and Chen (1995) with Kim and Lau (1994), mentioned earlier, support Young's findings, some studies suggest faster growth of total factor productivity in East Asia than Young's work suggests. Sarel (1997) depicts the position which put more importance on the role of productivity growth in economic growth in East Asia.

Sarel compares the rate of output growth, capital accumulation, labor force participation and total factor productivity in Hong Kong, Korea, Singapore, Taiwan, Japan, and the U.S. for the period of 1975~1990. East Asian countries show very high output growth and high labor force participation rates in general. Capital accumulation rates in East Asian countries are also very high, especially in

[4] See Sarel (1996).

Korea. The changing pattern of total factor productivity shows that total factor productivity in Hong Kong and Taiwan grows very high but remains lower in Singapore. Total factor productivity in Korea also shows a relatively high growth rate. Comparing the total factor productivity in these Asian countries with the U.S. and Japan reveals that the growth rate of total factor productivity in Hong Kong and Taiwan exceeds that of the U.S. and Japan.

This result is contradictory to Young's conclusion (1995). Sarel points out that, even though East Asian countries could move more quickly in accumulating capital and increasing labor force participation, the increase of these factors do not account for all the aspects of their extraordinary economic growth. In other words, growth of total factor productivity, which is enabled by innovative technologies, still accounts for the large part of Asian economic growth. The increase of total factor productivity in Singapore is relatively low, but still higher than the world average. Once contribution of productivity growth to output growth rate is taken into account, productivity increase in Hong Kong, Taiwan, Korea, and Singapore are similar to that of Japan and the U.S.

III. Methodology and Data

1.Methodology

The discussion so far has focused on the source of East Asian growth in terms of productivity growth vs. factor accumulation. Let's turn to the discussion of the estimation model for empirical analysis.[3] The volume of total output is determined by the amount of physical inputs used for production such as fixed capital, labor and intermediate inputs, and efficiency with which these inputs are used. We measure the output by the total amount of goods and services produced. We consider only the primary factors of production, namely labor and capital, as inputs. The relation can be expressed mathematically as equation (1).

$$Q_t = A_t F(K_t, L_t) \tag{1}$$

Q stands for output, K stands for the inputs of capital services, L for inputs of labor services and A represents the level of efficiency in equation (1). The subscript t stands for time.

By dividing both sides of equation (1) by F, we have Q/F (K, L) = A. Thus A is a ratio of output and an index of volume of combined input and becomes a measure of total factor productivity. One example of a widely used production function is the Cobb-Douglas production function that is expressed as[4]:

$$Q_t = A_t K_t^{a} L_t^{(1-a)} \tag{2}$$

Now, we do not assume a specific function form for equation (1) except that it is homogeneous of degree one. It is assumed that there is a constant return to

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[3] The purpose of this paper lies in the international comparison of growth factors in East Asia in terms of total factor productivity growth. The model for total factor productivity analysis and the method used for calculating data relies in large part on Oguchi's methodology (1998).

[4] Recent trend is to use the translog production function developed by Jorgenson *et al*(1987)in

scale for the economy.[5]

Mathematically we take the change of all terms in equation (1). Since differential calculus is easier to work with, we totally differentiate equation (1) with respect to time. This means that we take the instantaneous changes of the terms.

$$\frac{dQ_t}{dt} = \frac{dA_t}{dt}F + A_t\frac{dF}{dK_t}\frac{dK_t}{dt} + A_t\frac{dF}{dL_t}\frac{dL_t}{dt} \tag{3}$$

By dividing both sides of the equation by Qt, we have:

$$\frac{\frac{dQ_t}{dt}}{Q_t} = \frac{\frac{dA_t}{dt}F}{A_tF} + \frac{A_t\frac{dF}{dK_t}\frac{dK_t}{dt}}{A_tF(K_t, L_t)} + \frac{A_t\frac{dF}{dL_t}\frac{dL_t}{dt}}{A_tF(K_t, L_t)} \tag{4}$$

The left hand side of the equation (4) is the instantaneous growth rate of the output. We denote the growth rate by placing "." on top of the variable.

$$\dot{Q}_t = \dot{A}_t + \frac{MPK \cdot K_t}{Q_t}\frac{\frac{dK_t}{dt}}{K_t} + \frac{MPL \cdot L_t}{Q_t}\frac{\frac{dL_t}{dt}}{L_t} \tag{5}$$

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addition to the Cobb-Douglas production function to analyze total factor productivity

5 "Relaxation of the assumption of constant returns to scale could either increase or decrease the productivity estimates. If the true aggregate production function is characterized by increasing returns to scale, perhaps due to externalities among factors, then the growth accounting residual actually overstates the true degree of productivity growth, since it captures the increase in production. Conversely if the true production is characterized by decreasing returns to scale, the

$$\dot{Q}_t = \dot{A}_t + S_k \dot{K}_t + S_l \dot{L}_t \qquad (6)$$

where Sk=(MPK*Kt)/Qt and Sl=(MPL*Lt)/Qt.

Equation (6) says that the growth rate of output is the sum of the growth rate of total factor productivity and the weighted sum of the growth rates of capital and labor. Rewriting equation (6), we have:

$$\dot{A}_t = \dot{Q}_t - S_k \dot{K}_t - S_l \dot{L}_t \qquad (7)$$

This is the equation to estimate the growth rate of the total factor productivity. Thus the rate of total factor productivity is the residual of output growth after we take out the part that is due to increase in physical inputs. Application of equation (7) to annual data will cause an error of approximation. This error can be eliminated by modifying equation (7) as follows:

$$\begin{aligned} G_r(A) &= TFPG = G_r(Q_t) \\ &- (1/2)(Sk_t + Sk_{t-1})G_r(K_t) - (1/2)(Sl_t + Sl_{t-1})G_r(L_t) \end{aligned} \qquad (8)$$

where Gr(Qt) is the growth rate of the output from year t-1 to year t, that is,

growth accounting residual understates the degree of productivity growth." See Young(1995) for details.

Gr(Qt)=(Qt-Qt-1)/Qt-1. Similarly Gr(Kt) and Gr(Lt) are growth rate of capital and labor from year t-1 to year t, respectively. Thus for our computation of total factor productivity growth, we use equation (8).

2. Data

The change of total factor productivity in Korean economy during 1971~1996 is estimated with the use of Cobb-Douglas model in this paper. One major source for the analysis of total factor productivity is *National Account*. The value added, its deflator and the deflator for capital stock are taken from the *National Account*. Those data not deducible from the *National Account* are estimated from other sources consistent with the *National Account*. Capital and labor are estimated from *National Wealth Survey* and *Input-Output Table* respectively. Analysis of nine sectors in Korean economy is carried out in this paper along with the analysis of ten manufacturing industries.

A. Output

National Account provides data for gross output and the value added. Constant value added is used as output here, which is made constant value from the value added of the *National Account* using value added deflator.

B. Capital Stock

Pyo's capital stock (1998) is used in the estimation of total factor productivity. Pyo's capital stock is based on the *National Wealth Survey* in 1968, 1977 and 1987. With the capital stock data for the three years as a benchmark, capital stock is estimated from the investment data shown in the *National Account* for the periods of 1969~1976 and 1978~1986. The estimation method used here is the polynomial benchmark method shown in equation (9):

$$NK_t^i = I_t^i + (1-d_i)I_{t-1}^i + \cdots + (1-d_i)^{s-1} I_{t-s+1}^i + (1-d_i)^s NK_{t-s}^i \qquad (9)$$

In equation (9), NK^i_j stands for constant price net capital stock in i industry at the end of year j and i^i_j stands for constant price total fixed capital formation in i industry at the year j.

The estimated economic depreciation by sector are reported in Table 2.. Given two benchmark-year estimates of net capital stock (NKt and NKt-s) and the investment series (It-k), equation (9) can frequently be solves for a unique of di. The solution can be as the implicit rate of economic depreciation during the period between two benchmark years.

Capital stock after 1988 is estimated by the perpetual inventory method. For estimating the capital stock in manufacturing industries, Pyo divided capital stock into three capital structures: buildings and structures; machinery and equipment; and vehicles and transportation equipment. He made estimates of capital stock in major industrial classifications: agriculture, forestry and fishing;

mining and quarrying; manufacturing; electricity, gas and water; construction; wholesale and retail trade, restaurants and hotels; finance, insurance and real estate; transport, storage and communication; and business services. He also provided capital stock estimates in twenty-eight manufacturing industries.

Table 2 Economic Depreciation by Sectors(percent)

Sectors	1968-1977	1977-1987
Agriculture, forestry, and fishing	46.6	16.0
Mining, and quarrying	18.1	16.2
Manufacturing	2.5	6.6
Electricity, gas, and water	11.0	12.6
Wholesales and retail trade, restaurants, and hotels	NS	14.6
Transport, storage, and communication	13.1	5.4
Finance, insurance, real estate and business service	4.6	14.2
Community, social, and personal services	7.5	8.4

NS : Negative Solution

Source : Pyo(1998)

For the estimation, we use capital stock data in ten industries obtained from the sum of the capital stock in nine major classifications in Pyo (1998) and in twenty-eight manufacturing industries.

Table 3 shows capital stock increases per annum for the period of 1971~1996. Capital stock in the Korean economy showed 13.17% growth rate per annum for the period of 1971~1996. The Korean economy in general, especially during 1975~1980, showed very high capital stock growth rate, 17.25% per annum, among which capital stock growth in manufacturing, construction, and transport, storage and communication recorded 21.56%, 23.12%, and 23.52% growth rate per annum, respectively.

Table 3 Annual Rate of Capital Stock Growth

	1971-75	1975-80	1980-85	1985-90	1990-96	1971-96
All Economy	0.1404	0.1725	0.1059	0.1179	0.1224	0.1317
Agriculture, forestry and fishing	0.0812	0.1562	0.0819	0.1199	0.0811	0.1104
Mining and quarrying	0.1300	0.2057	0.0995	0.0423	-0.0189	0.0884
Manufacturing	0.1823	0.2156	0.0856	0.1532	0.1179	0.1491
Electricity, gas ad water	0.1355	0.1915	0.1292	0.0345	0.1215	0.1252
Construction	0.2098	0.2312	0.0773	0.0990	0.1180	0.1432
Wholesale and retail trade, Restaurants and hotels	0.1499	0.1357	0.1062	0.1245	0.0878	0.1207
Transport, storage and Communication	0.3808	0.2352	0.1568	0.0853	0.1079	0.1883
Finance, insurance, real estate and business services	0.1295	0.1470	0.1061	0.1166	0.1467	0.1288
Community, social and personal Services	0.0114	0.1157	0.1437	0.1096	0.0957	0.0975
Food, beverages and tobacco	0.0966	0.1592	0.0872	0.1474	0.1020	0.1223
Textiles, wearing apparel and leather industries	0.1740	0.1978	0.0586	0.0685	0.0694	0.1129
Wood and wood products	0.1035	0.1210	-0.0229	0.0917	0.1231	0.0866
Paper, paper products, Printing and publishing	0.1397	0.1809	0.0664	0.1958	0.1344	0.1496
Chemicals and chemical, petroleum, coal, rubber and plastic products	0.1181	0.1702	0.0755	0.2051	0.1542	0.1500
Non-metallic mineral products Except petroleum and coal	0.1255	0.2003	0.1172	0.1129	0.1484	0.1374
Basic metal industries	0.3435	0.2508	0.0345	0.1665	0.1016	0.1602
Fabricated metal products, Machinery and equipment	0.1864	0.2835	0.1725	0.2896	0.0788	0.2036
Transport equipment	0.2416	0.2603	0.1149	0.1899	0.1457	0.1870
Furniture, and other manufacturing Industries	0.2177	0.2310	0.0820	0.1379	0.0583	0.1441

In manufacturing, capital stock growth showed 14.91% growth rate in 1971~1996. Heavy industries, such as non-metallic mineral products except petroleum and coal, iron and steel, fabricated metal products, machinery and equipment and transportation equipment showed very high capital stock growth, 20~28% especially for the period of 1975~1980.

C.Labor inputs

Data for the compensation of employees are available in the Korean *National Account.* But there is no data related to the labor inputs, so they must be calculated by using other data sources. We can use both *The Annual Report on the Economically Active Population Survey* from which annual employee data by sector is available and *Input-Output Table* from which data by sector and individual industry is available. Labor inputs are calculated from the *Input-Output Table* consistent with the *National Account* in this study. *Input-Output Table* since 1970 provides employment tables for the ten years of 1970, 1973, 1975, 1978, 1980, 1983, 1985, 1986, 1990, and 1995. The employment tables provide us with data regarding unpaid family workers and employees. Data for the year not included in this source is estimated by the interpolation method[7].

The employment table in the *Input-Output Table* also gives the number of employees, unpaid family workers, and employed persons in all the industries as well as in the manufacturing industry. The data given by the *Input-Output Table* can be very useful for the analysis of total factor productivity of the overall economy. First, industrial classification in the *Input-Output Table* is adjusted to that of the *National Account*. The classification is merged into nine industries

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[7] Following equation is applied for the annual increase rate for the years not included in the data: $(\text{In}(L_t)\text{-In}(L_{t\text{-}s})/n$. N stands for the number of the intervening years

and ten manufacturing industries. Second, the data for the intervening years during 1970~1996 is estimated by interpolating average growth rate per annum in each period. Third, the data for the year 1996 is extrapolated by the use of the annual growth rate during 1994~1995. The labor inputs obtained through this process are adjusted by average monthly hours worked. Average monthly hours worked are obtained from the *Yearbook of Labor Statistics*.

Table 4 shows growth rate of labor inputs for the period of 1971~1996 in Korean economy. Labor inputs for the whole economy increased by 2.02% per annum for this whole period. Labor input growth rate shows a steady decline. The labor input especially in agriculture, forestry and fishing shows minus growth in all periods. This reflects the migration of large labor forces out of agriculture. Labor input in mining also shows minus growth in recent years. The finance and insurance sector has experienced high labor input growth, 12.99% per annum, for the period of 1971~1996.

Finance and insurance sector shows relatively high labor input growth compared to other sectors for the whole period. The manufacturing sector has slowed down its growth rate of labor. Labor input growth was very high in 1970s, compared to the remarkable drop in 1980s. There are a number of industries showing a minus growth rate of labor input in 1990~1996. Wages dramatically rose since the "democratization" in 1987. It has been observed that much labor is saved in the manufacturing sector in the efforts to overcome this high wage cost

Table 4 Annual Rate of Labor Input Growth

	1971-75	1975-80	1980-85	1985-90	1990-96	1971-96
All Economy	0.0218	0.0361	0.0206	0.0203	0.0144	0.0202
Agriculture, forestry and fishing	-0.0131	-0.0179	-0.0327	-0.0454	-0.0364	-0.0286
Mining and quarrying	0.0059	0.0242	0.0164	-0.1242	-0.0732	-0.0359
Manufacturing	0.1096	0.0804	0.0255	0.0537	-0.0038	0.0460
Electricity, gas ad water	0.0640	0.1557	0.0801	0.0546	0.0449	0.0625
Construction	0.0536	0.0938	0.0369	0.0685	0.0374	0.0538
Wholesale and retail trade, restaurants and hotels	0.0493	0.0729	0.0411	0.0219	0.0393	0.0393
Transport, storage and communication	0.0427	0.0253	0.0591	0.0261	0.0294	0.0352
Finance, insurance, real estate and business services	0.1561	0.2186	0.1284	0.1129	0.1019	0.1299
Community, social and personal services	0.0139	0.0574	0.0677	0.0381	0.0279	0.0302
Food, beverages and tobacco	0.0406	0.0296	0.0021	0.0140	-0.0314	0.0133
Textiles, wearing apparel and leather industries	0.1740	0.0878	0.0096	0.0242	-0.0585	0.0265
Wood and wood products	0.0331	0.0534	-0.1129	0.0324	-0.0182	0.0079
Paper, paper products, printing and publishing	0.0735	0.1046	0.0771	0.0560	0.0350	0.0550
Chemicals and chemical, petroleum, coal, rubber and plastic products	0.1260	0.0689	0.0219	0.0604	-0.0074	0.0547
Non-metallic mineral products except petroleum and coal	0.0909	0.1645	0.0442	0.0744	0.0095	0.0543
Basic metal industries	0.0790	0.1101	0.0698	0.0735	-0.0055	0.0590
Fabricated metal products, machinery and equipment	0.2512	0.0784	0.0590	0.1014	0.0402	0.1144
Transport equipment	0.2376	–0.0153	0.1148	0.1155	0.0369	0.1054
Furniture and other manufacturing industries	0.2166	0.3676	0.0032	0.0702	-0.0204	0.0782

D. Measuring Factor Shares

Estimating share is very important in estimating total factor productivity. Income share of labor is calculated from the *National Account*. In this analysis, the share is calculated from the percentage of compensation for labor divided by the value added. The value added here is made up of the subsidies added to the value added of *National Account* from which indirect taxes are subtracted. Compensation for labor is the sum of the compensation of employees in the *National Account* and the compensation for the unpaid and family workers. The share of capital is measured as (1-share of labor).

Wages for the unpaid and family workers are not included in the compensation of employees in the *National Account,* which, therefore, should be estimated by other methods. First, the number of employed persons, employees, unpaid and family workers are estimated from the *Input-Output Table.* Second, per capita wage for employees is obtained from the value of the compensation of employees divided by the number of employees. It is assumed that per capita wage for the unpaid and working proprietors are the same with that for employees[8]. The percentage obtained from the sum of compensation of employees from the *National Account* and per capita wage for employees (the number of the unpaid and working proprietors) which is divided by the value added from which indirect taxes are subtracted with subsidies added is reckoned to be the share of labor[9].

IV. Estimation Results and Comparisons

1.Estimation Results

Total factor productivity is estimated by categorizing the entire economy into nine sectors - agriculture, forestry and fishing; mining and quarrying;

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[8] Young (1995) has also pointed out that this assumption is reasonable.

[9] It is found that the income share of labor in the sectors of agriculture and wholesale and retail trade and hotels are overestimated in the process of estimating the income share of labor by adjusting the wages for the unpaid and the working proprietors. It is concluded in this study as the result of various efforts that only about 2/3 of the wages for the unpaid and the working proprietors in agriculture and wholesale and retail trade and hotels should be adjusted.

manufacturing; electricity, gas and water; construction; wholesale and retail trade, restaurants and hotels; finance, insurance and real estate; transport, storage and communication; and business services - and analyzes by grouping manufacturing industries into ten industries. Table 5 shows the results of the analysis of total factor productivity by nine sectors. The growth rate of output for the overall economy for the period of 1971~1996 is 8.99% per annum. The largest contribution for the economic growth comes from capital and labor plays the smallest role. The contribution of labor to the output growth in agriculture is minus for the whole period. This reflects the continuous migration of labor forces in agriculture into manufacturing industries

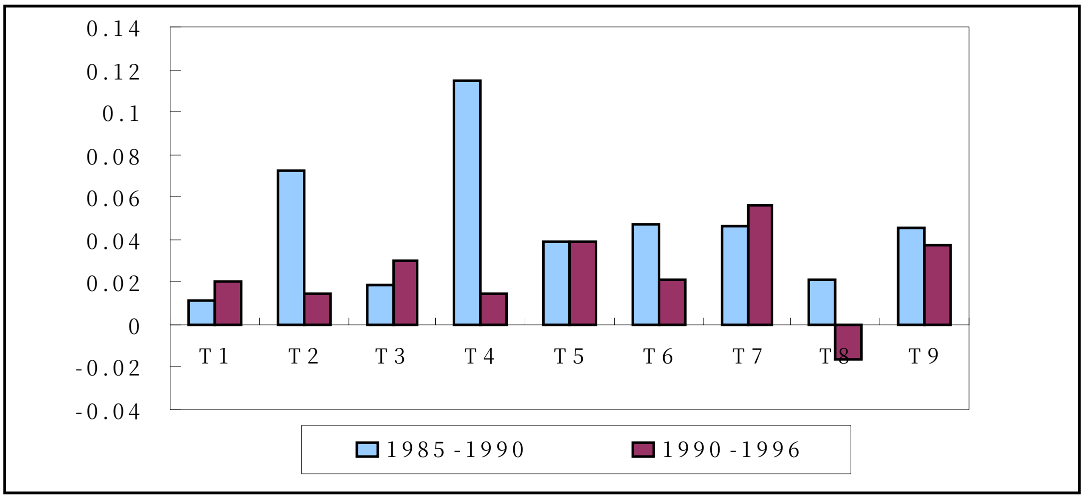
The growth rate of total factor productivity in finance and insurance sector is minus, which is evidence of inefficiency. The growth rate of output in finance and insurance sector is 10.7% per annum, while the growth rate of total factor productivity is –2.09% per annum. The finance and insurance sector has always recorded a minus growth rate of total factor productivity except during 1985~1990. The growth rate of total factor productivity in construction sector also remains very low. The output growth rate in construction sector during 1971~1996 is 10.28% and the total factor productivity growth rate is 1.16% per annum which results in a 11.31% contribution of total factor productivity growth to the output growth. The output growth rate in the manufacturing sector is 12.8% per annum and the average growth rate of total factor productivity per annum is 2.95%. The contribution of total factor productivity to output growth remains 23.01%.

Table 5 Annual Rate of TFP Growth in Korean Economy

Sectors	Contributions to output	1971-75	1975-80	1980-85	1985-90	1990-95	1971-96
All Economy	Output	0.0938	0.0778	0.0701	0.1024	0.0840	0.0899
	Capital	0.0442	0.0634	0.0361	0.0419	0.0378	0.0445
	Labor	0.0139	0.0227	0.0136	0.0129	0.0099	0.0131
	TFP	0.0358	-0.0083	0.0205	0.0476	0.0362	0.0324
Agriculture, forestry and fishing	Output	0.0479	-0.0096	0.0202	0.0091	0.0120	0.0234
	Capital	0.0335	0.0655	0.0228	0.0309	0.0195	0.0374
	Labor	-0.0077	-0.0112	-0.0236	-0.0334	-0.0277	-0.0203
	TFP	0.0222	-0.0639	0.0211	0.0116	0.0202	0.0064
Mining and quarrying	Output	0.0828	0.0435	-0.0095	-0.0002	-0.0388	0.0116
	Capital	0.0490	0.0741	0.0388	0.0133	-0.0078	0.0323
	Labor	0.0036	0.0151	0.0099	-0.0860	-0.0456	-0.0242
	TFP	0.0302	-0.0457	-0.0582	0.0725	0.0147	0.0035
Manufacturing	Output	0.1837	0.1367	0.0899	0.1216	0.0846	0.1282
	Capital	0.1049	0.1165	0.0421	0.0762	0.0564	0.0779
	Labor	0.0465	0.0353	0.0130	0.0268	-0.0018	0.0208
	TFP	0.0324	-0.0150	0.0348	0.0186	0.0299	0.0295
Electricity, gas and water	Output	0.1777	0.1782	0.1753	0.1527	0.1194	0.1577
	Capital	0.0948	0.1424	0.1038	0.0284	0.0954	0.0955
	Labor	0.0222	0.0408	0.0172	0.0092	0.0097	0.0150
	TFP	0.0608	-0.0050	0.0542	0.1150	0.0143	0.0472
Construction	Output	0.0808	0.1355	0.0727	0.1174	0.0978	0.1028
	Capital	0.1056	0.1064	0.0310	0.0345	0.0320	0.0591
	Labor	0.0264	0.0512	0.0219	0.0444	0.0272	0.0321
	TFP	-0.0513	-0.0221	0.0198	0.0386	0.0387	0.0116
Wholesale and retail trade, restaurants and hotels	Output	0.1118	0.0453	0.0653	0.1078	0.0735	0.0844
	Capital	0.0327	0.0536	0.0482	0.0468	0.0231	0.0412
	Labor	0.0397	0.0477	0.0222	0.0135	0.0291	0.0263
	TFP	0.0394	-0.0560	-0.0051	0.0475	0.0213	0.0169
Transport, storage and communication	Output	0.1358	0.1464	0.0650	0.0977	0.1167	0.1171
	Capital	0.1521	0.1078	0.0751	0.0366	0.0422	0.0807
	Labor	0.0259	0.0137	0.0307	0.0149	0.0180	0.0199
	TFP	-0.0422	0.0248	-0.0408	0.0462	0.0565	0.0166
Finance, insurance, real estate, and business services	Output	0.0788	0.1162	0.1014	0.1361	0.1094	0.1070
	Capital	0.0898	0.0982	0.0608	0.0634	0.0788	0.0773
	Labor	0.0495	0.0726	0.0559	0.0516	0.0472	0.0505
	TFP	-0.0605	-0.0546	-0.0153	0.0211	-0.0166	-0.0209
Community, social and personal services	Output	0.0761	0.0812	0.1206	0.1044	0.0821	0.0944
	Capital	0.0038	0.0273	0.0398	0.0320	0.0237	0.0257
	Labor	0.0090	0.0448	0.0504	0.0269	0.0209	0.0226
	TFP	0.0633	0.0091	0.0304	0.0455	0.0375	0.0461

One should note the decrease of total factor productivity growth rate in the Korean economy, which is revealed from the changing pattern of total factor productivity during the past decade. The change of output growth rate from the period of 1985~1990 to that of 1990~1996 shows a drop from 10.24% to 8.40% and total factor productivity from 4.76% in 1985~1990 to 3.62% in 1990~1996. The decrease of total factor productivity can be found in many sectors, as shown in Figure 1.

Figure 1 Total Factor Productivity Change between 1985-90 and 1990-96



Notes : T1 : Agriculture, forestry and fishing; T2 : Mining and quarrying; T3 : Manufacturing; T4 : Electricity, gas and water; T5 : Construction; T6 : Wholesale and retail trade, restaurants and hotels; T7 : Transport, storage and communication; T8 : Finance, insurance, real estate, T9 : business services, community, social and personal services.

The total factor productivity drops dramatically especially in finance and insurance sector. Once the fact that the banking industry is under government intervention is taken into account, the implications of this finding are significant. This point is extremely well expressed in the *IMF Memorandum of Understanding*. It states that "excessive intervention by the government made the finance sector inefficient and left a huge amount of debt in the business sector lacking sound market principles."[10]

Table 6 shows the analysis result of ten manufacturing industries. The contribution of capital input to growth is shown to be very high in manufacturing. The manufacturing industry shows a very high capital input growth rate reaching a peak between 1975 and 1980. Such a high capital input growth caused a low capital productivity growth rate.

The growth rate of capital productivity for the period of 1971~1996 went as low as –1.7%, while the growth rate of labor productivity per annum reaches 7.93% for the same period. Most of the manufacturing industries shows a minus growth rate of total factor productivity in 1975~1980. Food, beverage and tobacco, textiles, paper, non-steel metal, and steel and iron industries recorded decrease of total factor productivity in 1975~1980.

This reflects an efficiency slowdown of capital input for the period when the capital investment was actively carried out for heavy and chemical industries[11].

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[10] See *IMF Memorandum of Understanding* (1997). World Bank (1993) also points out that "government intervention incurs direct cost in the form of subsidies in strategic industries through policy finance and tax reduction during 1973~1979 for the heavy and chemical industries. It also observes that the intervention incurs indirect cost in the form of accumulated nonperforming loan and the ensuing difficulties of portfolio."

[11] It is well known that Korean government actively involved in the investment in this sector after the heavy and chemical industrialization policy initiated in 1973. Heavy and chemical industrialization focused on the promotion of steel and iron, petroleum and chemicals, machines, electricity and electronics industries brought the problem of over-investment. Follow-up measures are provided for the target industries such as preferential policy finance, low-interest loan, tax reduction and trade protection.

Table 6 Annual Rate of TFP Growth in Korean Manufacturing

Industries	Contributions to output	1971-75	1975-80	1980-85	1985-90	1990-95	1971-96
Food, beverages and tobacco	Output	0.1097	0.0925	0.0556	0.0582	0.0319	0.0714
	Capital	0.0525	0.0851	0.0379	0.0581	0.0456	0.0573
	Labor	0.0143	0.0126	0.0007	0.0087	-0.0170	0.0048
	TFP	0.0429	-0.0053	0.0170	-0.0086	0.0034	0.0092
Textiles, wearing apparel and leather industries	Output	0.2535	0.1204	0.0570	0.0493	-0.0642	0.0728
	Capital	0.0974	0.0991	0.0254	0.0291	0.0218	0.0530
	Labor	0.0765	0.0396	0.0052	0.0146	-0.0401	0.0083
	TFP	0.0796	-0.0183	0.0264	0.0056	-0.0458	0.0115
Wood and wood products	Output	0.1368	0.0864	0.0063	0.0525	0.0003	0.0606
	Capital	0.0408	0.0448	-0.0054	0.0412	0.0444	0.0350
	Labor	0.0182	0.0255	-0.0873	0.0156	-0.0119	-0.0011
	TFP	0.0778	0.0161	0.0990	-0.0042	-0.0321	0.0267
Paper, paper products, printing and publishing	Output	0.1212	0.1165	0.1348	0.1094	0.0632	0.1144
	Capital	0.0700	0.0840	0.0270	0.0812	0.0544	0.0653
	Labor	0.0352	0.0535	0.0458	0.0324	0.0206	0.0302
	TFP	0.0160	-0.0210	0.0620	-0.0042	-0.0118	0.0188
Chemicals and chemical, petroleum, coal, rubber and plastic products	Output	0.1962	0.1749	0.0830	0.1333	0.1193	0.1436
	Capital	0.0778	0.1066	0.0477	0.1290	0.0888	0.0930
	Labor	0.0431	0.0259	0.0086	0.0191	-0.0033	0.0188
	TFP	0.0752	0.0425	0.0267	-0.0148	0.0338	0.0319
Non-metallic mineral products excepts petroleum and coal	Output	0.1539	0.1248	0.0867	0.1233	0.0681	0.1185
	Capital	0.0768	0.1162	0.0612	0.0604	0.0696	0.0743
	Labor	0.0326	0.0645	0.0211	0.0347	0.0042	0.0224
	TFP	0.0445	-0.0560	0.0044	0.0282	-0.0057	0.0217
Basic metal industries	Output	0.3246	0.1901	0.1380	0.1260	0.0951	0.1813
	Capital	0.2436	0.1711	0.0226	0.1144	0.0676	0.1103
	Labor	0.0222	0.0357	0.0246	0.0219	-0.0021	0.0185
	TFP	0.0587	-0.0167	0.0908	-0.0103	0.0296	0.0526
Fabricated metal products, machinery and equipment	Output	0.3406	0.2242	0.1205	0.1859	0.1099	0.2089
	Capital	0.1098	0.1511	0.0802	0.1360	0.0407	0.1038
	Labor	0.1051	0.0374	0.0317	0.0526	0.0208	0.0530
	TFP	0.1257	0.0356	0.0086	-0.0026	0.0484	0.0521
Transport equipment	Output	0.2225	0.1734	0.1693	0.1871	0.1820	0.2016
	Capital	0.1179	0.1150	0.0475	0.0811	0.0596	0.0821
	Labor	0.1219	-0.0087	0.0670	0.0675	0.0218	0.0578
	TFP	-0.0173	0.0670	0.0548	0.0386	0.1006	0.0616
Furniture and other manufacturing industries	Output	0.0844	0.1183	0.1209	0.1402	-0.0291	0.0942
	Capital	0.1084	0.1169	0.0311	0.0607	0.0166	0.0650
	Labor	0.0993	0.1605	0.0023	0.0404	-0.0149	0.0364
	TFP	-0.1233	-0.1591	0.0875	0.0390	-0.0308	-0.0072

The rate of capital productivity change per annum in 1975~1980 is –6.57%. It should be noted that the total factor productivity decreases during the period of heavy and chemical industrialization when the government's industrial intervention was very active.[6] Capital productivity growth can be maximized when the capital investment runs well with proper technology and knowledge. This effect, however, seems to have been minuscule in Korea. Korea made large investments in manufacturing industries, while it neglected the introduction of advanced technologies and management systems since an efficient governance structure for banks and enterprises were not established. It resulted in a very low capital productivity and low total factor productivity in most manufacturing industries[12].

2. Comparisons with Earlier Research Findings

Numerous works has been done on total factor productivity in the Korean economy. The results of these works show a variety of findings. There is a certain limitation in comparing the analysis of this paper with those studies due to the difference of model used, analysis period, and applied statistical data. Major analyses on the total factor productivity of Korean economy are outlined below in Table 7.

The first discussion is focused on the entire economy. Christensen and Cummings (1981) published the highest total factor productivity estimates of Korean economy. They estimated very high total factor productivity growth rate,

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[6] See Yoo(1990), Kwon(1994, 1997), Stern, Kim, and Perkins(1995), Lee(1998) for more details about Korean industrial policies during Heavy and Chemical Industrialization .

4.1% per annum during 1960~1973. On the other hand, we have a total factor productivity calculation as low as 1.65% per annum in Pyo and Kwon's study (1991).

Table 7 Studies of Total Factor Productivity in Korean Economy

(Percent per annum)

Researcher	Time period	Economy		Manufacturing	
		Output	TFP	Output	TFP
This study	1970-1996	8.99	3.24	12.82	2.95
Christensen and Cummings(1981)	1960-1973	9.7	4.1	Na	Na
Kim and Park(1985)	1963-1982	8.24	3.05	Na	Na
Kim and Park(1988)	1966-1983	Na	Na	19.14	2.08
Pyo and Kwon(1991)	1960-1989	8.59	1.65	Na	Na
Pyo, Kong, Kwon, and Kim(1993)	1970-1990	8.38	1.31	12.77	1.07
Moon, Jo, Whang, and Kim(1991)	1971-1989	Na	Na	13.2	3.7
Young(1995)	1966-1990	10.4	1.7	14.1	3.0
Kwack(1997)	1970-1993	Na	Na	13.9	3.2
Lee(1998)	1967-1996	Na	Na	15.68	1.59

Na : Not applicable

The difference between those two estimates is due to age and gender differences in the labor input structure, as well as a difference in the capital stock estimate. Pyo, Kong, Kwon, and Kim's paper (1993) estimates the total factor productivity for the entire economy during 1970~1990 as 1.31% per annum. According to their estimates, capital stock shows rapid growth, since land and inventory are excluded in estimating capital stock. Income share of labor is

[12] Mail Business Newspaper(1998), p.52.

estimated lower by assuming that the income of the unpaid family workers be 1/4 of that of other employees. Capital input and labor input data designed consistent with *National Accounts* are used for estimating total factor productivity in this paper, which results in 8.99% output growth per annum and 3.24% total factor productivity growth per annum between 1971 and 1996.

Second, we will focus on the manufacturing industry. Kim and Park (1988) estimate 2.08% of total factor productivity during 1966~1983. Total factor productivity for the period of 1970~1990 estimated by Pyo, Kong, Kwon and Kim (1993) goes down to 1.07% per annum. Pyo, Kong, Kwon and Kim's studies made use of the value added from the *National Account* and capital stock from the *National Wealth Survey* along with labor statistics shown in the *Report on Mining and Manufacturing Survey.* It seems that they obtained lower total factor productivity estimates by using rapidly growing labor input and lower share of labor. On the contrary, Moon, Cho, Hwang and Kim's study in 1991 suggests 3.7% growth rate of total factor productivity in the manufacturing sector between 1971 and 1989. They use the *National Wealth Survey* and an *Input-Output Table* that is consistent with the *National Account.*

Lee's paper (1998) estimates an annual growth rate in total factor productivity to be 1.59% in the manufacturing industries based on the *Report on Mining and Manufacturing Survey.* His study depends on the *Report on Mining and Manufacturing Survey* for major statistical data, which makes it different from other studies. Young (1995) estimates growth of the total factor productivity to be 3.0% for the period of 1966~1990 in manufacturing. Young's research, however, does not use capita stock of *National Wealth Survey* consistent with the *National Accounts.* The growth of total factor productivity in this paper is 2.95%, similar to that of Young (1995) and Kwack (1997).

It is shown in the above studies that contribution of factor accumulation and productivity to output growth varies greatly according to whether they use value added approach or output approach. The output approach results in lower estimates than the value-added approach[13]. Kim and Park (1988) and Lee (1998) takes, for example, the amount of output rather than the value added for measuring output unlike Pyo, Kong, Kwon and Kim (1993).

Second, different time periods result in different estimates for contribution of total factor productivity and factor accumulation to growth. Taking Sarel's note (1997) into account that the growth rate estimates of total factor productivity are sensitive to the length of the time period, this paper applies a five-year demarcation.

Third, estimates are different according to the data applied. Statistical data suitable for productivity analysis can be obtained from the *Report on Mining and Manufacturing Survey* and *National Accounts.* They have their own pros and cons, but the application of that data makes a large difference in the importance of growth sources.

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[13] Norsworthy and Malmquist (1983) argues that the value-added approach for "output" moves the estimates upward by not taking intermediate input into account. But Yuhn (1991) refutes that

Even if these problems are taken into account, research findings so far generally show that growth of economy and manufacturing industries are due to quantitative growth of factors of production rather than due to productivity growth. Economic growth still heavily relies on capital input. The fact that banking system was very inefficient in allocating investment funds magnified the flaws in the Korean economy.

V. Summary and Conclusions

The change in total factor productivity is considered to be a major factor in determining economic growth with the growth of factors of production. There has not been much work on the analysis to determine which factors cause economic growth and which factors change total factor productivity, though this kind of work is very important.

This paper analyzes the change of total factor productivity in the Korean economy by the industrial sector. By the application of the Cobb-Douglas model for the period of 1971~1996, total factor productivity is estimated by sector in the entire economy and by industry within manufacturing, for which statistics consistent with the *National Accounts* are adopted as basic data.

First, economic growth in Korea is estimated to be about 8.99% per annum during 1971~1996. Growth of total factor productivity accounts for 3.24% of the

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they have no evidence for their argument.

growth and the rest is due to the growth of capital and labor input. Manufacturing grows annually by 12.82% during this period, of which 2.95% is due to the growth of total factor productivity and the rest due to the growth of input factors. Korean economic growth shows an input-factor driven pattern, achieved mainly by the quantitative growth of factors of production, especially capital input, rather than by improved productivity. It clearly supports the quantitative-growth hypothesis, like Krugman's argument, that the economic growth pattern in Korea still relies on factors of production.

Second, it is observed, from the changing pattern of total factor productivity in the past decade, that the efficiency in the entire economy has been declining. The change of total factor productivity remains minus in finance and insurance sector and shows a drastic drop in recent years.

Third, it turns out that the contribution of capital input is the largest among economic growth sources, but the Korean economy has been showing lower capital efficiency. Increase of capital input, if not accompanied by the increase of technology and knowledge, causes a drastic decline in efficiency. Remarks on Korean economic growth in the *McKinsey Report*(1998) is painful for us, but also gives many implications, viewed from this point. It states that "Koreans have pursued growth with their own bodies, that is, factor-input driven growth. But Korean economy cannot expect future prospects any more, relying on the past success story. Korea has continued economy growth, destroying their own values in the process."

Analysis of the sources of economic growth in the Korean economy offers the following implications. The financial sector, especially banking sector, plays an important role in terms of fund allocation and business governance structure and should not be neglected for productivity improvement. The Korean banking industry is accustomed to loose financial control and government-driven finance. Support for centralized investment of capital between 1970 and 1980 was enabled by this financial structure. That is, loose financial control contributed to capital accumulation but it did not lead to the improvement of productivity. A weak banking system led to a lax business governance system, which in turn lowered incentives for businesses to concentrate on productivity. The current financial crisis makes it clear that if Korea does not make any efforts to remarkably improve capital productivity by adopting advanced management techniques, it is vulnerable to another financial crisis in the future. It is advisable to make efforts to maximize efficiency in business and banking, such as introducing advanced management techniques and improving the business governance system.

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Comments welcome. This paper prepared for The Survey of Total Factor Productivity organized by Asia Productivity Organization. Byoungki Lee is the research fellow of industrial studies division at the Korea Economic Research Institute(KERI), FKI Building, Yoldo-dong 28-1, Yeongdungpo-ku, Seoul, 150-756, Korea, E-mail: lbk@keri.org, Tel: 82-2-3771-0031, Fax:82-2785-0273.